ISSN No. 2277-7628

Journal of Modern Science

Vol.7 - No.1 Price : ₹ 50/- May 2015

Tamil Nadu State Council for Higher Education

Chennai - 600 005

Annual Subscription : Individuals ₹ 90/-
Institutions ₹ 150/-

Half - Yearly

TAMIL NADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI-5

Vol. 7 May 2015

No. 1 Price : ₹ 50/-

ISSN 2277 - 7628

JOURNAL OF MODERN SCIENCE

A Half Yearly Journal of Higher Education published by Tamil Nadu State Council for Higher Education

ARTICLES

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A STUDY ON THE TIME KILLERS AND TIME DISPLACERS LEADING TO TIME WASTAGE AMONG PROFESSIONAL AND NON-PROFESSIONAL WORKING WOMEN

Sudha Rani.K * and Sushila Srivastava**

Abstract

Among all the human resources, time is one of the easiest to measure but one of the most difficult to understand. Many official and personal problems encountered by working women are directly associated with how these women allocate their time. Though most of the working women are aware of the vast potential and supreme importance of time, they tend to kill time thoughtlessly. As an individual's time is very precious, time killers and time displacers require special attention. Consequently, a comparative study was done among 200 professional and non-professional married, working women from various departments of the government and private sectors in Chennai, to find out the role of the time killers and the time displacers that lead to time wastage among them. It was observed that none of the time killers (lack of self-discipline, inconsistency, inefficiency, insecurity and poor goal setting) as well as the time displacers (personal, managerial and organizational), seemed to vary considerably among working women based on their Occupation (professional and non-professional) or Sector (Government and private). All the working women were similar in wasting their time due to various reasons. On considering the results of the effect of demographic variables on time killers, it revealed that the 'hours spent at work per day' seemed to considerably affect ($p<0.05$) the time killing aspect of the professional working women, whereas, it was found that 'number of children' and 'previous job experience' of the women seemed to have a significant effect ($p<0.05$) on the time displacing aspect among the non-professionals, but not the professionals. A direct relationship was found to be existing on dual role adjustment of both professional and non-professional women irrespective of their role as time killers or time displacers. The results also showed that only some of the time killers (inconsistency and lack of self discipline) were affected by the personality of an individual (Type A or Type B), and only the personal time displacers were affected by extremes of character (Organised or Flexible) of both the professional and non-professional working women.

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Keywords

Time killers, time displacers, working women, occupation, government sector, private sector.

Introduction

Time management seems to be the focus of the 90's and probably the new millennium as well. The real goal of time management is to organize one's day more effectively so that one can create more time for herself/himself (Jacqueline, 2001).Personal time management is at the root of effective management. It can help individuals become masters of their destiny and to achieve their goals and objectives. The concept of time varies from woman to woman. It is important that a homemaker achieves a balance between their work time, time to spend on maintaining herself and the discretionary or uncommitted time she has at her disposal (Fontana,1996). Time is largely a function of understanding sometimes, inter-related things such as personal time wasters, organizational time wasters and environmental time wasters and family time wasters. To manage time well, one needs to know the personal barriers that are managing her time, what her personal motivation is and how they relate to one's goals and objectives (Bhatia,1994).

Time wasters are the obstacles which prevent one from achieving the objectives in the most effective way possible. They are hurdles which pull one down. Time killers and time displacers are the time wasters that affect one's time. **Time killer** is an activity that robs one's time. They are internally generated and self-imposed, such as lack of self-discipline, inconsistency, inefficiency, insecurity and poor goal setting. **Time displacer** is an activity which may be relevant or irrelevant but is forced to perform. One cannot resist but do those activities, which are compelled by the individual's character or by the authorities or by the environment. While time displacers are universal, causes and solutions are personal, managerial and organizational (Reynolds,1994). One does not realize that the seeds of time wastage are embedded in his/her behavior. This realization helps one to analyse one's personality and habits.

Due to the dual career life of a working woman, her control of time is frequently affected by terms such as interruptions, procrastination, lack of delegation, uncertainty and inability to refuse. Time is a functional act and as more and more women are becoming aware of the importance of time, they are using innovative methods to cut down on time wastage. Working women in different occupations reflect a diversity that defies generalization. As one learns more about tips to manage their time, the less is the problem of work-life balance. Since occupational roles do differ from one another, the differences among professional and non-professional working women in respect to the variables selected also seem justifiable as the subject of exploration. Hence the present study was

taken up in an attempt to find out the role of time killers and time displacers leading to time wastage among married, working women.

Materials And Methods

Ex- post-facto research design was adopted to conduct the study. A group of 200 professional and non-professional working women from Chennai were selected by stratified random sampling method from various departments of the government and private sectors. The professionals who were 99 in total included doctors (25), engineers (13), lecturers (37), lawyers (12), chartered accountants (5), and computer personnel (7). The non-professionals who were 101 in total were employees from clerical, administrative, entrepreneurial, managerial and executive cadre. Data regarding the independent variables such as age of the respondent, educational qualification, number of children, type of family, size of family, type of occupation and work details such as working status, top priority of the individual, number of years of previous experience and number of hours spent at work per day were collected using a structured questionnaire.

To measure the time killed by the women, due to their lack of self discipline, inconsistency, inefficiency, insecurity and poor goal setting , 'Time Killer's Scale' (Reliability = 0.82), consisting of 26 items was administered.. To find out the time displaced by the women in their personal, managerial and organizational role, 'Time Displacement Inventory' (Reliability = 0.74) consisting of 37 items was administered. The other tools used for study of the dependent variables were Dual Role Adjustment Scale (Reliability = 0.72), Howard I Glazer's Type A Personality Test and a self-assessment Scale on Time Management Skills and Thinking Styles (Cooper, 1992). Cronbach's alpha used as an index of reliability for the tools was found to be highly significant. The content validity of the questionnaire was tested by their face validity, to check whether all the relevant statements pertaining to the topic had been adequately covered.

The data collected from the above tools was processed, to find out the difference between the working women in their time killing and time displacing aspects and to study the effect of the independent and dependent variables on these aspects of time wastage. Percentage analysis, mean and standard deviation was computed. ANOVA, Duncan's Multiple Range test and correlation co-efficient were the statistical tools used to analyse the collected data.

Results And Discussion

Time Killers

Time killers are self-generated. They are "internal" time wasters to a large extent, which are actions within one's control such as personality traits or work habits, that can affect the time

management practices of a working woman. Table 1 reveals the time killers of selected professional and non-professional women employed in private and Government sectors.

Table 1

Comparison of Time Killers between Working Women based on Occupation and Sector

Time killers	Category	Groups	N	Mean	SD	Std Error	't'
Lack of self discipline	Occupation	Professional	99	13.26	4.06	0.41	0.464
		Non-professional	101	13.53	4.23	0.42	
	Sector	Private	99	13.51	4.02	0.40	0.355
		Government	101	13.30	4.27	0.43	
Inefficiency	Occupation	Professional	99	15.46	4.61	0.46	0.632
		Non-professional	101	15.92	5.56	0.55	
	Sector	Private	99	15.66	4.97	0.50	0.105
		Government	101	15.73	5.25	0.52	
Inconsistency	Occupation	Professional	99	10.20	3.38	0.34	0.774
		Non-professional	101	9.84	3.21	0.32	
	Sector	Private	99	9.86	3.17	0.32	0.687
		Government	101	10.18	3.41	0.34	
Insecurity	Occupation	Professional	99	13.62	4.13	0.42	0.100
		Non-professional	101	13.55	4.59	0.46	
	Sector	Private	99	13.59	4.36	0.44	0.003
		Government	101	13.58	4.38	0.44	
Poor goal setting	Occupation	Professional	99	16.25	4.91	0.49	0.168
		Non-professional	101	16.13	5.53	0.55	
	Sector	Private	99	16.35	4.99	0.50	0.118
		Government	101	16.03	5.45	0.54	

Considering the mean scores of the time killers based on **Occupation** and **Sector (**Table 1**),** it is interesting to note that there was no significant difference between the professionals and non-professionals as well as between the women working in the government and private sectors on any of their time wasting activities. It can be inferred from the above table that all the working women were similar in the time killing aspect (lack of self discipline, inefficiency, inconsistency, insecurity and poor goal setting), irrespective of their Occupational status and Sector**.**

Willingly or unwillingly, wasting time is a common feature found among all working women. Time killing could occur due to personal traits such as prolonging time during coffee breaks, enjoying gossip, getting distracted by frequent interruptions such as telephone calls and visitors, not prioritizing tasks, inability to dispose visitors, procrastinating unduly, unable to refuse requests made by colleagues, superiors or family members, maintaining unnecessary records and working below one's capacity or due to psychological factors such as lack of concentration, stress, frustration and burnout (Bhatia,1994).

These results are supported by the research finding of Pace Productivity(2003), an American organization, which also stated the similar time killers as factors within one's control which got in the way of productivity. The research findings by Sahgal (1987), Allcock (1995), Helen (1998), Taraban et al (1999), Panella (2001), O'Brien (2002) and Lockwood (2004) also support the present findings that telephone, visitors, procrastinating, inability to refuse to requests, personal disorganization such as a cluttered desk, inconsistency and lack of self-discipline were some of the factors that could cause time killing.

Time Killers and Demographic Profile

The findings related to the effect of the **demographic variables** on the time killers revealed that none of them except '**hours spent at work per day'** showed significant difference ($p<0.05$) between professional and non-professional women. It is found that as the hours spent on the job increased, the scores of time killing was found to decrease among the professionals and thereby affected their time management. (With reference to the scoring pattern of the 'Time Killer's Scale', increase in mean scores indicates lesser time killed and therefore better management of time.)

Table 2

Correlation of Time Killers between Professional and Non-professional Working Women on Dual Role Adjustment

Variable	Dual role adjustment (`r' value)	
	Professional	Non-professional
Lack of self discipline	0.380**	0.473**
Inefficiency	0.235**	0.451**
Inconsistency	0.157	0.450**
Insecurity	0.372**	0.444**
Poor goal setting	0.373**	0.417**
Time killer (Total)	0.372**	0.515**

**Significant at 0.01 percent level

Table 2 reveals that a direct correlation existed between the dual role adjustment of the **Professional** working women and all the time killers (r=0.372; p<0.01), except inconsistency. In case of the **Non-professionals** (r=0.515; p <0.01), this dual role adjustment seemed to have a positive correlation with all the time killers**.** As the time killers are self-imposed (like moods, disorganized nature, etc.), the dual role adjustment of a working woman depends on how one is able to handle her time killers. Therefore, the time wasting of a woman is related to how one could manage herself.

Time Killers and Personality

Table 3

Comparison of Time Killers between Professional and Non-professional Working Women based on Personality

Time Killers	Occupation	Personality	N	Mean	SD	Std Error	't'
Lack of Self discipline	Professional	Type A	57	13.36	4.21	0.44	3.011**
		Type B	42	15.01	4.01	0.41	
	Non-professional	Type A	64	13.68	4.28	0.49	2.437*
		Type B	37	15.45	4.19	0.40	
Inefficiency	Professional	Type A	57	14.63	4.53	0.49	0.961
		Type B	42	14.29	4.72	0.38	
	Non-professional	Type A	64	14.76	5.58	0.61	0.439
		Type B	37	14.53	5.01	0.47	
Inconsistency	Professional	Type A	57	9.20	3.21	0.38	2.585**
		Type B	42	10.84	3.47	0.29	
	Non-professional	Type A	64	9.32	3.58	0.41	2.109*
		Type B	37	10.95	3.19	0.30	
Insecurity	Professional	Type A	57	13.38	4.20	0.36	0.538
		Type B	42	13.12	4.11	0.45	
	Non-professional	Type A	64	13.75	4.89	0.51	0.710
		Type B	37	13.08	4.43	0.43	
Poor Goal setting	Professional	Type A	57	16.49	5.03	0.55	0.819
		Type B	42	16.28	4.87	0.47	
	Non-professional	Type A	64	16.37	5.88	0.73	0.233
		Type B	37	16.13	5.67	0.49	

*Significant at 0.05 percent level **Significant at 0.01 percent level

On comparing the time killers among working women based on **personality (**Table 3), it is found that the scores of the professional and non-professional working women of the **Type A personality** were lower than those of the **Type B personality** regarding lack of self discipline and inconsistency. This indicated that the women of Type A personality seemed to be lacking in self discipline and consistency more than their Type B counterparts. The reason for such a finding may be that the women of Type A personality are over-ambitious, restless, hasty in carrying out their activities resulting in wastage of more amount of time. Since the women of Type B personality are more calm and unhurried in carrying out their tasks they are more consistent and self-disciplined.

The other time killers - inefficiency, insecurity and poor goal setting of selected women subjects were not significantly differing between Type A and Type B personalities of both the professionals and the non-professionals.

Time Killers and Character based on Thinking Styles and Time Management Skills

Table 4

Comparison of Time Killers between Professional and Non-professional Working Women based on Extremely Organized and Extremely Flexible Characters

Time Killers	Occupation	Character	N	Mean	SD	Std Error	't'
Lack of Self Discipline	Professional	Extremely Organised	39	14.53	4.35	0.42	2.901**
		Extremely Flexible	60	12.98	4.11	0.47	
	Non-professional	Extremely Organised	40	14.28	4.25	0.48	2.037*
		Extremely Flexible	61	12.68	4.72	0.40	
Inefficiency	Professional	Extremely Organised	39	14.36	4.57	0.44	0.125
		Extremely Flexible	60	14.14	4.39	0.35	
	Non-professional	Extremely Organised	40	14.79	5.62	0.59	0.470
		Extremely Flexible	61	14.24	5.19	0.42	
Inconsistency	Professional	Extremely Organised	39	10.98	3.71	0.21	2.831**
		Extremely Flexible	60	8.13	3.53	0.39	
	Non-professional	Extremely Organised	40	11.01	3.68	0.52	1.972*
		Extremely Flexible	61	10.16	3.88	0.29	
Insecurity	Professional	Extremely Organised	39	13.65	4.13	0.33	0.393
		Extremely Flexible	60	14.01	4.72	0.62	
	Non-professional	Extremely Organised	40	13.15	4.98	0.55	0.422
		Extremely Flexible	61	13.88	5.03	0.49	
Poor goal setting	Professional	Extremely Organised	39	16.87	5.16	0.61	0.935
		Extremely Flexible	60	16.95	4.32	0.54	
	Non-professional	Extremely Organised	40	16.22	6.01	0.82	1.027
		Extremely Flexible	61	16.73	5.79	0.70	

*Significant at 0.05 percent level **Significant at 0.01 percent level

The results of the self-assessment Scale based on Thinking Styles and Time Management Skills (Table 4) reveals that the professional and non-professional working women of the **extremely flexible nature** seem to have lower mean scores than those of the **extremely organised nature** regarding the time killers – lack of self discipline and inconsistency, which indicate that they are very poor in self discipline and consistency. (With reference to the scoring pattern, lesser the scores, greater the time killed and therefore poor management of time.) This could be due to the fact that their random and spontaneous nature tends to involve them in more than one task at a time, because of which they get stuck in trivial matters and hence are not able to maintain discipline and consistency.

The other time killers – inefficiency, insecurity and poor goal setting, did not seem to be differing significantly between professionals and non-professionals.

Time Displacers

Time displacers are the time wasters that occur by "internal" or "external" factors, which are the events or items over which one has very little control.

Table 5

Comparison of Time Displacers between Working Women based on Occupation and Sector

Time displacers	Category	Group	N	Mean	SD	Std Error	't'
Personal time displacers	Occupation	Professional	99	42.42	11.59	1.17	0.574
		Non-professional	101	41.41	13.46	1.34	
	Sector	Private	99	41.67	11.95	1.20	0.271
		Government	101	42.15	13.16	1.31	
Managerial time displacers	Occupation	Professional	99	27.03	8.09	0.81	0.187
		Non-professional	101	26.80	9.17	0.91	
	Sector	Private	99	26.58	8.85	0.89	0.549
		Government	101	27.25	8.44	0.84	
Organizational time displacers	Occupation	Professional	99	29.21	9.88	0.99	0.206
		Non-professional	101	29.49	8.82	0.88	
	Sector	Private	99	29.24	8.94	0.90	0.161
		Government	101	29.46	9.76	0.97	

Table 5 reveals that time displacement of working women seems to be an unanimous aspect, which does not have significant difference based on **Occupation** and **Sector.** The time displaced

could be due to personal reasons, managerial or organizational. According to Bhatia (1994)(, some of the common **personal** causes of time displacement may be that women misplace things and keep on searching for them, trying to be perfect in everything, changing one's mind frequently while carrying out the plan, excess tensions and impatience. Partin(1982) has stated that perfectionism in all efforts is a neurotic dream and impossibility, setting up the dreamer for certain failure.

Managerial causes of time displacement may be that working women plan more tasks each day than can be accomplished, have a very poor filing system, are interrupted by unexpected arrival of visitors, are diffident to delegate work, are not prioritizing jobs, and are unable to tackle subordinates efficiently. Bliss(1976), had mentioned with esteem as to delegate work only to the right person and not to dump on anybody.

Certain **organizational** factors which can lead to time displacement can be that a working woman is not rewarded by the family or profession when necessary, incompetent subordinate, lack of proper labour saving devices, distractions from media, poor communication system, inconsistent and conflicting authorities (boss or spouse), and frequent altering of goals when values keep changing at family or office. According to Lakein(1973), the expectation of some managers for subordinates to perform well in all situations does not support good time management. Similarly, Bliss(1978), argues that "perfection" sets in when one thinks of terms of the task instead of the time available for it, which thereby causes undue waste of time.

Time Displacers and Demographic Profile

The results of the effect of the **demographic variables** on the time displacers indicated that the effect of '**number of children'** on the time displacement among the non-professionals seemed to be affected and not the professionals. It can be inferred that the non- professionals with no children wasted less hours and thereby could manage time better, than those with children, who wasted time on less prioritised jobs due to overprotection or care shown to the child or spent on the television / CD viewing along with children apart from the actual family or office job. The effect of '**previous experience'** on the time displacement of women revealed that the non-professionals with more experience seemed to be affected and not the professionals. This may be due to the fact that, as one becomes a senior, disturbance and unnecessary interruptions from external forces lead to greater displacement of time than the women having lesser experience.

Table 6

Correlation of Time Displacers between Professional and Non-professional Working Women on Dual Role Adjustment

Variable	Dual role adjustment (`r' value)	
	Professional	Non-professional
Personal time displacers	0.360**	0.608**
Manangerial time displacers	0.267**	0.501**
Organisational time displacers	0.292**	0.494**
Time Displacer (Total)	0.342**	0.598**

**Significant at 0.01 percent level

A direct relationship is found to exist between the dual role adjustment and all the **time displacers** among both the P**rofessional** (r=0.342; p<0.01) and **Non-professional** (r=0.598; p>0.01) working women (Table 6). Unlike the personal time displacers (like cluttered desk, not prompt in completing tasks, etc.), the managerial and organizational time displacers (like non co-operative staff, breakdown of equipments, inadequate resources) are not in one's control. But yet, the way in which one tackles the problem and makes up for the time lapse, decides her dual role adjustment.

Time Displacers and Personality

Table 7

Comparison of Time Displacers between Professional and Non-professional Working Women based on Personality

Time Displacers	Occupation	Personality	N	Mean	SD	Std Error	't'
Personal Time Displacers	Professional	Type A	57	45.70	11.13	1.19	0.564
		Type B	42	46.08	12.56	1.05	
	Non-professional	Type A	64	46.27	13.21	1.29	0.613
		Type B	37	46.67	14.07	1.38	
Managerial Time Displacers	Professional	Type A	57	28.94	9.59	0.92	0.386
		Type B	42	29.67	7.98	0.78	
	Non-professional	Type A	64	29.99	11.13	1.03	0.215
		Type B	37	30.14	8.99	0.84	
Organisational Time Displacers	Professional	Type A	57	34.93	10.35	1.10	0.144
		Type B	42	35.42	9.22	0.87	
	Non-professional	Type A	64	35.62	7.66	0.79	0.287
		Type B	37	34.69	9.18	0.96	

The results indicate that the personal, managerial and organizational time displacers were not affected by the type of **personality** among both the professional and non-professional working women (Table 7). Since most of the time displacement occurs due to environmental factors such as unexpected visitors, frequent telephone calls and interruptions by fellow workers, which are out of control of the individual, personality has no role to play on time wasting aspects of either professionals or non-professionals.

Time Displacers and Character based on Thinking Styles and Time Management Skills

Table 8

Comparison of Time Displacers between Professional and Non-professional Working Women based on their Extremely Organized and Extremely Flexible Character

Time Displacers	Occupation	Character	N	Mean	SD	Std Error	't'
Personal Time Displacers	Professional	Extremely Organised	39	43.69	11.70	1.62	2.412*
		Extremely Flexible	60	42.05	12.12	1.43	
	Non-professional	Extremely Organised	40	44.72	11.65	1.55	2.128*
		Extremely Flexible	61	43.09	13.59	1.89	
Managerial Time Displacers	Professional	Extremely Organised	39	28.57	9.28	0.25	0.233
		Extremely Flexible	60	28.02	7.83	0.68	
	Non-professional	Extremely Organised	40	29.95	10.22	0.91	0.517
		Extremely Flexible	61	30.12	9.01	0.79	
Organisational Time Displacers	Professional	Extremely Organised	39	34.46	11.25	0.80	0.653
		Extremely Flexible	60	33.89	10.30	1.02	
	Non-professional	Extremely Organised	40	33.50	7.29	0.75	0.922
		Extremely Flexible	61	33.29	8.66	0.88	

**Significant at 0.01 percent level

It had been found (Table 8) that the time displacement due to personal reasons differs significantly on the extremely flexible and extremely organised characters, between the professional and the non-professional working women, whereas, the managerial and organizational time displacement did not show any significant difference between the two groups, be it professional or non-professional. (With reference to the scoring pattern of the 'Time Displacer's Inventory', greater the scores, lesser is the time displaced and therefore better management of time.)

Being personal, due to their systematic and organized pattern of working, the women of the extremely organized nature did not seem to unduly waste their time by misplacing things, worrying unnecessarily or being affected by psychological factors (moods, absence of motivation, low self-esteem), in comparison to the extremely flexible natured. But the causes of the other two time displacements are external factors that are not within one's control, and hence did not show significant difference in the scores between both groups of women.

Conclusion

One contaminates time when one is not able to stay focused in the moment, or when one is trying to do a task, but thinking about another. If an individual's time is contaminated, she does not get the full benefit of either work (peak productivity) or play (total relaxation). The purpose of this article calls for an intensive identification of time wasters because nothing is a waste of time if people use their knowledge wisely. Efficient utilization of time is highly essential for achieving the objectives of a task competently and quickly. Accomplishing this mission involves a positive effort on the part of an individual at the expense of productive activities in terms of time. Time, the coin is in the hands of the individual who can only determine how it can be spent. Hence, one must use time as a tool, and not as a crutch.

Note: **Type A:** Characterized by competitiveness, aggressiveness, time urgency and feeling of struggle against limitation of time.

Type B: Characterized by not caught in a constant struggle to be on time, feels ambitious, confident, secure and is more relaxed.

Convergent Thinker: Well organized, systematic and perfect in every act.

Divergent Thinker : Clumsy, disorganized, cluttered and very flexible in every act.

References

1. Allcock, D. (1995). *Time and Work Load Management*. Canada, Industrial Society, Robert Hyde House.
2. Bhatia, R. L. (1994). *Managing Time (For a competitive edge*). (1st edition). New Delhi: Wheeler publishers.
3. Bliss, A., & Edwin, C. (1976, 1978). *Getting things done. The ABC's of Time Management*. A Survey of Teachers regarding skills involved in Time Management.
4. Cooper, A. Mc. (1992). *Time management for Unmanageable people.* Canada: Dallas Publishers.
5. Fontana, D. (1996). *Managing Time*. New Delhi: British Psychological society.
6. Helen, V. (1998). Organising time. *Journal of Occupational and Organisational Psychology*, 4(5), 63-75.
7. Jacqueline, M.C. (2001). *Improving your Time Management Skills: Directory of Great Deals*. Canada: Goodwill Publishers.

8. Lakein, A. (1973). *How to get control of your time and your life*. In Chauhan, Neelam Singh (2001). A Study Of Role Perception, Expectation, Performance and Marital Adjustment of Working and Non Working Women of Different Income groups, Ph.D. dissertation, Department of Home science, University of Nagpur.
9. Lockwood, G. (2004). *Practice of time management*. Retrieved from www.ideasmerchant.com
10. O'Brien, K. (2002). *Stress and its management.* Retrieved from http://www.yorku.ca/cdc/lsp/tmonline/tm6.htm2004
11. Pace Productivity. (2003). Toronto, New Orleans Publishers.
12. Panella, V. (2001). Managing the time resourcefully. *Journal of Occupational and organizational Psychology,* 52(10), 46-54.
13. Partin, R. L. (1982). *Time Management American Secondary Education*.In Atkins,T.T (1990). Time Management Techniques And Sources of Stress in high school Principals. Ph.D.dissertation, Memphis State University, Athens.
14. Reynolds, H., & Mary, E. T. (1994). *Executive Time Management.* England: Gower Publishing Co. Ltd.
15. Sahgal, P., & Madan T. (1987). *Time management for executives.* New Delhi: Madras Publications.
16. Taraban et.al. (1999). Retrieved from http://www.yorku.ca/cdc/lsp/tmonline/tm6.htm2004.

A NOTE ON RADIAL GRAPHS

Selvam Avadayappan and M. Bhuvaneshwari

Abstract

Let G(V, E) be any graph. The Radial graph R(G) of a graph G has the vertex set V and two vertices u and v in R(G) are adjacent if and only if either G is connected and d(u,v) = r(G) or u and v are in different components of G, where d(u,v) is the distance between u and v in G and r(G) is the radius of G. A vertex v is defined to be a boundary vertex of a vertex u if d(u,w) d≤ d(u,v) for all w ∈ N(v). The b – eccentricity of a vertex u is the distance of a shortest boundary vertex from u. In this paper, we establish some results on radial graphs and b – eccentricity of a vertex.

Keywords: *radius of a graph, radial graph, b – radius, b – eccentricity.*

AMS Subject Classification Code (2000): 05C (Primary).

1 Introduction

The graphs considered in this paper are finite, simple and undirected. For notations and terminology, we follow [4]. Let n denote the number of vertices in a graph G. The *distance* d(u,v) [5], between any two vertices u and v is the length of a shortest path between them. The *eccentricity* e(u) of a vertex u is the distance of a farthest vertex from u. The *radius* r(G) of G is the minimum eccentricity and the *diameter* d(G) of G is the maximum eccentricity of the graph G. A graph G for which r(G) = d(G) is called a *self – centered graph* of radius r(G). A vertex v is called an *eccentric vertex* of a vertex u if d(u,v) = e(u).

A vertex v is said to be a *full vertex* if degree of v is n – 1. A *1 – factor* of G is a 1 – regular spanning subgraph of G and it is denoted by F. For any two distinct vertices u and v in G, u is said to be *pairable* with v if N[u] = N[v] in G. A vertex is called a *pairable vertex* if it is pairable with a vertex in G. Any connected graph with at least 3 vertices is said to be a *neighbouhood highly irregular graph* (or simply NHI)[13], if and only if it does not contain a pairable vertex. For example, any cycle of order at least four is NHI.

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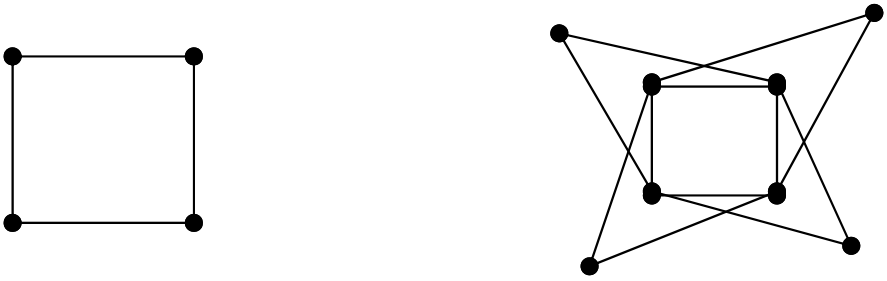
A subset S of V is called a *dominating set* of G if every vertex in V – S is adjacent to at least one vertex in S. The *domination number* r(G) is the minimum cardinality taken over all dominating sets in G. A dominating set S of a connected graph G is said to be a *connected dominating set* of G if the subgraph induced by S is connected. The minimum cardinality taken over all such connected dominating sets is the *connected domination number* and is denoted by $\gamma_c(G)$. The chromatic number of G is denoted by χ (G) and the cartesian product of G_1 and G_2 is denoted by $G_1 \times G_2$.

The concept of splitting graph was introduced by Sampath Kumar and Walikar[12]. The graph S(G) obtained from G, by taking a new vertex v' for every vertex $v \in V$ and joining v' to all vertices of G adjacent to v, is called a s*plitting graph* of G. For example, a graph G and its splitting graph S(G) are shown in Figure 1.



G **S(G)**

Figure 1

The concept of eccentric graphs was introduced in [1] and studied in detail by Chartrand et al., in [6]. The *eccentric graph* G_e of a graph G is a graph with vertex set V(G) and any two vertices in G_e are adjacent if and only if $d(u,v) = \min\{e(u), e(v)\}$.

The antipodal graphs were introduced and further developed by R.Aravamuthan and B. Rajendran in [2] and [3]. The *antipodal graph* of a graph G denoted by A(G), is the graph on the same vertices of G and two vertices in A(G) are adjacent if the distance between them is equal to the diameter of G. A graph is said to be antipodal if it is the antipodal graph of some graph H.

Inspired by these two concepts, KM Kathiresan and Marimuthu [11] have introduced a new type of graphs called radial graphs. Two vertices of a graph G are said to be *radial* to each other if the distance between them is equal to the radius of the graph. The *Radial graph* R(G) of a graph G, is a graph with vertex set V(G) and two vertices in R(G) are adjacent if and only if they are radial in G.

And if G is disconnected, then two vertices in R(G) are adjacent if they belong to different components of G. A graph G is called a *radial graph* if R(H) = G, for some graph H.

The necessary and sufficient condition for a graph to be a radial graph has been obtained in [10]. Also the following results have been discussed in [10] and [11].

Result 1 For any graph G with r(G) ≠ 1, $R(G) \subseteq \overline{G}$.

Result 2 R(G) = G if and only if G has a full vertex.

Result 3 R(G) = $\overline{G}$ if and only if $\overline{G}$ is self centered of radius 2 or G is disconnected in which each component is complete.

Result 4 A graph G is a radial graph if and only if G is a radial graph of itself or the radial graph of its complement.

A vertex v is defined to be a *boundary vertex* of a vertex u if $d(u,w) \leq d(u,v)$ for all $w \in N(v)$. For example in the graph G shown in Figure 2, v is a boundary vertex of u. For further details on boundary vertices one can refer [7] and [8].

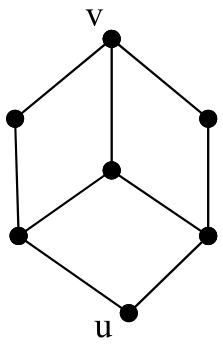


Figure 2

For a connected graph G, the *b – eccentricity* $e_b(u)$ of a vertex u is defined by $e_b(u)$ = min {d(u,w) / w is a boundary vertex of u}. The minimum b – eccentricity is called the *b – radius* $r_b(G)$ and the maximum b – eccentricity is the *b – diameter* $d_b(G)$ of a graph G. A graph G is called a *b – self centered graph* if $d_b(G) = r_b(G)$. The b – eccentricity concept was introduced and studied in detail by KM Kathiresan and Marimuthu [9].

In this paper, we provide some more results on radial graphs. In addition, we give another characterisation for a graph to be radial. Also we prove that any graph is an induced subgraph of a b – self centered graph of b – radius 1.

2 Main Results

P_{2n} and C_{2n} are the graphs with maximum degree two such that $R(P_{2n}) \cong R(C_{2n}) \cong nK_2$. The following theorem proves the existence of an r – regular graph G with $R(G) \cong (r+1)K_2$.

Theorem 1 For any $r \geq 3$, there exists an r – regular, self centered radial graph G with radius 3 such that $R(G) \cong (r+1)K_2$.

Proof Consider the graph $G = K_{r+1,r+1} - F$ with vertex set $V(G) = \{u_1, u_2, ..., u_{r+1}, v_1, v_2, ..., v_{r+1}\}$ and $E(F) = \{u_iv_i / 1 \leq i \leq r+1\}$. It is clear that G is r – regular. Moreover from the construction, it is easy to note that v_j is the farthest vertex from u_j for $1 \leq j \leq r + 1$. Each vertex in G is of eccentricity 3 and hence it is a self centered graph of radius 3.

Since G has no full vertex, if G is radial, then by Result 4, G is isomorphic to the radial graph of its complement. But $\overline{G}$ is nothing but $(r+1)K_2$. Clearly $\overline{G}$ is self centered with radius 2. Hence by Result 3, $R(\overline{G}) \cong G$. Therefore G is radial. In addition each vertex in G has a unique vertex at a distance 3 from it and therefore $R(G) \cong (r+1)K_2$.

For example, a 3 – regular self centered radial graph is shown in Figure 3.

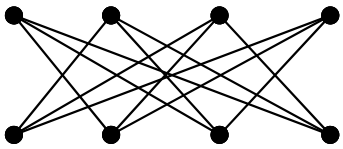


Figure 3

The graph constructed above is not the only graph with all these properties. For example, for any even $r \geq 4$, the graph G constructed below can be easily verified to have the same properties. $V(G) = \{u, u_1, u_2, \ldots, u_r, v_1, v_2, \ldots, v_r, v\}$ and $E(G) = \{uu_i / 1 \leq i \leq r\} \cup \{vv_j / 1 \leq j \leq r\} \cup \{u_iu_j / 1 \leq i, j \leq r; j = (r/2) + i\} \cup \{v_iv_j / 1 \leq i, j \leq r; j\ (r/2) + i\}$.

For example, the case when r = 6 is illustrated in Figure 4.

The following theorem gives a characterisation for a graph to be radial.

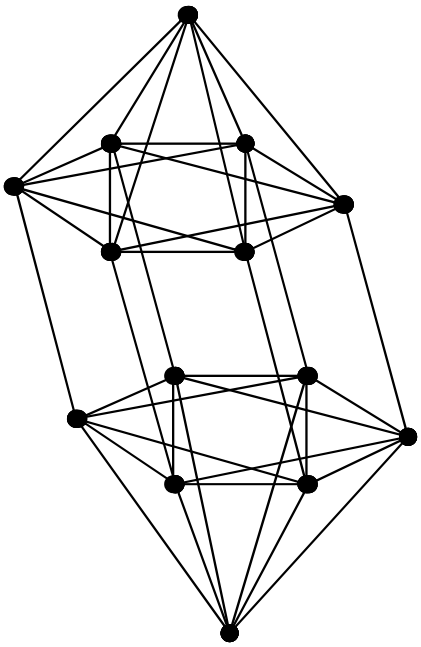


Figure 4

Theorem 2 A graph $G \neq K_{m,n}$ is radial if and only if $\gamma_c(G) \neq 2$.

Proof Let G be any radial graph. Then by Result 4, $G \cong R(G)$ or $G \cong R(\overline{G})$. Suppose $\gamma_c(G) = 2$. Then G does not contain a full vertex and therefore by Result 1, G is not isomorphic to R(G). Thus $G \cong R(\overline{G})$.

Now $\gamma_c(G) = 2$ implies that there exist two adjacent vertices u and v in G such that $N(u) \cup N(v) = V(G)$. Therefore u and v are adjacent in G and so they are not adjacent in $\overline{G}$. Also $N(u)^c \cap N(v)^c = \phi$ in G. This means that $d(u,v) > 2$ in $\overline{G}$ Hence we conclude that $\overline{G}$is not a self centered graph with radius 2.

And since $G \cong K_{m,n}$, $\overline{G}$ is not a disjoint union of complete graphs. Hence by Result 2, $G \neq R(\overline{G})$, which is a contradiction. Thus $\gamma_c(G) \neq 2$.

Conversely, let G be any graph with $\gamma_c(G) \neq 2$. Then $\gamma_c(G) = 1$ or $\gamma_c(G) > 2$.

If $\gamma_c(G) = 1$, then G has a full vertex and by Result 1, G is isomorphic to R(G). If $\gamma_c(G) > 2$, then G does not contain two adjacent vertices u and v such that $N(u) \cup N(v) = V(G)$. That is, such that $N(u)^c \cap N(v)^c = \phi$ in G. In other words, every two adjacent vertices in G have a common neighbour in $\overline{G}$. Then diameter of $\overline{G}$is 2. Also its radius is not equal to 1.

Therefore $\overline{G}$ is a self centered graph with radius 2. By Result 4, $G \cong R(\overline{G})$. This proves the converse part.

Corollary 3 $G \cong R(G)$ if and only if G has a full vertex or G is self complementary with $\gamma_c(G) \neq 2$.

Next we establish a necessary and sufficient condition for a vertex to have b – eccentricity equal to one.

Theorem 4 The b – eccentricity of a vertex v in a graph G is one if and only if there exists a neighbour u of v such that $N[u] \subseteq N[v]$.

Proof Let v be any vertex in a graph G with $e_b(v) = 1$. Then there exists a vertex $u \in N(v)$ such that u is a boundary vertex of v. Then $d(v, w) \leq d(u, v) = 1$ for all $w \in N(u)$. This forces that $d(v,w) = 1$ for all $w \in N(u)$. That is, every neighbour of u is adjacent to v. Then $N[u] \subseteq N[v]$.

Conversely, suppose that there exists a vertex $u \in N(v)$ such that $N[u] \subseteq N[v]$. Then clearly u and v are adjacent and u is a boundary vertex of v at a distance 1. Hence $e_b(v) = 1$.

Recall that two vertices u and v are pairable if $N[u] = N[v]$. Then by Theorem 4, the pairable vertices are boundary vertices of each other and hence they are of b – eccentricity one. Hence we can state that,

Corollary 5 The b – eccentricity of any pairable vertices is one.

Corollary 6 For a graph G with $\delta(G) > 1$, if $r_b(G) = 1$, then $\chi(G) \geq 3$.

Proof Let G be a graph with no pendant vertices. If $r_b(G) = 1$, then there exists a non pendant vertex v in G with a boundary vertex u as its neighbour. Then by Theorem 4, $N[u] \subseteq N[v]$. Therefore u and v along with its neighbours form at least one triangle in G and so G is not bipartite. Hence $\chi(G) \geq 3$.

Corollary 7 If for any graph G, $r_b(G) \neq 1$, then G is NHI.

Proof Let G be any graph for which $r_b(G) = 1$. Then G contains no vertex with its boundary vertex as its neighbour. Therefore G does not contain pairable vertices. Hence G is NHI.

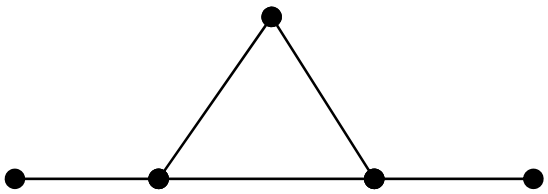


Figure 5

The converse of the above statement need not be true. For example the graph shown in Figure 5 is NHI with $r_b(G) = 1$.

It is impossible to find a self centered graph with radius 1 in which any given graph is an induced subgraph. The following theorem proves the existence of such b – self centered graph with b – radius one.

Theorem 8 Any graph G is an induced subgraph of b – self centered graph with b – radius one.

Proof Let G be any graph with $V(G) = \{u_1, u_2, ..., u_n\}$. Construct H with $V(H) = \{ u_1, u_2, ..., u_n, v_1, v_2, ... , v_n\}$ and edge set, $E(H) = \{u_iu_j / u_iu_j \in E(G), 1 \leq i, j \leq n\} \cup \{v_iv_j / u_iu_j \in E(G), 1 \leq i, j \leq n\} \cup \{ u_iv_j / u_iu_j \in E(G), 1 \leq i, j \leq n\} \cup \{u_iv_i , 1 \leq i \leq n\}$.

From the construction, it is clear that $N[u_i] = N[v_i]$, for all $1 \leq i \leq n$ and hence u_i and v_i are boundary vertices of each other at a distance 1. Hence H is a b – self centered graph with b – radius one, which contains G as an induced subgraph.

Note that the graph H constructed above is the edge disjoint union of G x G and S(G). For example, the b – self centered graph of b – radius one, which contains P_4 as an induced subgraph is shown in Figure 6.

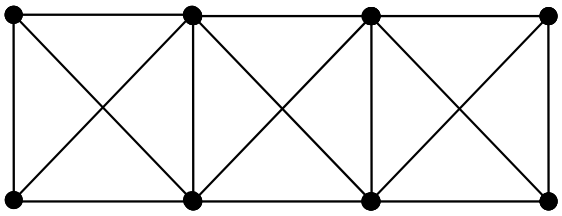


Figure 6

References

1. J. Akiyama, K. Ando and D. Avis, *Eccentric graphs*, Discrete Math. 16 (1976) 187-195.
2. R.Aravamuthan and B.Rajendran, *Graph equations involving antipodal graphs*, Presented at the seminar on Combinatorics and applications held at ISI (Culcutta during 14-17 December 1982) 40-43.
3. R.Aravamuthan and B.Rajendran, *On antipodal graphs*, Discrete Math.49 (1984) 193-195.
4. R.Balakrishnan and K.Ranganathan, A Text Book of graph Theory, Springer-Verlag, New York, Inc (1999).
5. F. Buckley and F. Harary, Distance in Graphs, Addison-Wesley Reading, 1990.
6. G. Chartrand, W. Gu, M. Schultz and S.J. Winters, *Eccentric graphs*, Networks 34 (1999) 115-121.
7. G. Chartrand, David Erwin, G. L. Johns and P. Zhang, *On boundary vertices in graphs*, J. Combin. Math. Combin.Comput., 48 (2004), 39-53.
8. G. Chartrand, David Erwin, G. L. Johns and P. Zhang, *Boundary vertices in graphs*, Disc. Math., 263 (2003), 25-34.

9. KM. Kathiresan and G. Marimuthu, *On b -eccentricity in graphs*, J. Combin. Math. Combin. Comput., 69 (2009), 89-94.
10. KM. Kathiresan and G. Marimuthu, *Further results on radial graphs*, Discussions Mathematicae, Graph Theory 30 (2010) 75-83.
11. KM. Kathiresan and G. Marimuthu, *A study on radial graphs*, Ars Combin. (to appear).
12. Sampath Kumar.E, Walikar.H.B, *On the Splitting graph of a graph,*(1980), J.Karnatak Uni. Sci 25: 13.
13. V.Swaminathan and A.Subramanian, *Neighbourhood highly irregular graphs,* International Journal of Management and Systems, 8(2): 227-231, May-August 2002.

INTUITIONISTIC FUZZY NEAR-RINGS BY INTUITIONISTIC FUZZY GRAPHS

[1]Kalaiyarasi and [2]N.Meenakumari

Abstract

In this paper we show how to associate an intuitionistic fuzzy near- ring and sub near-ring with an intuitionistic fuzzy graphs in a Natural way.

Introduction

The notion of intuitionistic fuzzy graphs was introduced by Young bae Jun [3].The theory of fuzzy sets proposed by Zadeh [4]. He has achieved a great success in various fields. Out of several higher order fuzzy sets, intuitionistic fuzzy sets introduced by Atanassov [1] have been found to be highly useful to deal with vagueness.

Graph has numerous applications to problems in system analysis, operation research, transportation and economics. However, in many cases, some aspects of a graph theoretic problem may be uncertainty using fuzzy set theory. Young bae Jun introduced the notion of intuitionistic fuzzy graphs. He showed how to associate an intuitionistic fuzzy sub semi-group with an intuitionistic fuzzy graph in a natural way.

In this paper, we show how to associate an intuitionistic fuzzy near-rings and sub near-ring with an intuitionistic fuzzy graphs.

2.Preliminaries

Definition 2.1

An intuitionistic fuzzy graph with under lying set V is defined to be an ordered pair (α, β) where $\alpha = (\mu_\alpha, \gamma_\alpha)$ is an IFS in V and $\beta = (\mu_\beta, \gamma_\beta)$ is an IFS in L such that $\mu_\beta(\{u, v\}) \leq \min\{\mu_\alpha(u), \mu_\alpha(v)\}$ and $\gamma_\alpha(\{u, v\}) \geq ma\,x\{\gamma_\propto(u),\ \gamma_\propto(v)\}\ \ \forall\, u,\ v \in V$.

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Definition 2.2

Let (α, β) be an intuitionistic fuzzy graph with the underlying set V. A one–to–one and onto map $\emptyset : V \rightarrow V$ is called an intuitionistic automorphisom of (α, β) if it satisfies : for all $x, y \in V$, we have $(i)\mu_\beta(\{\emptyset(x), \emptyset(y)\}) = \mu_\beta(\{x, y\})$ $(ii)\gamma_\beta(\{\varphi(x), \varphi(y)\}) = \gamma_\beta(\{x, y\})$

(iii) $\mu_\alpha(\emptyset(x)) = \mu_\alpha(x)$, $(iv)\ \gamma_\alpha(\emptyset(x)) = \gamma_\alpha(x)$ Given an intuitionistic fuzzy graph (α, β) with the underlying set V, $\mathfrak{A}(\alpha, \beta)$ denote the set of all intuitionistic automorphisms of (α, β)

Definition 2.3

An IFS $\propto = (\mu_\propto, \gamma_\propto)$ in a near-ring N is called an Intuitionistc fuzzy group (IFG) if for all $x, y\ z \in G$

(i) $\mu_\propto(x - y) \geq \min\{\mu_\propto(x), \mu_\propto(y)\}$

(ii) $\mu_\propto(x) = u_\propto(x^{\dashv})$

(iii) $\mu_\propto(x) \geq \mu_\propto(x)$

(iv)$\mu_\propto[(x + y) + z] = \mu_\propto[x + (y + z)]$

(v) $\gamma_\propto(x - y) \geq \min\{\gamma_\propto(x), \gamma_\propto(y)\}$

(vi) $\gamma_\propto(x) = \gamma_\propto(x^{\dashv})$

(vii) $\gamma_\propto(x) \geq \gamma_\propto(x)$

(viii) $\gamma_\propto[(x + y) + z] = \gamma_\propto[x + (y + z)]$

Definition 2.4

An IFS $\propto = (\mu_\propto, \gamma_\propto)$ in a near-ring N is called an Intuitionistic fuzzy semi group (IFSG) if (i) $\mu_\propto[(xy)z] = \mu_\propto[x(yz)]$

(ii) $\gamma_\propto[(xy)z] = \gamma_{\propto[x(yz)]}$

Definition 2.5

An IFS $\alpha = (\mu_\alpha, \gamma_\alpha)$ in a near-ring N is called an Intuitionistic fuzzy near-ring if

(i) $\alpha = (\mu_\alpha, \gamma_{\alpha)}$is an IFG

(ii) $\alpha = (\mu_\alpha, \gamma_{\alpha)}$is an IFSG

(iii) $\mu_\alpha[(x+y)z] = \mu_\alpha[xz+yz]$

(iv) $\gamma_\alpha[(x+y)z] = \gamma_\alpha[xz+yz]$ for all $x, y, z \in N$

3 . INTUITIONISTIC FUZZY NEAR-RINGS

Theorem 3.1 Let (α, β) be an intuitionistic fuzzy graph with the underlying set V. Then $(\mathfrak{A}(\alpha, \beta), \bullet)$ is a group.

Theorem 3.2 Let (α, β)be an Intuitionistic fuzzy graph with the underlying set V.

Then $(\mathfrak{A}(\alpha, \beta), \bullet)$ is a semi group.

Theorem 3.3 Let (α, β) be an IFG with underlying set V Then $(\mathfrak{A}(\alpha, \beta), +, \bullet)$ is a near-ring.

Proof:

By theorem 3.1, $(\mathfrak{A}(\alpha, \beta), +)$ is a group.

By theorem 3.2, $(\mathfrak{A}(\alpha, \beta), \bullet)$ is a semi group.

We prove the distributive law

Consider for any $\emptyset, \psi, h \in \mathfrak{A}(\alpha, \beta)$

$\mu_\beta[\{(\emptyset + \psi) o \hbar](x), [(\emptyset + \psi) o \hbar](y)\}]$

$= \mu_\beta\{[(\emptyset + \psi)\hbar(x)], [(\emptyset + \psi)\hbar(y)]\} / \ x, y \in V]$

$= \mu_\beta\{[(\emptyset + \psi)\hbar(x)], [(\emptyset + \psi)\hbar(y)] / x, y \in V\}$

$= \mu_\beta\{[\emptyset(\hbar(x)) + \psi(\hbar(x))], [\emptyset(\hbar(y)) + \psi(\hbar(y))] / x, y \in V\}$

$= \mu_\beta\{[(\emptyset o\hbar)(x) + (\psi o\hbar)(x)], [(\emptyset o\hbar)(y) + (\psi o\hbar)(y)] / x, y \in V\}$

$= \mu_\beta\{[\emptyset o\hbar + \psi o\hbar](x), [\emptyset o\hbar + \psi o\hbar](y) / x, y \in V\}$

$= \mu_\beta[\emptyset o\hbar + \psi o\hbar]$

$\therefore \mu_\beta[(\emptyset + \psi)o\hbar] = \mu_\beta[\emptyset o\hbar + \psi o\hbar]$

Also for any $\emptyset, \psi, h \in \mathfrak{A}(\alpha, \beta)$

$\gamma_\beta[\{(\emptyset + \psi)o\hbar](x), [(\emptyset + \psi)o\hbar](y)\}]$

$= \gamma_\beta\{[(\emptyset + \psi)\hbar(x)], [(\emptyset + \psi)\hbar(y)]\} / x, y \in V]$

$= \gamma_\beta\{[(\emptyset + \psi)\hbar(x)], [(\emptyset + \psi)\hbar(y)] / x, y \in V\}$

$= \gamma_\beta\{[\emptyset(\hbar(x)) + \psi(\hbar(x))], [\emptyset(\hbar(y)) + \psi(\hbar(y))] / x, y \in V\}$

$= \gamma_\beta\{[(\emptyset o\hbar)(x) + (\psi o\hbar)(x)], [(\emptyset o\hbar)(y) + (\psi o\hbar)(y)] / x, y \in V\}$

$= \gamma_\beta\{[\emptyset o\hbar + \psi o\hbar](x), [\emptyset o\hbar + \psi o\hbar](y) / x, y \in V\}$

$= \gamma_\beta[\emptyset o\hbar + \psi o\hbar]$

$\therefore \gamma_\beta[(\emptyset + \psi)o\hbar] = \gamma_\beta[\emptyset o\hbar + \psi o\hbar]$

Also $\mu_\alpha[(\emptyset + \psi)o\hbar(x)] = \mu_\alpha[(\emptyset + \psi)\hbar(x)]$

$= \mu_\alpha[\emptyset(\hbar(x))] + \mu_\alpha[\psi(\hbar(x))]$

$= \mu_\alpha[\hbar(x)] + \mu_\alpha[\hbar(x)]$

$= \mu_\alpha[x] + \mu_\alpha[x]$

$=2\mu_\alpha[x]$…….(A)

Also $\mu_\alpha[(\emptyset o\hbar)(x) + (\psi o\hbar)(x)]=\mu_\alpha\left[\emptyset\left(\hbar(x)\right) + \psi\left(\hbar(x)\right)\right]$

$=\mu_\alpha[\emptyset\left(\hbar(x)\right)] + \mu_\alpha[\psi\left(\hbar(x)\right)]$

$=\mu_\alpha[\hbar(x)] + \mu_\alpha[\hbar(x)]$

$=\mu_\alpha[x] + \mu_\alpha[x]$

$=2\mu_\alpha[x]$……..(B)

From (A) and (B)

$\therefore(\emptyset + \psi)o\hbar = \emptyset o\hbar + \psi o\hbar$

Also $\gamma_\alpha[(\emptyset + \psi)o\hbar(x)]= \gamma_\alpha\ [(\emptyset + \psi)\hbar(x)]$

$=\gamma_\alpha[\emptyset\left(\hbar(x)\right)] + \gamma_\alpha[\psi\left(\hbar(x)\right)]$

$=\gamma_\alpha[\hbar(x)] + \gamma_\alpha[\hbar(x)]$

$=\gamma_\alpha[x] + \gamma_\alpha[x]$

$=2\gamma_\alpha[x]$…….(C)

Also $\gamma_\alpha[(\emptyset o\hbar)(x) + (\psi o\hbar)(x)]=\gamma_\alpha\left[\emptyset\left(\hbar(x)\right) + \psi\left(\hbar(x)\right)\right]$

$=\gamma_\alpha[\emptyset\left(\hbar(x)\right)] + \gamma_\alpha[\psi\left(\hbar(x)\right)]$

$=\gamma_\alpha[\hbar(x)] + \gamma_\alpha[\hbar(x)]$

$=\gamma_\alpha[x] + \gamma_\alpha[x]$

$=2\gamma_\alpha[x]$……..(B)

From (C) and (D)

$(\emptyset + \psi)o\hbar = \emptyset o\hbar + \psi o\hbar$

Hence $(\mathfrak{A}(\alpha, \beta), +, \bullet)$ is a near ring.

Theorem 3.4 Let (α, β) be an IF graph with the underlying set V. Define anIFS g= (μ_g, γ_g) in $\mathfrak{A}(\alpha, \beta)$ by $\mu_g(\varphi)$ =Sup $\{\mu_\beta(\{\varphi(x), \varphi(y)\})\}$ and

$\gamma_g(\varphi)$ =inf$\{\gamma_\beta(\{\varphi(x), \varphi(y)\})\}$ for all $\varphi \in \mathfrak{A}(\alpha, \beta)$ then g = (μ_g, γ_g) is an Intutionistic fuzzy group.

Theorem 3.5 $g = (\mu_g, \gamma_g)$ defined in Theorem 3.4 is an intuitionistic fuzzy semi group under composition of mappings.

Theorem 3.6 $g = (\mu_g, \gamma_g)$ defined in Theorem 3.4 is an intuitionistic fuzzy near–ring under the two binary operations '+' and '• '.

Proof :

Using Theorem 3.4, we get $g(\mu_g, \gamma_g)$ is an Intuitionistic fuzzy group under '+'. Also by using theorem 3.5, we get $g = (\mu_g, \gamma_g)$ is an intuitionistic fuzzy semigroup under '•'.

Next we claim that $g = (\mu_g, \gamma_g)$ satisfies the right distributive law.

Let $\varphi, \psi, \hbar \in \mathfrak{A}(\alpha, \beta)$ and $x, y \in V$

Consider

$$\mu_g[(\varphi + \psi)o\hbar] = Sup\{\mu_\beta\{[(\varphi + \psi)o\hbar](x), [(\varphi + \psi)o\hbar](y)\}/\ x, y \in V\}$$

$$= Sup\{\mu_\beta\{(\varphi + \psi)\hbar(x), (\varphi + \psi)\hbar(y)\}/x, y \in V\}$$

$$= Sup\{\mu_\beta\{\varphi(\hbar(x)) + \psi(\hbar(x)), \varphi(\hbar(y)) + \psi(\hbar(y))\}/\ x, y \in V\}$$

$$= Sup\{\mu_\beta\{(\varphi o\hbar)(x) + (\psi o\hbar)(x), (\varphi o\hbar)(y) + (\psi o\hbar)(y))\}/\ x, y \in V\}$$

$$= Sup\{\mu_\beta\{[\varphi o\hbar + \psi o\hbar](x), [\varphi o\hbar + \psi o\hbar](y)\}/\ x, y \in V\}$$

$$= \mu_g[\varphi o\hbar + \psi o\hbar]$$

Also $\gamma_g[(\varphi + \psi)o\hbar] = \inf\{\gamma_\beta\{[(\varphi + \psi)o\hbar](x), [(\varphi + \psi)o\hbar](y)\}/x, y \in V\}$

$$= \inf\{\gamma_\beta\{[(\varphi + \psi)\hbar(x)], [(\varphi + \psi)\hbar(y))]\}/\ x, y \in V\}$$

$$= \inf\{\gamma_\beta\ \{\varphi\big(\hbar(x)\big) + \psi\big(\hbar(x)\big), \varphi\big(\hbar(y)\big) + \psi(\hbar(y))\}/x, y \in V\}$$

$$= \inf\{\gamma_\beta\ \{(\varphi o\hbar)(x) + (\psi o\hbar)(x), (\varphi o\hbar)(y) + (\psi o\hbar)(y)\}/x, y \in V\}$$

$$= \inf\{\gamma_\beta\{[\varphi o\hbar + \psi o\hbar](x), [\varphi o\hbar + \psi o\hbar](y)\}/\ x, y \in V\}$$

$$= \gamma_g[\varphi o\hbar + \psi o\hbar]$$

$g = (\mu_g, \gamma_g)$is an intuitionistic fuzzy near-ring.

References

1. K.T.Atanassov, Intuitionistic fuzzy sets, Fuzzy sets and systems 20 (1986).
2. J.N.Mordeson and P.S.Nair, Cycles of fuzzy graphs, inform.sci.90 (1996), 39-49.
3. Young Bae Jun, Intuitionistic fuzzy sub semi groups and subgroups associated by intuitionistic fuzzy graphs.
4. L.A.Zadeh, Fuzzy sets,Iinform and Control 8 (1965). 338-353.

EFFECT OF ANEMIA ON THE PHYSICAL WORK CAPACITY OF SCHOOL GOING ADOLESCENT GIRLS IN RURAL TAMILNADU

***S.Gayathri Devi, **K. Mageshwari**

Abstract

Anemia during adolescence may reduce physical work capacity of the individuals. The objective was to compare the physical work capacity of anemic and non anemic adolescent girls in rural area of Tamilnadu. A cross sectional study was conducted in Government girl's higher secondary school, Natrampalli village in Vellore district of Tamilnadu by selecting 100 girls who were studying in 8th to 12th standard and aged 12 to 16 years. The selected girls were classified into group-I (anemic) containing 64 girls and group-II (non anemic) containing 36 girls based on WHO guodelines. Data regarding their socio economic status, anthropometry, nutrient intake and physical work capacity were collected and analysed. Parents of most of the girls in group-I were educated upto school level only and came under lower income group. The height and weight of the girls in group-I was much lesser than the normal value (NCHS). The BMI was also lower in 68.7 per cent of the girls in group-I. Break fast skipping habit was seen among all the girls. Intake of energy, protein, iron, fat, calcium and vitamin-c was also less among group-I girls than group-II girls and was lesser than the RDA (ICMR. 2010). The girls in group-I showed poor physical work capacity than the girls in group-II which was measured using modified Harvard's step test and six minute walk test. It can be concluded that anemia affects the growth as well as physical work capacity of rural adolescent girls. Immediate intervention is necessary.

Introduction

Adolescence is defined by World Health Organisation (WHO) as the period of life spanning the ages between 10-19 years which is the period where both physical as well as psychological changes occur[1]. But for many years, the health of adolescents has been neglected because they were considered to be less vulnerable to disease than the young children or the very old[2].The world's

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adolescent population is facing a series of serious nutritional challenges which are not only affecting their growth and development but also their livlihood as adults[3].

Adolescents are the best human resources. The technological advancement and economic development of a nation depend heavily on its trained human resources. The behavioural effects of anemia are highly relevant consequently. If anemia is highly prevalent in a country, it can substantially affect its intellectual and economical potential.[4]

Globally, anemia affects 1.62 billion people,which corresponds to 24.8 per cent of the population[5].Prevalence of anemia in non pregnant adolescent girls showed rates as high as 90.1 per cent, among them 7.1 per cent of the girls had severe anemia[6].

Anemia is one of the most common health problems in India which is much more prevalent in the rural than the urban areas.[7]Anemia is said to be present when the hemoglobin level in the blood is below the lower extreme of the normal range of the age and sex of the individual[8].According to WHO criteria, the cut off level of the hemoglobin concentration in blood for the diagnosis of anemia is less than 12g/dl for non pregnant women and children who are 6-14 years old[9].

Anemia affects the physical and mental development of an individual leading to decreased working capacity, which inturn affects the development of the country[10] . Iron defeciency anemia is the third leading cause of disability adjusted life years for females aged 15-45 years. In country like India, adolescent girls face serious health problems due to socio economic conditions, nutrition and gender discrimination[11]. Apart from over all poverty and lower literacy rate, the health status of women in India reflects gender discrimination from birth. Intra familial food distribution, where the males are privileged with high quality nutritious food and the females are deprived of it, is seen in India. In spite of increased iron needs many adolescent girls have iron intake of only 10 - 11 mg/day, resulting in approximately 1mg of absorption of iron[12].

Iron defeciency is a systemic condition which has many non hematological consequences, which occurs in relation to its severity, like decreased physical work capacity, decreased athletic performance, lowered indurations, depressed immune function, decreased scholastic performance, compromised growth and development and increased risk of pregnancy complications including prematurity and total growth retardation and impaired cognitive function[12].

So the present study was carried out with an objective of assessing the effect of anemia on the growth and physical work capacity of the adolescent school going girls in rural area of Tamilnadu.

Materials and methods

This cross sectional study was carried out in Government girl's higher secondary school, Natrampalli village in Vellore district of Tamilnadu after getting oral permission from the school head master. Adolescent girls aged 12-16 years studying in 8th-12th standard in that school were addressed and explained in detail about the study. Twenty girls from each class were recruited for the study after getting a written consent from their parents or the guardian.

Data collection

The participants were screened for anemia with the Sahli's haemoglobinometer using standard procedure[13] and classified into anemic (Group-I) and non anemic (Group-II) groups as per WHO guidelines. A pretested questionnaire was administered to collect data regarding socio economic status, anthropometry and nutrient intake; Physical work capacity was measured using modified Harvard's step test and six minute walk test.

Socio economic status : Details regarding age, class, religion, type of the family, details of the family members including their educational qualification, occupation and total monthly income of the family were collected using the questionnaire. The economic status was assessed using modified Kuppuswamy's scale which is based on the composite score of education and occupation of the head of the family along with monthly income of the family, which yields a score of 3-29. This scale classifies the study population into upper (score = 26-29), upper middle (score = 16-25), lower middle (score = 11-15), upper lower (score = 5-10) and lower (score = 3-5) socio-economic status[14].

Anthropometric measurements : Standing height was recorded without shoes and with light cloths using SECA bodymeter 208 to the nearest of 0.1 cm. Weight was recorded without shoes and with light cloths to the nearest of 0.5 kg using Tanita digital weighing scale (Model HD 309). Body Mass Index (BMI) was calculated by the formula BMI = Weight(kg)/ Height (m^2) and categorised into low (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2) and high (> 25 kg/m^2) according to the WHO criteria[15].

Nutrient intake: 24 hours recall method[16] was used to obtain information regarding the intake of different nutrients. The quantity of food consumed by the respondents in terms of household measures was recorded in the diet sheet by asking the adolescent girls to recall the actual food consumed by them during the last 24 hours. The quantity measured using standard containers was converted into metric weight and the nutritive value was calculated.

Physical work capacity: Modified Harvard's step test[17]- The selected adolescent girls were asked to climb up and down a set of five steps (six inches height) for a period of three minutes as fast as they

could. The total number of steps climbed up and down was counted. The resting pulse rate was recorded before the girls began the test. Post exercise, the time taken (minutes) to revert to the basal pulse rate was also recorded (recovery time).

Six minute walk test[18]- Six minute walk test was performed by the adolescent girls using standard protocol, by walking around two flag poles positioned 30m apart on a flat ground. Subjects were instructed to walk as fast as possible (without running) at a steady pace for six minutes. The distance covered and the time taken to revert to the basal pulse rate was recorded.

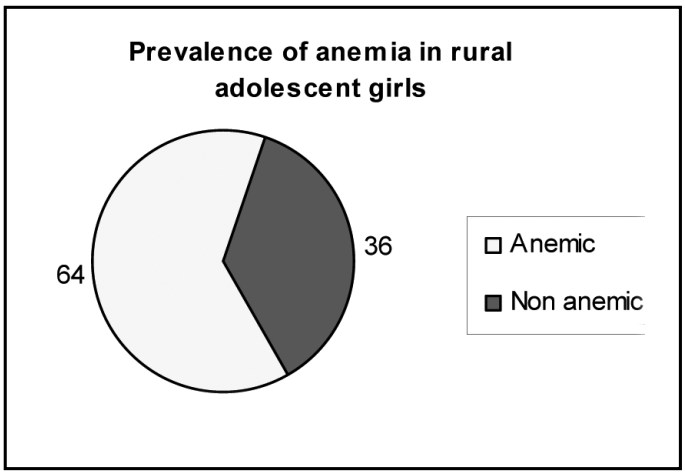
The results were consolidated, tabulated and analysed.

Results and discussion

Classification of anemic and non anemic group

Among the selected 100 adolescent girls, the hemoglobin level was less than 12g/dl in 64 girls and they were classified as anemic group (Group-I) and the remaining 36 adolescent girls whose hemoglobin level was more than 12g/dl were classified as non anemic group (Group-II) (Fig-1). Findings of the present study was almost in accordance with Seshadri (1996)[19] who had reported 63 per cent prevalence of anemia among adolescent girls.

Figure-1 Prevalence of anemia in rural adolescent girls



Socio - Economic status of selected subjects

Table-1 exhibits the social status namely religion,family type, parent's education and occupation of the selected subjects.

Table-I Social status of the selected adolescent girls

Criteria	**Anemic** (n=64)%	**Non-anemic** (n=36)%
Religion		
Hindu	100	97.22
Muslim	—	—
Christian	—	02.78
Type of family		
Nuclear	81.25	72.22
Joint	18.75	27.78
Parent's education		
Illiterate	29.68	22.22
Primary school	18.75	13.89
Middle school	23.43	16.67
High school	28.14	25.00
Graduate	—	22.22
Parent's occupation		
Coolie	65.63	25.00
Agriculture	31.25	61.12
Business	03.12	05.55
Employed	—	08.33

The age of all the girls were with in the range of 12-16 years. All the anemic girls and 97.22 per cent of the non anemic girls were Hindus. 81.25 per cent of anemic and 72.22 per cent of non anemic girls were from nuclear family and the remaining were from the joint family. Sachan et al (2012)[20] stated that the prevalence of anemia was more (66.7%) in rural adolescent girls who lived in joint families in Lucknow. But Premalatha et al (2012)[21] reported that the prevalence of anemia was higher in nuclear families living in Chennai.

The parents of majority of adolescent girls [Group-I (29.68%) and II (22.22%)] were illeterates. Patil et al (2014)[22] had supported this fact stating that the very high prevalence of anemia may be due to the low educational status of the parents. However, the next higher percentage of the parents of the adolescent girls from group-I and group-II were either completed high school education (28.14%, 25% respectively) or middle school education (23.43%, 16.67%). Overall prevalence of anemia was found to be associated with education of mothers as with increasing education level of mothers, the prevalence declined[23].

The parents of 65.63 per cent of anemic girls were coolies and parents of 61.12 per cent of non anemic girls were agriculturists (Table-I). According to Kuppusamy (2012)[24] classification (which is based on a composite score of education and occupation of the head of the family along with the monthly income of the family), 57.82 per cent of anemic girls belonged to the lower income group (score = 3-10) and the remaining anemic girls belonged to the middle income group (score =11-25). In non anemic group, 41.67 per cent were from the lower income group (score =3-10); 50 per cent were in the middle income group (score = 11-25) and 8.33 per cent belonged to the upper income group (score = 26-29) (Table-II). A review of Indian studies on anemia in adolescent girls revealed that more than 70 per cent of adolescent girls from low income communities had hemoglobin level less than 110g/L[25].

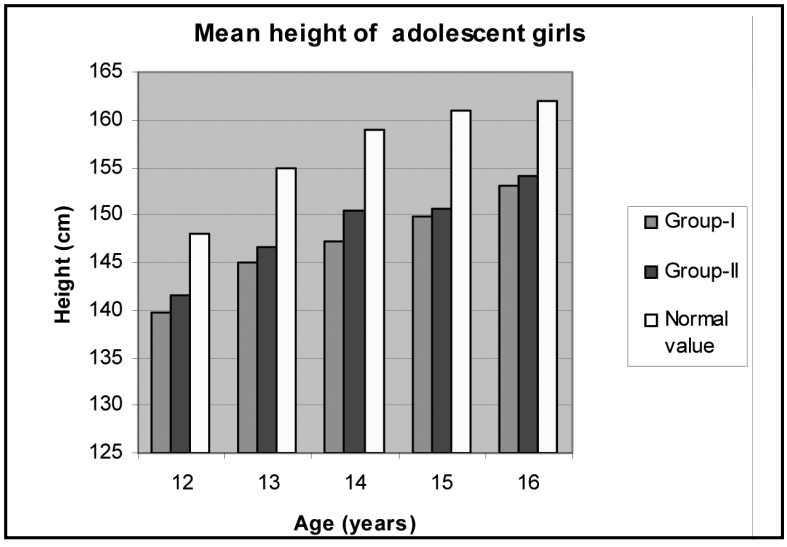
Table-II Economic status of the parents

Economic status (Kuppusamy,2012)	**Anemic** (n=64)%	**Non-anemic** (n=36)%
Upper (Rs.)	-	08.33
Upper middle (Rs.)	10.93	22.22
Lower middle (Rs.)	31.25	27.78
Upper lower (Rs.)	20.32	30.56
Lower (Rs.)	37.50	11.11

Anthropometric measurements of the selected adolescent girls

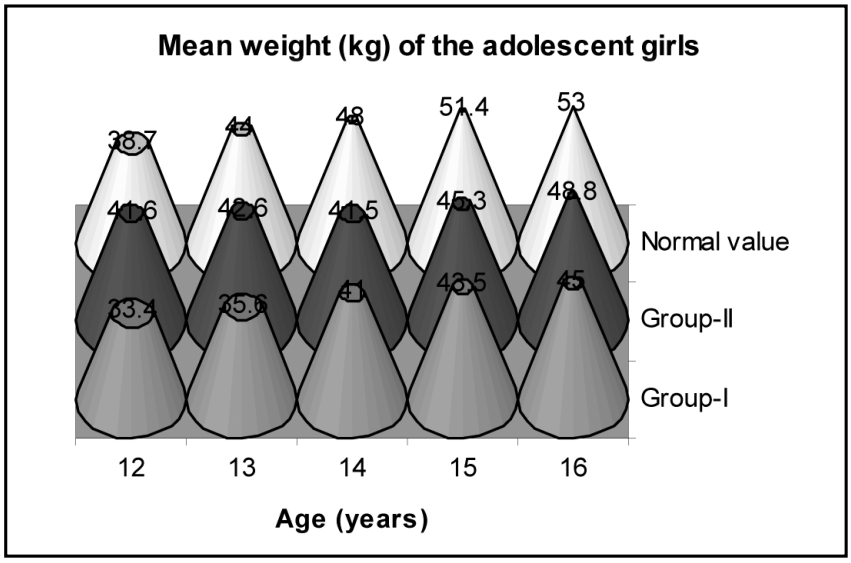
Height : In all the age groups, the height of the girls was less compared with the normal value (NCHS)[26] and the difference was more in the case of group - I anemic (Fig-2).

Figure-2 Mean height of the selected adolescent girls



Weight: Weight of all the selected adolescent girls was less than the normal value (NCHS)[26] and the difference was more in group-I (Fig-3). Sanjeev and Dhage (2008), based on a study conducted in Nagpur among adolescent females, reported that mean height and mean weight of subjects with anemia was significantly less than the subjects without anemia, which suggests that anemia affects the overall growth of adolescents[27].

Figure-3 Mean weight of the selected adolescent girls



Body Mass Index (BMI): Among the 100 selected adolescent girls, 51 were under weight and among them 86.27 per cent were anemic. Though 43 selected adolescent girls had normal BMI, 41.86 per cent of them were anemic. 6 per cent of the total selected girls were over weight. Sudhagandhi et al (2011) reported that prevalence of anemia was more in individuals having low BMI. 51.3 per cent of children with normal BMI were found to be anemic[28].

The BMI of 69.4 percent of non anemic group was with in the normal range (18.5 to 25.0), where as in anemic group, only 28.2 per cent of the girls had normal BMI. 68.7 per cent in anemic group had low BMI (below 18.5). Over weight (BMI=25.1to29) was also seen among 3.1 per cent of anemic group and 11.2 percent of non anemic group (Table-III). A positive correlation of hemoglobin to grades of BMI has been shown by Peter et al (2012)[13]. The BMI of anemic school children in North West region of China was lower than the BMI of their non anemic counterparts[29].

Table-III Body mass index of the selected adolescent girls

BMI classification	**Anemic** (n=64)%	**Non-anemic** (n=36)%
Low (below 18.5)	68.7	19.4

BMI classification	Anemic (n=64)%	Non-anemic (n=36)%
Normal (18.5-25)	28.2	69.4
Over weight (25.1-29.1)	03.1	11.2

Nutrient intake

87.5 percent of anemic girls and 83.4 per cent of the non-anemic girls were non vegetarian diet consumers. The rest of the girls in both the groups were consuming vegetarian diet. All the selected adolescent girls were found to be skipping break fast atleast once in a week. Table-IV reveals the mean nutrient intake of both anemic (N=20) and non-anemic (N=20) groups.

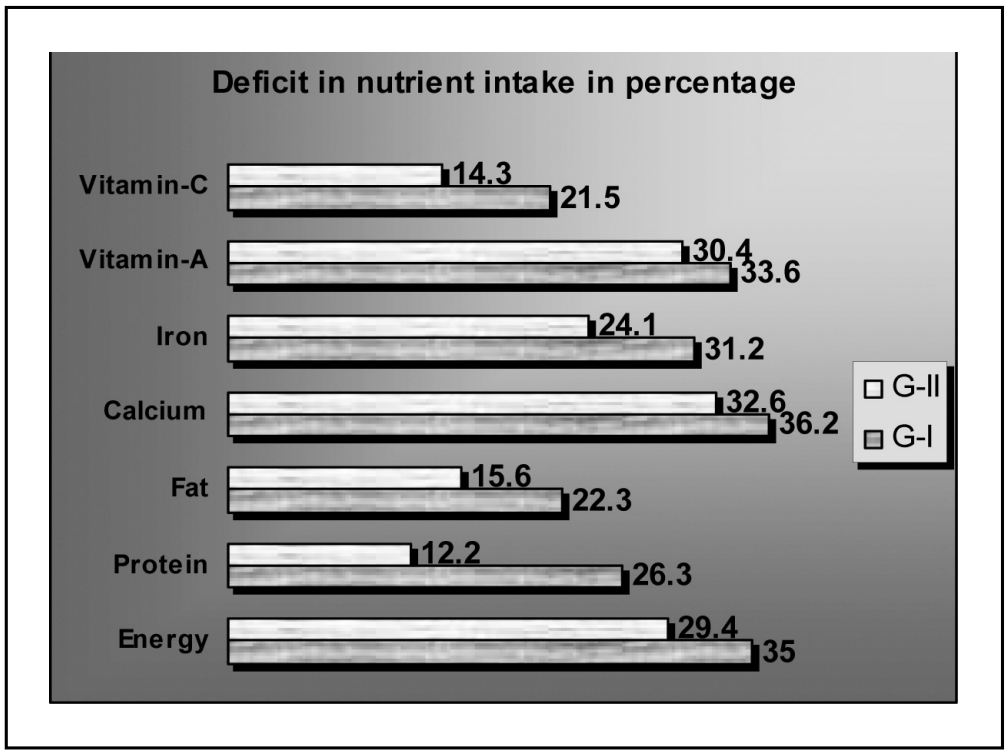
Table-IV Mean nutrient intake of the selected adolescent girls

Groups	Energy (Kcal.)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Vitamin-A (mg)	Vitamin-C (micro g)
Anemic group	1516	38.3	31.11	510	18.6	398	31.4
Non anemic group	1645	45.6	33.79	539	20.5	417	34.31
RDA	2330	51.9	40.0	800	27.0	600	40.0

Nutrient intake of 20 girls in group-I and 20 girls in group-II in the age group of 13-15 years was calculated and compared with the RDA given by ICMR(2010). The mean intake of all the nutrients was found to be less when compared with the RDA. It was lesser in girls of anemic group than of non anemic group (Table-IV). This is in accordance with the results revealed by Chang et al (2009) based on the study conducted in Kuala Lumpur who stated that the nutrient intake of anemic individuals was lower than the non anemic counterparts, with most nutrient intakes below the Recommended Nutrient Intake of Malaysia[16].

The percentage deficit in the nutrient intake of the selected subjects is shown in figure-4. In general the percentage deficit in the intake of nutrients was found to be higher in anemic group (Group-I) than the non anemic group (Group-II). In the anemic group, the deficiency was found to be more in the intake of protein, iron and vitamin-C,the nutrients which are considered to be essential

Figure-4 Deficit nutrient intake



for the formation of hemoglobin. Diets of rural children indicate large deficits in micro nutrients intake, particularly of folic acid, riboflavin and iron[30]. Intake of iron and calcium of anemic adolescent girls were the most critical. Energy, vitamin B1, iron and calcium intakes were the most unattainable nutrients for the adolescent girls despite their anemic status[16].

Physical work capacity

Table V shows the results of the tests conducted to assess the physical work capacity of the selected adolescent girls.

Table-V Physical work capacity of the selected adolescent girls

Groups	Step test		Walk test	
	Steps covered (Number)	Recovery time (minutes)	Distance covered (meters)	Recovery time (minutes)
Anemic group	195	7	555	6
Non anemic group	220	4.1	599	5

The mean number of steps covered by the anemic group (Group-I) in the modified Harvard's step test was found to be lesser than the number of steps covered by the non anemic group (Group-II). The time taken by the anemic group for recovery was found to be more indicating their lower physical fitness when compared with non anemic group.The effects of sub clinical iron defeciency on physical fitness using Harvard step test was reported in Punjab, India among 18 to 23 years old college girls. A significantly lower rapid fitness index calculated from total exercise time and pulse rate after the exercise was observed among anemic subjects against non anemics, revealing that even sub clinical iron deficiency reduces physical fitness[17].

In 3 minutes walk test, it was found that the mean distance covered was less and the mean recovery time was more in the anemic group (Group-I) when compared with the non anemic group (Group-II). This is due to the lower physical ability of the anemic group. The study done on younger children in Varanasi also revealed that with increasing severity of under nutrition, the number of steps completed in the step test became fewer and recovery time was prolonged[31]. Sen and Kanani (2006) also reported that the mean number of steps climbed by the non anemic girls was higher than the anemic girls and the anemic girls took longer time than the non anemic girls to return to their basal pulse rate after finishing the step test[32].

Even among the adults, anemia compromises work capacity. In a Coimbatore based study on adult women of the same age group, it was found that non anemic women performed much better than anemic women in various physical activities like walking, running, skipping. number of steps climbed and mopping/cleaning[33] .

Conclusion

This study highlights the fact that the prevalence of anemia was more in rural adolescent girls who were having low BMI and hailing from low socio economic communities. It is evident that the anemic adolescent girls are vulnerable to the adverse consequences of iron defeciency anemia, that is, poor growth and reduced physical work capacity. In the absence of intervention, anemia will affect the quality of life of these girls, increase the drop-out rate in schools due to poor performance and jeoparadize their future reproductive health. Hence, it is time to focus the anemic adolescent girls especially in rural areas, for better future of the country.

References

1. World Health Organization (1999). Programming for adolescent health and development.WHO Technical Report Series 886.
2. Kalhan.M.,Vashisht.B.,Kumar.V. and Sharma.S.(2010). Nutritional status of adolescent girls of rural Haryana.Internet J Epidemiol;8(1).

3. Chatterjee.R. (2008). Nutritional needs of adolescents.Paediatrics Today;3:110-14.

4. Sathyanarayana.K.,Pradhan.D.R.,Ramnath.J. and Rao.N.P. (1990). Anemia and physical fitness of school children of rural Hyderabad. Indian Pediatr;27:715-21.[PUBMED]

5. Worldwide prevalence of anemia 1993-2005:WHO global database on anemia/Edited by Bruno de Benoist, Erin Mc Lean,Ines Egli and Mary Cogswell.

6. Teoteja G.S.and Singh.P.(2002). Micronutrient profile in the Indian population (Part-I).Indian Council of Medical Research;131-40.

7. Seshadri.S. (1999). A database on iron defeciency anemia (IDA) in India: Prevalence,causes, consequences and strategies for prevention.Department of Foods and Nutrition.WHO Collaborating Centre for Nutrition Research. The Maharaja Sayajirao University of Baroda, Vadodara, India.

8. Firkin.F.,Chesterman.C.,Penington.D. and Rush.B. (1989). Editors de Gruchy's Clinical Haematology in Medical Practice. 5th Ed. Oxford:Blackwell Science Ltd;17-36.

9. Dhaar.G.M.and Rabbani.I. (2008). Editors.Foundation of Community medicine. 2nd Ed.New Delhi:Elsevier India;272-76.

10. UNICEF/United Nations University/World Health Organization. (2001). Iron defeciency anemia.Assessment,Prevention and Control:A guide for program managers.Document WHO/NHD/01.3.Geneva:World Health Organization.

11. Balasubramaniam.P. (2005). Health needs of poor unmarried adolescent girls.A community based study in rural Tamilnadu.Indian Journal of Population Education 2829;18-33.

12. Sarika More,V.B.,Shivkumar,Nitin Gangane and Sumeet Shende. (2013). 'Effects of Iron Defeciency on Cognitive Function in School Going Adolescent Females in Rural Area of Central Asia,'Anemia,Vol 2013,819136. http://dx.doi.org/10.1155/2013/819136.

13. Peter.R.,Kumar.R.,Sangwan.L. and Pandey.S.(2012). 'Prevalence of anemia and its correlation to body mass index:Study among unmarried girls', International Journal of Basic and Applied Medical Sciences ISSN:2277-2103(online). Vol.2(3)Sep-Dec,58-62 at http://www.cibtech.org/jms.htm

14. Bairwa.M, Rajput.M. and Sachdeva.S. (2013). Modified Kuppuswamy's socio economic scale: Social researcher should include updated income criteria,2012.Indian J Community Med 2013, 38:185-6.

15. Physical status:The use and interpretation of anthropometry.In:WHO Technical Report Series No 854.Geneva:WHO,1995.

16. Chang.M.C.,Poh.B.K.,June.J.,Jefridin.N. and Das.S.(2009). 'A study of prevalence of anemia in adolescent girls and reproductive age women in Kuala Lumpur',Arch Med Sci;5,1:63-68.

17. Baini.K.and Mann.S.K.(2000). Sub-clinical iron defeciency:A major factor in reducing physical fitness of young women.The Indian J Nutr Dietet;37:296-302.

18. Sivaranjini.S.,Vanamail.P., Eason.J.(2010). 'Six minute walk test in people with tuberculosis sequelae"cardio pulmonary physical therapyJournal,Vol.21,5-10.

19. Seshadri S.A. (1996). Database for iron defeciency anemia in India; Prevalence, etiology, consequences

and strategies for control. Task force for micronutrients malnutrition control, Department of Women and Child Development. New Delhi: Ministry of Human Resource Development.

20. Sachan B, Idris M.Z. and Singh A. (2012). Effect of socio- demographic characteristics on the prevalence of anemia among school going adolescent girls in Lucknow district, India. South East Asia Journal of Public Health. 2(1):8-12.

21. Premalatha T, Valarmathi S,Srijayanth P, Sundar J.S. and Kalpana S. (2012). Prevalence of Anemia and its Associated Factors among Adolescent School Girls in Chennai, Tamilnadu, India. Epidemiol 2:118. doi:10.4172/2161-1165,1000118.

22. Patil S.V., Durgawale P.M., Kakade S.V. and Dighe S. (2014). An assessment of interventional strategies for control of anemia among adolescent girls in an urban slum of Karad district, Satara, Maharashtra. Al Ameen J Med Sci. 7(3):195-200.

23. Lamba R, Misra S.K. and Rana R. (2014). A study on the effect of iron and folic acid supplementation and deworming among college going adolescent girls in urban Agra. Indian Journal of Community Health. 26(2);160-164.

24. Kuppusamy.B. (2012). Socio economic status scale 2012.The need for periodic revision.Indian J Pediatr;79:395-6.

25. Bhanushali M, Shirode A, Joshi Y. and Kadam V. (2011). An Intervention of Iron Defeciency Anemia and Change in Dietary Behaviour among Adolescent Girls. International Journal of Pharmacy and Pharmaceutical Sciences. 3:40-42.

26. Srilakshmi.B. (2011). Dietetics. 5th Edition, New Age International Ltd,India. 419.

27. Sanjeev M.C. and Dhage V.R. (2008). A study of Anemia Among Adolescent Females in the Urban Area of Nagpur. Indian J Community Med. October;33 (4):243-245.

28. Sudhagandhi B, Sundaresan S, William W. and Prema A. (2011) Prevalence of anemia in the school children of Kattankulathur, Tamil Nadu, India. Int J Nutr Pharmacol Neurol Dis. 1:184-8.

29. Renfu Luo, Linxiu Zhang, Chengtang Liu, Qiran Zhao, Yaojiang Shi, Grant Miller, Elaine Yu, Briom Sharbono, Alexis Medina, Scott Rozelle and Reynaldo Martorell. (2011). Anemia among students of rural China's elementary schools: Prevalence and correlates in Ningxia and Qinghai's poor countries, J Health Popul Nutr. October; 29(5): 471-485.

30. Swaminathan S, Edward B.S. and Kurpad A.V. (2013). Micro nutrient deficiency and cognitive and physical performance in Indian Children. European Journal of Clinical Nutrition. 67,467-474.

31. Agarwal D.K., Upadhyay.S.K., Tripathi.A.M. and Agarwal.K.N. (1987). Nutritional status, physical work capacity and mental function in school children.Scientific report 6, Nutrition Foundation of India.

32. Sen A. and Kanani S.J. (2006). Deleterious fuctional impact of anemia on young adolescent school girls. Indian Pediatrics. 43:219-226.

33. Vijayalakshmi P. and Selvasundari S. (1983). Relationship between iron defeciency anemia and energy expenditure of young adult women. The Indian J Nutr Dietet. 20:113-117.

WIND ENERGY GENERATORS (WEG) – ROLE IN POWER GENERATION AND CONSERVATION, ENVIRONMENTAL PROTECTION AND RURAL DEVELOPMENT

J.Durga Devi

Introduction

All Nations around the world have their own planning, policies and proposals for the development of their country, which would include poverty alleviation, employment generation, economic growth, sophistication, modernization and self-dependence. The fulfillment of these dependent mainly on resource like men, materials, machines and money: but today another essential factor, energy-mainly electricity-the economy driver-plays a dominant role for governments to have proper energy planning (Guruswamy ,1997).

Only after "power" came into existence, the global perspective on "development" changed differently exhorts Sastri (2001). The invention of the new prime mover 'electricity' – the key to economic development – has enabled the world to achieve exponential growth in all walks of life. Interpretations for us keeping something going for an "indefinite" period of time. The challenge is getting tougher by the day in the context of exploding population and shrinking the sources. The "three important E's" of immediate as well as long term concern are : Environment, Energy and Economy. Not only are they individually important but also more so as a linked single entity states (Venkatesh, 2003).

The growth in energy demand, the limitations of supply and increasing cost of fossil fuel generation and environmental concerns have made wind power a competitive option in countries which have a good wind resource base. In addition, they can also provide a degree of national energy security. With this backdrop the study was launched on **"Wind Energy Generators (WEG) – Role in power generation and conservation, environmental protection and rural development**". The literature pertaining to the study is reviewed under

A. Concept of wind and wind power generation.

B. Significance of wind energy generation.

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C. Factors to be considered for WEG installation.

D. Ministry and Institution/Agencies supporting WEGs.

E. Clean Develop Mechanism.

F. Wind energy scenario in Tamil Nadu.

G. Structural configuration.

H. Techno -Benefits.

A. Concept of wind and wind power generation:

Solar energy is responsible for the blowing of wind. The sun rays fall on the whole earth, but it is much more intense near the equator than in the Polar Regions. Hence the air near the surface of equatorial regions becomes quite hot. This hot air, being lighter, rises upward. The cooler air from the polar regions fill the space vacated by the hot rising air. This way, the air flows from higher pressure regions to lower pressure region of earth. Flow of air is continuously distributed by rotation of earth and local conditions. One or two percent of the energy absorbed by the earth from the sun is converted into wind via the mechanisms of convection and casioles forces (Chikkoba, 2003).

Wind energy has been used throughout recorded history for sailing, pumping water and grinding (Kealy ,1987 and Hills, 1994).

India is placed in the fifth position in wind power generation, yielding 990MW of wind energy, whereas it has a potential of atleast 20,000MW (Banerjee, 2001) and currently 45,000MW (Chikkoba 2003, Deambi 2003).

As per the declarations made by ministry, a project of 10,000MW is planned to be added by the end of XI plan, in the year 2012. The strong southwest summer monsoon beginning in May – June in India influences wind speed and power density. Between March and August, the winds are uniformly strong over the entire Indian peninsular coast, except the east. In contrast the wind speeds during the period November to March are weaker in comparison, barring those experienced at the coastline of Tamilnadu.

The rapid strides made in wind power generation are due to :

- Availability of good wind potential in selected plain area.
- Availability of vast tracts of dry lands without detriment to agriculture.

- Easy accessibility to the lands; availability of infrastructural facilities like roads and communication facilities.
- Availability of extensive network of power lines of the electricity system in the windy zones (Ayyadurai, 1997).

B. Significance of Wind Energy Generation

The need for energy in the world is growing faster than the conventional energy generating capacity. Fossil fuel resources for power generation are depleting fast and there is a growing concern over the environmental degradation caused by such power plants. Wind energy is a non-polluting, renewable and sustainable source. It is available at free of cost, clean and perennial and also helps to conserve fossil fuel. As WEG, they can improve grid quality and efficiency and thus ultimately helps in rural development. Since wind turbines use only the wind and occupy little space, they can share the land with agriculture. Low gestation period, economically competitiveness, low operating cost, improvement in grid quality and efficiency, rural development, pollution free atmosphere and environmental protection are added merits. (Directory of wind power, 2003).

C. Factors to be considered for WEG Installation

Location, the mean wind speed, the height variation of wind, the wind direction, distribution, the seasonal density of air and hazard conditions such as sandstorms, humidity, and salt spray are few factors to be considered for installation of WEGs (www.earthsci.org). Wind farms are located in geographical areas which have continuous, steady, favourable wind in the speed range between 6 mts to 30 mts. Annual average wind speed of 10 mts is considered to be very suitable. Wind velocity should be adequate and uniform. Freedom from cyclones, floods, lightning strokes also are highly important. The generation of units per WEG also depends upon factors like:

1. Siting : Favourable wind sites are generally away from forests, cities and hills, states Rao et al. (1999). Sites such as deserts, flat vacant lands, onshore/offshore and top of hills are considered highly favourable (Sivakumar, 2003).

2. Obstruction: Coconut groves, nearby tall buildings and also inter distance between WEG's will bring down the velocity of wind which affect generation (Ramesh and Kaliappan, 2001). Strict avoidance of all objects more than 3 m in height, within the radius of 100 m of the installation site is recommended adds Ghuman, (1985).

3. Surface roughness: Height and character of surface exert considerable influence on wind speed. Winds are strongest over grass land. Coastal area and deserts with few wind breaks are ideal for generation (Jogi, 2000).

4. Terrain: Wind speed increases on required, around and over the hills and ridges and enable a sustainable impact on output, and reduce estimates.

Height above sea level should be less (Jogi, 2000).

5. Topography: In Rao's (1989) viewpoint suitable terrain and soil for installing the wind turbine towers, movement of crane etc. is an absolute necessity. Approach roads upto site for movement of erection equipment and the wind turbine subassemblies should be there.

6. Wind power density: Sites having wind power density greater than 200W/m^2 at 50 m height are considered as potential sites (Garg, 2003)

7. Air density: The consistency of rotation of blades depends on this factor.

8. Ventury effect: Ventury of air passage produces additional energy than others but leads to high stress on the machines.

9. Grid connection: Availability of a distribution substitution connected to the electrical grid, within a short distance (< 10 km) should be assured (Rai, 1999 and Ramesh and Kaliappan, 2001).

10. Size: One of the factors that emerge with the experience is that wind farm, size is an important factor for its viability comments Sivakumar (2003).

The factors contributing to power generation as envisaged by Gusain (1990), MNES Report (1995-96), Begarudre (2000), Chikkoba (2003) and Malayappan et al, (2003) are the design of aero foil blade and the stability of the wind turbine to tower which should have the maximum impact on the amount of power generated, the grid frequency not to fall below 48.7 cycles and trained man power for supervision and O&M.

D. Ministry and Institutions / Agencies supporting WEGs

MNES: India is perhaps the only country in the world to have an exclusive **Ministry for Non Conventional Energy Sources (MNES)** which started functioning as a separate Ministry from 1992 to develop all areas of renewable energy. The key functions of the Ministry include policy making and planning, programme formulation and implementation, research and development, technology development and commercialization, promotion of demonstration, pilot projects and extensive programmes, implementation of fiscal and financial incentives, human resource development, training, promotion of Intellectual Property Rights (IPR), protection, international cooperation, consultancy services and coordination and international cooperation (Directory of Wind Power, 2003). It's objectives include promoting research, development, demonstration, dissemination and popularization

of new and renewable energy technologies for harnessing sun, wind, water, biomass, ocean, geothermal, hydrogen and chemical energy sources (Guruswamy, 1997).

The Supporting bodies for WPG are:

The Centre for Wind Energy Technology (C-WET) was established as an autonomous institution at Chennai to provide technical support to the energy sector with a wind turbine Test station at Kayathar in Thuthukudy District of Tamil Nadu. C-WET serves as the technical focal point for wind power development in the country, and is coordinating all activities relating to research and development, and wind resource assessment. The Centre is also responsible for developing standards, testing and certification of wind turbines (Garg, 2003).

Centre for Wind Energy: It is supporting the wind industry in achieving and sustaining the quality, such that the products of highest quality and reliability are installed for effectively harnessing the available wind energy. The center has also been recognized for research facility.

State Nodal Agencies: The SNA's implement the programmes for dissemination of Renewable Energy Technologies (RETs)

IREDA: In order to promote RETs on commercial basis MNES has established the Indian Renewable Energy Development Agency. Realizing the potential and the significance of new and renewable sources of energy for national development with particular reference to rural sector and to implement the government policy of conserving / creating energy, IREDA was incorporated as a public administrative control of MNES with "Energy for Ever" as its motto (Directory of Wind Power, 2003). Under the wind energy equipment financing scheme, proposals for wind farms upto 1 Mw are eligible.

TEDA: With a view to develop and propagate the non conventional energy sources, the **Tamil Nadu Energy Development Agency** was formed in 1985 (www.tn.gov.in). On par with the Government of India, the objectives of TEDA are: to promote the use of new and renewable sources of energy and to implement the project therefore, strengthen energy conservation activities and encourage research on development of RET (Guruswamy, 1997).

Consolidated Energy Consultants Ltd: CECL provides technical consultancy services in wind mast and data logger installation, data analysis and wind power potential mapping, siting, preparation of feasibility report and detailed project report, preparation of technical specification and bidding documents and evaluation of bids and detailed engineering (Civil, electrical and WEG)

Policy: Without a legislative support private sector investment in the renewable sector would not happen. Considering the fact that renewable sources of energy are the only answer to supply energy, without any environmental problem in the future. The Government of India recently initiated steps to formulate a comprehensive policy and to enact suitable legislation on RES to ensure its efficient and effective exploitation, the energy policy (formulated by MNES) centres on energy efficiency, energy security, sustainable development and production of power from environmentally cleaner sources of energy (Chikkoba, 2003). The policy envisages meeting the minimum energy need through renewable energy and providing decentralized energy supply (Directory of wind power, 2003).

Incentives and Motivation: Largely based on the success of innovative guidelines for WPG introduced by the Tamil Nadu Electricity Board (TNEB), the MNES has formulated guidelines on the implementation of wind farm development projects with private sector participation.

The attractive incentives introduced by the Government of India like 100 per cent accelerated depreciation, tax holidays for power generation projects, soft loans, duty and tax exemptions, liberalized foreign investments, procedures and the conducive policies evolved by the state governments and state electricity board will certainly lead to more wind power installations projects, Report (1996), Mahajan (1999) and Sastry (2001).

E. Clean Development Mechanism (CDM)

If one stopped to think about the energy use, one would encounter some shocking realities about the impacts of the energy production process on the environment and human health. Smog, sout and haze reduce visibility hurting the eyes and cause breathing difficulty that may lead to respiratory and heart diseases. Ozone formation at the ground level further aggravates pollution cond Mcma. (Cherail, 2003).

The developed world needs 21,000 Million tonnes of $C0_2$ reduction. The answer to this is the Clean Development Mechanism (CDM) is one of the flexibility mechanisms authorized in the 1997 KYOTO Protocol. This specified legally binding commitments by most industrialized countries to reduce their collective greenhouse gas (GHG) emissions by at least five per cent compared to 1990 levels before 2008-2012. Article 12 of the KYOTO protocol identifies three specific goals for the CDM.

* Achieving Sustainable Development.
* Attaining the Environmental Goals to the Frame Work Convention.
* Assisting Developed Countries Parties in Complying with their Emission Reduction Commitments.

The main objective in the power industry under the CDM is the reduction of carbondioxide emissions through CERs (Certified Emission Reductions). The CERs could then be banked for the use in the first commitment period or transacted in an international market.

To jump start the carbon emission reduction (CERs) trading market die world bank promoted the proto typed carbon fund (PLF). PLF encourages project developers to sell their CERs to them before the implementation of the emission reducing project. These CERs are then distributed among the member countries that contribute to PLF. The PLF seeks a letter of Approval to be issued by the Host country, and the final approval of the Executive Board of the United Nations framework Convention on climate change (UNFCCC) for registration of a project (Ratan,2003).

CDM appears to be an important tool on more than one count. First, it enables the countries where the emission reduction costs are very high to find economically viable alternatives in other countries. Second, this would result in a transfer of technology and resources to the host country usually a developing country. Third and perhaps the most important (but, least talked about) feature is that indirectly brings the developing country parties into the realm of emission reduction commitments (Parikh and Babu, 2003).

Wind Power Potential in India :

- ✓ Upto eleven states in India are identified with good potential for wind energy generation. As an initiative, demonstration farms were set up in these states enabling power generation.
- ✓ There are more than 483 wind monitoring stations in the country shown an annual wind power density higher than 200 Watts/m^2 at 50 m height.
- ✓ There are WEGs owned by many stakeholders installed in India. NEPC, Vestas, Suzlon and Enercon were the most popular makes from among the 31 makes available in India. All the popular makes belong to India - Foreign collaboration companies and had received Type Certification from C-WET.
- ✓ There are five totally indigenized (India) companies namely, BHEL, CWEL, Himalaya, Husumer TTG and NEPC India, also in the production line.
- ✓ Among owners of WEGs Tamil Nadu ranked first with 492 possessing 3360 wind turbines followed by Maharastra with 203 owning 993 machines and Gujarat with 111 owners and 812 systems.
- ✓ The three states of Karnataka, Maharastra and Tamilnadu showed sustained interest in WEGs in the last few years. Current generation details (2002-03) revealed only 241.3 Mw of energy conversion with 132.9 Mw coming from Tamil Nadu.

F. Wind Energy Scenario in Tamil Nadu

- The major potential sites are lying in the Districts of Kanyakumari, Coimbatore, Tuticorin, Madurai, Erode, Thiruvallur.
- Year wise installed capacity showed oscillation. The years 1991-94 were warming up periods followed by a quantum jump in installations in the years between 1994-97 with 592.4 Mw - more than 50 per cent of the total installation till date (990.3 Mw)
- The cumulative generation from 1992 onwards from Tamil Nadu installations alone amounted to 79.62 Crore Kwh of power. Year wise generation pointed to a steady increase in energy harvest till date, almost contributing to 70 per cent of the generation achieved all over India.

G. Techno – benefits

Techno - economic benefits: Though the capital cost of turbines amounted to Rs.4.5 crore per Mw, the cost of generation is estimated at Rs.2.50 per Kwh; The life time of a WPG being guaranteed as 20-25 years; the environmental benefits are highlighted by the samples to project the technology as an economically viable one. Arguments focusing on possibilities for entrepreneurship, employment, export and import of less fuel, and zero cost input push the technology to front stage appearance.

Techno – Social benefits: The technology has proved a fertile ground for sound entrepreneurship - manufacturing, erection and commissioning and O&M, and entrepreneurship. Employment by both stakeholders and entrepreneurs stand proof for the employability of the technology - a Mw installation employing nearly 50-60 personnel on different cadres. Mushrooming service companies have left tell - tale marks on manpower in both business and labour sectors.

On the stakeholders part, they expressed willingness to partake in the sector because of the 'produce and use' power generated, fiscal incentives, soft loans and monetary benefits gained through WPGs.

Techno – Environmental benefits: The public awareness created and the know-how on CDM disseminated through the Associations had left indelible imprints especially on the stakeholders about the environmental benefits of the technology. WPGs pollution free nature, energy conservation evinced though the generation, carbon credit quality, coal replacement statistics and fossil fuel substitution were highlighted, while expressing why they would patronize the technology.

The equivalent saving of coal and other pollutants, by way of WPG (with courtesy to MNES) was to the tune of coal substitution (45,42,990 tonnes) SO2-73,820 tonnes, NO -51,110 tonnes, C02

-1,13,57,460 tonnes and particulates - 6,100. Within ten years if we could achieve curtail of this much pollutants, sustained use could curtail total pollution in our country.

Foreign exchange prospects are also very bright with many foreign manufacturing companies ready to have collaborative efforts with India (apart from the existing 10 manufacturers). The CDM and KYOTO Protocol further enhance the chances for international relationship.

The findings stand testimony to the fact that wind power generation is the most appropriate technology for Indian conditions to generate and conserve power, protect the environment and develop the rural areas and achieve sustainable development.

To improve the **status quo the following recommendations are putforth:**

1. Subsidize wind turbines
2. Insist on energy studies, particularly, wind energy generation in the educational curriculum at all levels.
3. Sustain tax benefits and incentives offered to stakeholders.
4. Motivate mass production of turbines to reduce costs.
5. Envisage electrification of villages using the value added wind energy.

Conclusion

The success of the wind energy programme is one of the important reasons for optimism about the likely role that renewable energy sources can play in the energy sector in India The eco-friendly policies, which are gathering dust, have to be given new life for implementation. More developer - friendly schemes should be introduced to encourage participation by more people in this field.

Swami Vivekananda said "An Ounce of practice is better than tonnes of talk". The sector practices and thus service.

References

1. Ayyadurai, R.K (1997). "Grid Related Problems on Absorption of Wind Electric Generation", New Delhi RameshR, Udatkumar.K and Anandakrishnan. "Renewable Energy Technologies, Norosha Pulishing House, pp 179-181.
2. Banerjee, S. (2001). "Wind Energy Potential in India", Kurushetra, Vol.49, No.5, p.29.
3. Cherail, K. (2003). "Wind Pro", Indian Wind Power Association, Chennai, No.75, p.2.
4. Chikoba, (2003). "Wind Pro", Indian Wind Power Association, Chennai, No.60-79, p.2 and 33.

5. Deambi, S. (2003), “The Winds of Change”, Journal of Science Reporter”, pp.42-45.

6. Directory, Indian Wind Power-2003, Consolidated Energy Consultants Ltd, Bhopal, Third Edition, p.4-1.

7. Garg,B.M.L. (2003). “Directory of Indian Wind Power”, Consolidated Energy Consultants Ltd, Bhopal, Third Edition, pp.1-1 to 5-40.

8. Ghuman (1985) “Wind Energy, Resources, Systems and Regional Strategies”, California Island Press, p.173.

9. Guruswamy (1997) “The Role of Energy, Environment and Technology for Sustainable Economic and Social Development, Narosa Publishing House, New Delhi, pp.37-40.

10. Cambridge Hills, R.L. (1992). “Power from Wind: A History of Wind Mill Technology, Cambridge University Press,

11. Kealy, E.J (1987). “Harvesting the Air: Wind Mill Pioneers in 12th Century England”, Berkley, CA, University of California Press.

12. Mahajan,V.S., Agnihorti,S.K. and Athparia,R.P. (1999), “Energy and Energy Resource Management”, New Delhi Deep and Deep Publications, p.124

13. Malayappan,S.et.al. (2003), “Design of Wind Turbine Blade and an analysis”,No.68,p.37.

14. Parish. J and Bahu, P.G.”Clean Development Mechanism and Sustainable in Conference of Parties-8",Wind Pro,No.65,pp.23-29.

15. Rao, S and Parulekar, B.B. (1999). “Energy Technoloies (Non Conventional Renewable and Conventional)”, Khannan Publication, New Delhi, pp.306-343.

16. Sastry, J.P.L.N. (2001) “Overview of Wind Energy”, Palaniappan,C, Koolar,A.J and Haridasan.T.M. Renewable Energy Technology, Narosha New Delhi Publishing Home, pp.202-204.

17. Sivakumar (2003) “R and D panel for Wind generation”, Chennai, Wind Pro, No.69, p.12.

18. Venkatesh, R. (2003), “Some Aspects of Reactive Power Management in Wind Farms”, Chennai, Wind Pro, No.71, pp.3-9.

ULTRASONIC INVESTIGATION OF BINARY MIXTURES OF BENZALDEHYDE WITH SOME ALCOHOLS AT 303.15 K

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Abstract

The existence of specific molecular interactions has been investigated through the thermo physical properties of eight binary systems of benzaldehyde with different alkanols. The physical properties such as ultrasonic velocity (υ), density (ρ) and dynamic viscosity (η) for these systems at 303.15 K and at atmospheric pressure were measured over the whole range of composition. From the measured properties various thermo acoustical parameters and their deviations from ideal values were computed. The trend in these parameters with composition was discussed in terms of nature and strength of interaction. The non- ideal behavior of the binary systems is discussed on the basis of dipole – dipole interactions and hydrogen bonding. The excess parameters were fitted to polynomial type Redlich – Kister equation and the coefficients of the fitting were found to support the present investigation. The present study identifies the structure breaking property of benzaldehyde and the strength of interaction appears to decrease with chain length of alcohols.

Keywords

Benzaldehyde, Alkanol, Acoustic parameters, Excess parameter, Non - ideal, Hydrogen bond

1. Introduction

Study of thermodynamic properties of binary mixtures in varying composition and condition provides ample opportunities for optimizing the choice of solvent in manifold applications[1,2]. The degree of deviation from ideality has been found to be an excellent qualitative and quantitative way to elicit information about molecular structure and intermolecular forces in liquid mixtures. This has given impetus to the theoretical and experimental investigations of the excess thermodynamic

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properties of liquid mixtures[3]. In continuation of our earlier studies on the molecular interactions of the eight alkanols with unsaturated aromatic aldehyde viz. cinnamaldehyde[4], the present paper reports on the presence of specific interactions between saturated aromatic aldehyde viz. benzaldehyde with the eight alcohols and the influence of the structure of components on these interactions. The study of thermo-acoustic properties involving systems with alkanol is shown keen interest because of its potential applications in the chemical and pharmaceutical industries. Branching of alkyl group attached to the hydroxyl group may influence the properties of alcohols. Hydrogen bonded systems are very interesting because hydrogen bond plays a vital role in chemical, physical and biological processes. In the present investigation, thermo-acoustic and excess parameters have been computed for the entire composition range for eight binary liquid mixtures of benzaldehyde and eight alkanols, namely, methanol (MA), ethanol (EA), n-propyl alcohol (NPA), iso-propyl alcohol (IPA), n-butyl alcohol (NBA), iso-Butyl alcohol (IBA), sec-butyl alcohol (SBA)and tert- butyl alcohol (TBA). The excess parameters when fitted into Redlich-Kister polynomial shall throw light on the validity of the experimental results and the computed coefficients may reveal exposition on strength of inter-molecular forces. There is no possibility of chemical reaction in the investigated binary mixtures in the absence of acid[5] as protonation of carbonyl compound is the first step in the mechanism of hemiacetal formation between aldehyde and alcohol,

2 Experimental

All the compounds used in the present work were of AnalaR grade samples and they were purified before use in accordance with the procedure described elsewhere[6]. The estimated purity was > 99.8%. Ultrasonic sound velocities were measured in a single crystal variable path ultrasonic interferometer operating at 2 MHz frequency supplied by Mittal Enterprises, India, Model F81, at 303.15 K. The sound velocities are accurate to 0.2 m/s. The densities of the solutions were determined using a 10 ml specific gravity bottle and a Shimadzu digital balance of accuracy $\pm 10^{-6}$ kg. Viscosity measurements were made with an Ostwald's viscometer in which the flow time for solutions was measured through a digital stop clock of accuracy ±0.01 s. Digitally controlled and well-stirred thermostatic water bath with a temperature T = (303.15 ± 0.1) K was used for all the measurements.

The various acoustical and excess parameters as a function of ultrasonic velocity 'μ', density 'ρ' and viscosity 'η' were computed using standard relations as found elsewhere[7]. The measured properties and the calculated acoustical parameters are summarized in Tables 1 and Table 2 given in appendix. The excess properties were fitted by the method of nonlinear least squares to a Redlich-Kister type polynomial[8]. The derived parameters, a_i, and the estimated standard deviation,σ, are given in Table 3 in appendix.

3 Results and discussion

The measured properties and the computed acoustical parameters for the eight binary systems at various compositions are listed in tables 1 and respectively. Fig.1 (a-c) contains the plot of ultrasonic velocity (μ), adiabatic compressibility 'κ' and internal pressure 'π' against mole fractions of alcohols.

The variation in ultrasonic velocity 'υ' with mole fraction of alcohol as observed from the data in Table 1 and Figure 1(a) is in accordance with the view proposed by Eyring and Kincaid[9]. The dominance of the expansive forces over the contractive unlike molecular association between alcohol and aldehyde may decrease the velocity. The disruption of associates in pure liquids seems to be more pronounced than the unlike molecular interactions[10]. The adiabatic compressibility (κ) and intermolecular free length show an exact reverse trend as that of ultrasonic velocity. Analysis of the data in Table 2 given in appendix, and a close look at Fig. 1(b) shows the non-linear increase in 'κ' with concentration which confirms the existence of specific interactions between unlike molecules. The dominance of expansive forces makes the systems more compressible and lead to increasing value of 'κ'[11]. The 'π_i' values also show an inverse trend with 'υ' (Table 2 in appendix & Fig. 1(c)) in the entire mole-fraction range investigated. This may be attributed to the possibility of strong intermolecular interactions of the type dipole – dipole or complex formation through intermolecular hydrogen bonding[12]. The free volume shows an exact reverse trend with 'π_i'. This suggests increasing compactness due to association at higher alcohol concentration. Similar acoustical properties were reported for systems involving DMA with alkanols[13]. Molecular interaction parameter values as a function of ultrasonic velocity are calculated for the eight systems. Positive values of molecular interaction parameter for all composition at 303.15 K indicate presence of strong attractive forces between components. The values are changing from positive to negative in certain concentration range for IBA and TBA systems, indicating weakening molecular interactions in these cases. A perusal on the magnitude of LJP indicates that it is in the range of hydrogen bonding type of interaction.

The plots of excess velocity, excess compressibility and excess internal pressure versus mole fraction of alcohol are shown in Fig.2 (a-c). It can be seen from the plots (Fig.2 (a)) that there is positive deviation in u^E for all the systems over whole range of composition except for TBA and IBA systems. In these two systems u^E varies from positive at low concentration to negative at high mole fraction of alcohol. This shows that the unlike molecular interaction weaken in alcohol rich region. The trend in u^E as well as ÷ with concentration in all the systems indicates the presence of hydrogen bond and it leads to increase in sound velocity[14]. The excess velocity for the binary systems at a particular composition follows the order MA>SBA>EA>IPA»NPA»NBA. The values of κ^E depend on balance between opposing effects reported earlier[15]. Analysis of data in Table 3 given in appendix,

reveals that the variation in κ^E and L_f^E supports the existence of strong dipole-dipole interaction between the components. The order of magnitude for κ^E and L_f^E follows almost similar to that of u^E. According to Ali et.al[16] negative deviations in k^E and L_f^E from linear dependence on mole fraction 'x' of alcohols suggest the presence of strong interactions between components and become increasingly negative as the strength of interaction between component molecules increases. Further the interaction is between aromatic and aliphatic components there may be a possibility of interstitial penetration of the aliphatic alkanols into the aromatic aldehyde[17]. This may be the reason for methanol to exhibit the closest approach as evident from larger negative deviations.

The excess internal pressure (Tables 3 in appendix and Fig. 2 (c)) shows large negative values contrary to the positive deviations in u^E for systems with order IBA < SBA < IPA » EA » TBA. Such variations in π_i^E have been reported for system with the dominance of structure breaking effect and dispersive interactions[18]. The π_i^E values for MA system vary from negative to positive which indicates the increasing magnitude of interaction in this system. In the case of NPA system the π_i^E values show an inverse 'S' type variation indicating the weakening of interaction. The behaviour of excess free volume is observed to follow a similar trend as those of κ^E and L_f^E. The trend in excess free volume may be explained based on the structural difference of aromatic aldehyde and aliphatic alcohols and also the presence of fitting of components.

Variation in excess molar volume (V_m^E) is negative for three systems and change sign from negative to positive in three other systems but positive in IBA system in the entire composition range (Table 3 given in appendix). In this case, the excess volume values of lower alcohols are negative. Further, the increased breaking of ordered structure in higher alcohols may result in positive deviation in molar volume. V_m^E and κ^E both tend to decrease as the strength of interaction between component increases, although packing effects must be taken into account[19]. On the other hand, positive values of V_m^E may be due to the increase in the volume occupied by the large size hetero molecular clusters as reported. The size of the cluster would however depend upon whether the hetero molecular interactions are of short range or long range. Interactions of short range would lead to clusters of smaller size, while long range interactions producing ordering of cluster which would lead to large size clusters[20].

The salient features observed in the present acoustical study can be enumerated as follows: (i) As the chain length increases, the interaction is expected to be stronger due to positive inductive (+I) effect. However, But the interaction is weakened with increase in chain length, may be due to the presence of –OH (protic) group in alcohols. (ii) There are reports that TBA systems show weaker interactions due to steric hindrance[3]. Inductive release of electrons by three – methyl groups may

increase the negative charge density on oxygen atom and consequently the attraction between tertiary butyl alcohol and aldehyde is increased[21]. (iii) Benzaldehyde forms hydrogen bond more favorably with MA, EA since the positive charge on hydrogen of –OH group decreases with increase in the chain length of the alkyl group[22]. Further the structure breaking of alkanols by benzaldehyde becomes easier as the size of the aldehyde molecule is smaller in benzaldehyde than cinnamaldehyde and hence benzaldehyde is more polarizable. (iv) It interesting to observe the magnitude of acoustical and excess parameters for benzaldehyde systems compared with our earlier observations for cinnamaldehyde systems[6] that unlike molecular interaction appears to be less pronounced than the structure breaking effect of benzaldehyde. This may be due to the extension of conjugation in cinnamaldehyde.

4. Conclusions

This paper deals with the investigation on thermo physical properties of binary systems of benzaldehyde and structurally different eight alkanols. The measured parameters and the computed acoustical and excess parameters establish the presence of hydrogen bonding between the alkanols and benzaldehyde. The dominance of structure breaking effect of benzaldehyde has been observed from the variation of the acoustical parameters with composition. It is observed from the sign and magnitude of excess parameters that the strength of intermolecular interactions decreases with increasing chain length and branching of alkyl group in the alcohols. The excess parameters fitted into Redlich-Kister polynomial proved the validity of theoretical models on the experimental results. The computed coefficients reveal exposition on strength of inter-molecular forces.

References

1. Pitzer, K. S. (1995) Thermodynamics, Third ed., pp 22-27 McGraw Hill Book Co., NY
2. Ali Basu, M., Samanta, T. and Das, D. (2013) Volumetric and acoustic properties of binary mixtures of tri-n-butyl phosphate with n-hexane, cyclohexane, and n-heptane from T = (298.15 to 323.15) K, J. Chem. Thermodynamics 57, 335–343
3. Kumar, R., Mahesh, R., Shanmugapriyan, B. and Kannappan, V. (2012) Volumetric, viscometric, acoustic and refractometric studies of molecular interactions in certain binary systems of o-chlorophenol at 303.15 K, Indian J. Pure & Appl. Phys., 50, 633-640
4. Padmanabhan, G., Kumar, R., Ulagendran, V., Kannappan, V. and Jayakumar, S., (2012) Molecular interaction of studies of cinnamaldehyde with certain alcohols by ultrasonic method at 303.15 K, Indian J. Pure & Appl. Phys., 50, 899-906
5. John McMurry (2008) Organic Chemistry, 7thEdn., pp717 Thomson Brooks/Cole, Belmont, USA.
6. Vogel, A. I., A Textbook of Practical Organic Chemistry (1989) 5thEdn., John Willey, New York.

7. Baldev Raj, Rajendran, V. and Palanichamy, (2004) Science and Technology of Ultrasonics, Narosa Publishing House, New Delhi (2004)

8. Redlich, O. and Kister, A. T. (1948) Thermodynamics of Nonelectrolytic Solutions: Algebraic Representation of Thermodynamic Properties and the Classification of Solutions, Ind. Eng. Chem., 40, 345-348.

9. Eyring, H. and Kincaid, J.F. (1938) Free volume and free angle ratio of molecules in liquids, J. Chem. Phys., 6 (1938) 620-625

10. Ali, A., Nain, A. K., Sharma, V. K. and Ahmad, S. (2001) Ultrasonic studies in binary liquid mixtures, Indian J Phys, 75B, 519-525

11. Arul, G. and Palaniappan, L. (2001) Molecular interaction studies in the ternary mixtures of cyclo hexane + toluene + 2-propanol, Indian J. Pure & Appl. Phys., 39, 561-564

12. Kannappan, A. N., Kesavasamy, R. and Ponnuswamy, V. (2008) Moluecular interaction studies in the ternary liquid mixture of pyridine+benzene+N, N-dimethylformamide by ultrasonic velocity measurements, ARPN J. Eng. Appl. Sci., 3, 41-45

13. Lakshmi Nadh, M., Madhu Mohan, T., Vijaya Krishna, T. and Ch. Ravi Shankar Kumar (2013) Acoustical and computational studies on hydrogen bonded binary mixtures of N, N – dimethylacetamide with alcohols, Indian J. Pure & Appl. Phys., 51, 406-412

14. Mahendran, G. and Palaniappan, L. (2011) Molecular interactions of aniline in toluene + iso-butabol system, Indian J. Pure & Appl. Phys., 49, 803-808

15. Neerajakshi, K. G., Krishna Rao, K. S. V., Bharathi, R., Kiran Kumar, A. B. V., Subha, M. C. S. and Narayanaswamy, G. (2006) Speeds of sound and isentropic compressibilities of non electrolyte liquid mixtures containing ethylene glycol and amines J. Pure & Appl. Ultrason., 28, 144-149

16. Ali, A., Yasmin, A. and Nain, A. K. (2002) Study of intermolecular interactions in binary liquid mixtures through ultrasonic speed measurement, Indian J. Pure & Appl. Phys., 40, 315-318.

17. Rathnam, M. V., Reema, T. Sayed, Kavita, R., Bhanushali and Kumar, M. S. S. (2012) Molecular interaction study of binary mixtures of methyl benzoate: Viscometric and ultrasonic study J. Mol. Liq., 166, 9-16.

18. Manisha Gupta, Isht Vibhu and Shukla, J. P. (2006) Ultrasonic velocity, viscosity and excess properties of binarymixture of tetrahydrofuran with 1-propanol and 2-propanol, Fluid Phase Equilib, 244, 26-32.

19. Mosteiro, L., Casas, L. M. and Legido, J. L. (2009) Surface tension, density, and speed of sound for the ternary mixture {diethyl carbonate + p-xylene + decane}, J. Chem. Therm., 41, 695-704.

20. Bhandakkar, V. D., Tabhane, V. A. and Sharda Ghosh (2003) Ultrasonic study of molecular interactions in binary liquid mixtures: acrolien & cinnamaldehyde in methanol, cyclohexane & p-dioxane, Indian J. Pure & Appl. Phys., 41, 849-854.

21. Kannappan, V. and Jayasanthi, R. (2005) Ultrasonic studies of isomeric butyl alcohol in aqueous solutions, Indian J. Pure & Appl. Phys., 43, 167-171.

22. Ali, A., Nain, A. K., Sharma, V. K. and Ahmad, S. (2004) Molecular interactions in binary mixtures of tetrahydrofuran with alkanols (C6, C8, C10): An ultrasonic and volumetric study, Indian J. Pure & Appl. Phys, 42, 666-673.

Table 1 Ultrasonic velocity 'u', density 'r' and viscosity 'h' for various mole fraction 'x_2' of alcohols for eight binary systems of benzaldehyde and alcohols at 303.15 K

x_2	U /(ms^{-1})	ρ /(Kgm^{-3})	η / (10^{-3} Nsm^{-2})	x_2	U /(ms^{-1})	ρ /(Kgm^{-3})	η / (10^{-3} Nsm^{-2})
		BA+MA				**BA+EA**	
0.0000	1416.2	1047.1	1.401	0.0000	1416.2	1047.1	1.401
0.2567	1408.6	1049.0	1.480	0.1935	1401.2	1026.4	1.337
0.4370	1403.4	1041.2	1.590	0.3509	1384.6	1003.6	1.289
0.5709	1394.4	1030.3	1.762	0.4808	1365.6	978.6	1.246
0.6742	1375.6	1015.5	1.853	0.5901	1339.7	951.7	1.206
0.7565	1347.3	993.5	1.796	0.6836	1309.7	920.9	1.169
0.8233	1311.4	962.7	1.637	0.7643	1278.2	892.7	1.145
0.8787	1266.7	926.2	1.399	0.8344	1245.8	866.3	1.141
0.9254	1222.1	883.9	1.166	0.8963	1215.4	841.6	1.152
0.9655	1185.4	844.1	0.9711	0.9512	1186.2	819.1	1.194
1.0000	1144.4	797.1	0.7740	1.0000	1161.0	797.7	1.313
		BA+NPA				**BA+IPA**	
0.0000	1416.2	1047.1	1.401	0.0000	1416.2	1047.1	1.401
0.1572	1399.5	1032.7	1.647	0.1567	1398.4	1025.8	1.381
0.296	1382.1	1015.1	1.827	0.2948	1378.1	1003.2	1.356
0.4187	1363.8	995.6	1.953	0.4174	1355.0	979.1	1.323
0.5284	1345.6	975.3	1.956	0.527	1331.4	953.4	1.287
0.6271	1327.2	952.3	1.926	0.6259	1308.1	924.5	1.274
0.7161	1308.3	927.9	1.913	0.715	1283.6	898.7	1.284
0.7968	1288.4	900	1.869	0.7959	1259.6	874	1.329
0.8704	1267.6	871.5	1.881	0.8698	1234.2	849.8	1.472
0.9381	1247.6	841.8	1.890	0.9378	1207.4	826.8	1.673
1.0000	1227.0	809.5	1.899	1.0000	1181.2	805.1	1.974
		BA+NBA				**BA+IBA**	
0.0000	1416.2	1047.1	1.401	0.0000	1416.2	1047.1	1.401
0.1318	1409.4	1038.3	1.950	0.1313	1431.4	1021	1.468
0.2547	1398.7	1021.9	2.182	0.2542	1431.6	994.9	1.528
0.3693	1382.8	1001.5	2.160	0.3686	1419.8	970	1.584
0.4769	1363.4	978.6	1.711	0.476	1401.4	945.4	1.645
0.5778	1341.2	954.5	1.627	0.5769	1374.6	921.6	1.709
0.6723	1317.9	929.1	1.675	0.6716	1343.8	898.5	1.789
0.7613	1293.2	901.2	1.760	0.7607	1314.5	875.8	1.896
0.8452	1268.8	871.9	1.890	0.8449	1295.7	853.2	2.058
0.925	1243.4	842.6	2.030	0.9247	1292.2	831.1	2.304
1.0000	1217.7	812.2	2.269	1.0000	1305.4	809.6	2.709
		BA+SBA				**BA+TBA**	
0.0000	1416.2	1047.1	1.401	0.0000	1416.2	1047.1	1.401
0.1324	1431.4	1021	1.468	0.1303	1422.6	1028.1	1.519
0.2555	1431.6	994.9	1.528	0.2516	1417.2	1007.2	1.538
0.3704	1419.8	970	1.584	0.3657	1397.8	982.3	1.579
0.4777	1401.4	945.4	1.645	0.4729	1356.6	954.8	1.683
0.5784	1374.6	921.6	1.709	0.5739	1299.3	925.4	1.667
0.673	1343.8	898.5	1.789	0.6687	1240.4	894.4	1.771
0.7619	1314.5	875.8	1.896	0.7584	1192.6	864.5	1.934
0.8457	1295.7	853.2	2.058	0.8432	1155.2	838.1	2.195
0.9252	1292.2	831.1	2.304	0.9239	1141	815.8	2.954
1.0000	1305.4	809.6	2.709	1.0000	1147.6	799.5	3.857

Appendix

Table 2 Computed acoustical parameters, adiabatic compressibility 'k', free length' L_f', Lennard Jones Potential 'LJP', interaction parameter 'c', internal pressure 'p_i' and free volume 'V_f' for various mole fraction 'x_2' of alcohols with benzaldehyde at 303.15 K

x_2	L_f /(A°)	V_m /(10^{-4} m^3mol^{-1})	LJP /(J mol^{-1})	χ	V_f /(10^{-8} m^3mol^{-1})
			BA+MA		
0.0000	0.4364	1.013	39.231		12.53
0.1324	0.4384	0.8565	37.157	0.0780	8.930
0.2555	0.4417	0.7438	35.830	0.1456	6.383
0.3704	0.4468	0.6562	33.693	0.1960	4.420
0.4777	0.4562	0.5874	29.781	0.2192	3.328
0.5784	0.4710	0.5340	24.990	0.2164	2.835
0.673	0.4915	0.4936	20.264	0.1918	2.652
0.7619	0.5188	0.4619	15.803	0.1448	2.722
0.8457	0.5505	0.4302	12.404	0.0978	2.842
0.9252	0.5807	0.4164	10.155	0.0518	3.174
1.0000	0.6190	0.4019	8.071		3.681
			BA+EA		
0.0000	0.4364	1.013	39.231		12.53
0.1935	0.4455	0.9380	35.290	0.0391	11.45
0.3509	0.4560	0.8745	31.568	0.0702	10.34
0.4808	0.4682	0.8206	27.956	0.0922	9.325
0.5901	0.4839	0.7747	23.881	0.0977	8.371
0.6836	0.5032	0.7368	20.069	0.0914	7.485
0.7643	0.5237	0.7012	16.832	0.0776	6.597
0.8344	0.5454	0.6677	14.103	0.0581	5.672
0.8963	0.5672	0.6364	11.961	0.0382	4.797
0.9512	0.5891	0.6059	10.200	0.0171	3.913
1.0000	0.6099	0.5775	8.868		2.936
			BA+NPA		
0.0000	0.4364	1.013	39.231		12.53
0.1572	0.4447	0.9684	34.880	0.0118	8.847
0.296	0.4542	0.9295	31.057	0.0206	6.811
0.4187	0.4648	0.8949	27.644	0.0260	5.542
0.5284	0.4759	0.8628	24.736	0.0297	4.974
0.6271	0.4883	0.8351	22.191	0.0311	4.581
0.7161	0.5018	0.8101	19.911	0.0300	4.163
0.7968	0.5174	0.7896	17.809	0.0256	3.872
0.8704	0.5345	0.7711	15.881	0.0181	3.442
0.9381	0.5525	0.7548	14.242	0.0103	3.067
1.0000	0.5729	0.7422	12.737		2.732
			BA+IPA		
0.0000	0.4364	1.013	39.231		12.53
0.1567	0.4465	0.9751	34.619	0.0189	11.51
0.2948	0.4582	0.9410	30.263	0.0318	10.61
0.4174	0.4717	0.9105	26.184	0.0383	9.852
0.527	0.4865	0.8833	22.741	0.0415	9.184
0.6259	0.5028	0.8608	19.888	0.0429	8.342
0.715	0.5197	0.8370	17.341	0.0401	7.365

0.7959	0.5371	0.8136	15.202	0.0359	6.249
0.8698	0.5559	0.7912	13.244	0.0272	4.780
0.9378	0.5761	0.7687	11.452	0.0142	3.508
1.0000	0.5967	0.7463	9.923		2.435
			BA+NBA		
0 0000	0 4364	1 013	39 231		12 53
0.1318	0.4404	0.9876	37.367	0.0216	7.206
0.2547	0.4473	0.9700	34.690	0.0376	5.720
0.3693	0.4570	0.9562	31.199	0.0457	5.421
0.4769	0.4689	0.9449	27.575	0.0481	7.143
0.5778	0.4827	0.9350	24.094	0.0454	7.127
0.6723	0.4979	0.9267	21.030	0.0402	6.297
0.7613	0.5152	0.9211	18.291	0.0320	5.380
0.8452	0.5338	0.9174	15.986	0.0234	4.444
0.925	0.5541	0.9141	13.921	0.0125	3.659
1.0000	0.5763	0.9126	12.111		2.833
			BA+IBA		
0.0000	0.4364	1.013	39.231		12.53
0.1313	0.4373	1.005	43.940	0.0391	11.30
0.2542	0.4429	0.9969	44.007	0.0572	10.12
0.3686	0.4523	0.9881	40.274	0.0573	8.993
0.476	0.4642	0.9791	35.338	0.0473	7.908
0.5769	0.4793	0.9695	29.591	0.0242	6.881
0.6716	0.4965	0.9593	24.471	-0.0052	5.883
0.7607	0.5141	0.9488	20.625	-0.0327	4.938
0.8449	0.5284	0.9381	18.548	-0.0451	4.040
0.9247	0.5369	0.9271	18.189	-0.0352	3.208
1.0000	0.5385	0.9155	19.587		2.411
			BA+SBA		
0.0000	0.4364	1.013	39.231		12.53
0.1324	0.4355	0.9965	43.940	0.0519	10.54
0.2555	0.4394	0.9831	44.623	0.0860	9.624
0.3704	0.4460	0.9724	43.009	0.1104	9.507
0.4777	0.4564	0.9645	38.892	0.1211	8.867
0.5784	0.4698	0.9572	33.557	0.1192	8.182
0.673	0.4859	0.9507	28.273	0.1083	7.305
0.7619	0.5066	0.9451	22.781	0.0813	6.082
0.8457	0.5296	0.9355	18.088	0.0456	4.931
0.9252	0.5513	0.9228	14.875	0.0168	3.523
1.0000	0.5705	0.9096	12.806		2.272
			BA+TBA		
0.0000	0.4364	1.013	39.231		12.53
0.1303	0.4385	0.9981	41.115	0.0515	10.64
0.2516	0.4447	0.9854	39.516	0.0874	9.878
0.3657	0.4565	0.9766	34.478	0.1027	8.839
0.4729	0.4771	0.9705	26.441	0.0830	7.290
0.5739	0.5060	0.9666	18.926	0.0360	6.574
0.6687	0.5391	0.9648	13.696	-0.0153	5.306
0.7584	0.5704	0.9622	10.564	-0.0503	4.149
0.8432	0.5980	0.9558	8.583	-0.0701	3.091
0.9239	0.6137	0.9449	7.915	-0.0531	1.835
1.0000	0.6164	0.9271	8.220		1.170

Table 3- Smoothening coefficients (a_i) of Redlich-Kister polynomial and standard deviation (s) of excess parameters for benzaldehyde and alcohols systems

Excess parameters	a_0	a_1	a_2	a_3	σ
BA+MA					
$u^E\ 10^3\ ms^{-1}$	0.4651	-0.3511	0.0438	0.122	0.0015
$\kappa^E\ 10^{-10}\ pa^{-1}$	-8.7947	6.7618	-5.2713	4.5243	0.0392
$L_f^E\ 10^{-12}\ m$	-32.772	24.992	-15.314	8.3171	0.1236
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	-15.477	8.0837	-6.4174	-0.8476	0.0852
$\pi_i^E\ 10^8\ pa$	-1.0660	-10.3525	9.903	-0.3237	0.0607
$V_f^E\ 10^{-8} m^3\ mole^{-1}$	-13.5463	7.1694	-0.0845	0.0295	0.0768
BA+EA					
$u^E\ 10^3\ ms^{-1}$	0.2435	-0.0257	-0.0888	0.0226	0.0004
$\kappa^E\ 10^{-10}\ pa^{-1}$	-5.2766	1.838	0.4438	-0.2905	0.0051
$L_f^E\ 10^{-12}\ m$	-18.065	4.3936	3.2385	-0.9618	0.0231
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	-1.5094	-5.6964	4.3666	2.5164	0.0506
$\pi_i^E\ 10^8\ pa$	-6.4183	3.8742	-4.2077	3.8727	0.0296
$V_f^E\ 10^{-8} m^3\ mole^{-1}$	3.9294	-1.7823	1.5590	0.02901	0.0184
BA+NPA					
$u^E\ 10^3\ ms^{-1}$	0.0798	-0.0198	0.0026	0.0162	0.0002
$\kappa^E\ 10^{-10}\ pa^{-1}$	-3.0217	1.2572	-0.4823	-0.0321	0.0046
$L_f^E\ 10^{-12}\ m$	-10.399	3.7806	-1.2165	-0.5191	0.0175
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	-8.4574	2.3691	-0.8564	-1.0967	0.0364
$\pi_i^E\ 10^8\ pa$	0.2060	2.3702	-1.0568	-1.7122	0.0207
$V_f^E\ 10^{-8} m^3\ mole^{-1}$	-11.1209	-10.957	-4.1603	1.6160	0.0395
BA+IPA					
$u^E\ 10^3\ ms^{-1}$	0.1091	-0.0086	0.0218	0.0059	0.0004
$\kappa^E\ 10^{-10}\ pa^{-1}$	-3.2756	0.7264	-0.3428	0.2785	0.0050
$L_f^E\ 10^{-12}\ m$	-10.465	1.2438	-0.8134	0.9305	0.0194
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	-0.5784	-5.4074	1.5007	3.6836	0.0506
$\pi_i^E\ 10^8\ pa$	-6.1149	5.3058	-3.0553	0.2638	0.0137
$V_f^E\ 10^{-8} m^3\ mole^{-1}$	6.0371	-5.6456	-3.1833	6.5912	0.0403
BA+NBA					
$u^E\ 10^3\ ms^{-1}$	0.1215	0.0535	0.006	-0.0242	0.0002
$\kappa^E\ 10^{-10}\ pa^{-1}$	-3.2001	0.3227	-0.2818	0.0438	0.0021
$L_f^E\ 10^{-12}\ m$	-11.008	-0.2567	-0.8722	0.0579	0.0083
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	-10.117	-1.4635	-2.5668	-3.4787	0.0274
$\pi_i^E\ 10^8\ pa$	-1.6163	7.2797	6.3948	-0.3999	0.1327
$V_f^E\ 10^{-8} m^3\ mole^{-1}$	-3.1886	-20.708	-34.468	-11.189	0.3419
BA+IBA					
$u^E\ 10^3\ ms^{-1}$	0.077	0.3506	-0.1327	0.0015	0.0012
$\kappa^E\ 10^{-10}\ pa^{-1}$	-1.3643	-2.656	1.9745	-0.5622	0.0116
$L_f^E\ 10^{-12}\ m$	-4.5842	-11.558	6.7382	-1.3867	0.0463
$V^E\ 10^{-6}\ m^3\ mole^{-1}$	3.0122	0.1512	-0.1836	-0.7516	0.0082

π_i^E 10^8 pa	-3.413	1.5767	-0.9533	0.6596	0.0048
V_f^E 10^{-8} m^3 $mole^{-1}$	-1.4532	0.2094	-0.1673	-0.1439	0.0039
BA+SBA					
u^E 10^3 ms^{-1}	0.3134	0.0703	-0.1024	0.1280	0.0007
κ^E 10^{-10} pa^{-1}	-4.1012	0.1716	1.0824	-1.4856	0.0079
L_f^E 10^{-12} m	-15.035	-1.4767	4.4132	-5.2413	0.0318
V^E 10^{-6} m^3 $mole^{-1}$	-0.7926	-8.1427	1.6231	2.6599	0.0565
π_i^E 10^8 pa	-4.8749	4.4952	-1.4739	2.3702	0.0196
V_f^E 10^{-8} m^3 $mole^{-1}$	4.0781	-5.259	-10.66	-5.8498	0.0849
BA+TBA					
u^E 10^3 ms^{-1}	0.1192	0.6133	-0.1955	-0.2554	0.00137
κ^E 10^{-10} pa^{-1}	-3.5008	-5.7426	5.1991	0.2892	0.0154
L_f^E 10^{-12} m	-10.537	-24.562	16.027	5.3082	0.0542
V^E 10^{-6} m^3 $mole^{-1}$	-0.9507	-11.588	6.1293	1.2911	0.0274
π_i^E 10^8 pa	-7.4536	6.18313	-2.5760	-0.3827	0.0831
V_f^E 10^{-8} m^3 $mole^{-1}$	-0.511	0.1945	-5.2097	-2.4289	0.195

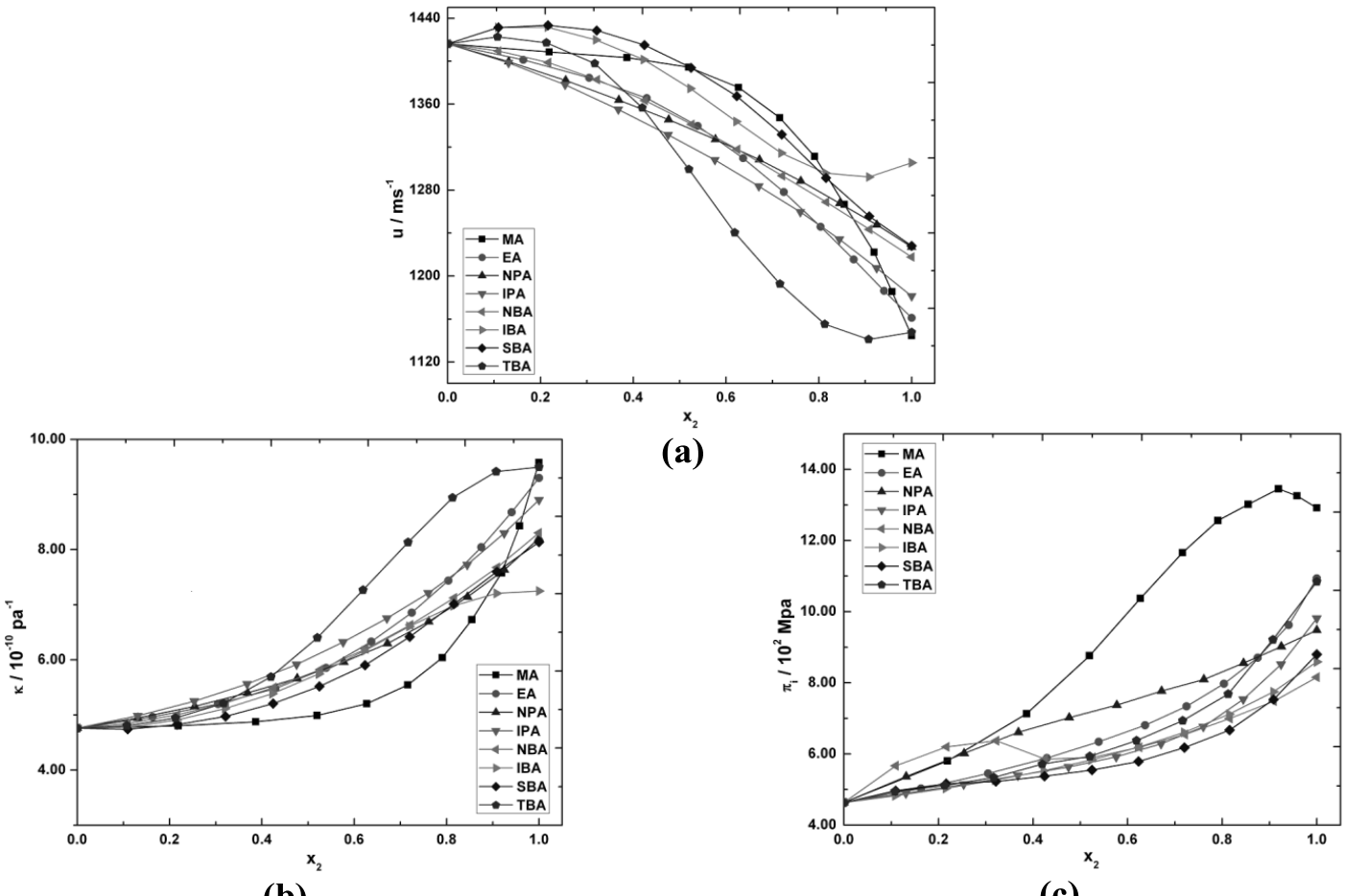

Fig.1 Plot of a) ultrasonic velocity, b) adiabatic compressibility and c) internal pressure versus mole fraction 'x_2' of alcohol for eight binary mixtures of benzaldehyde with alcohols at 303.15 K

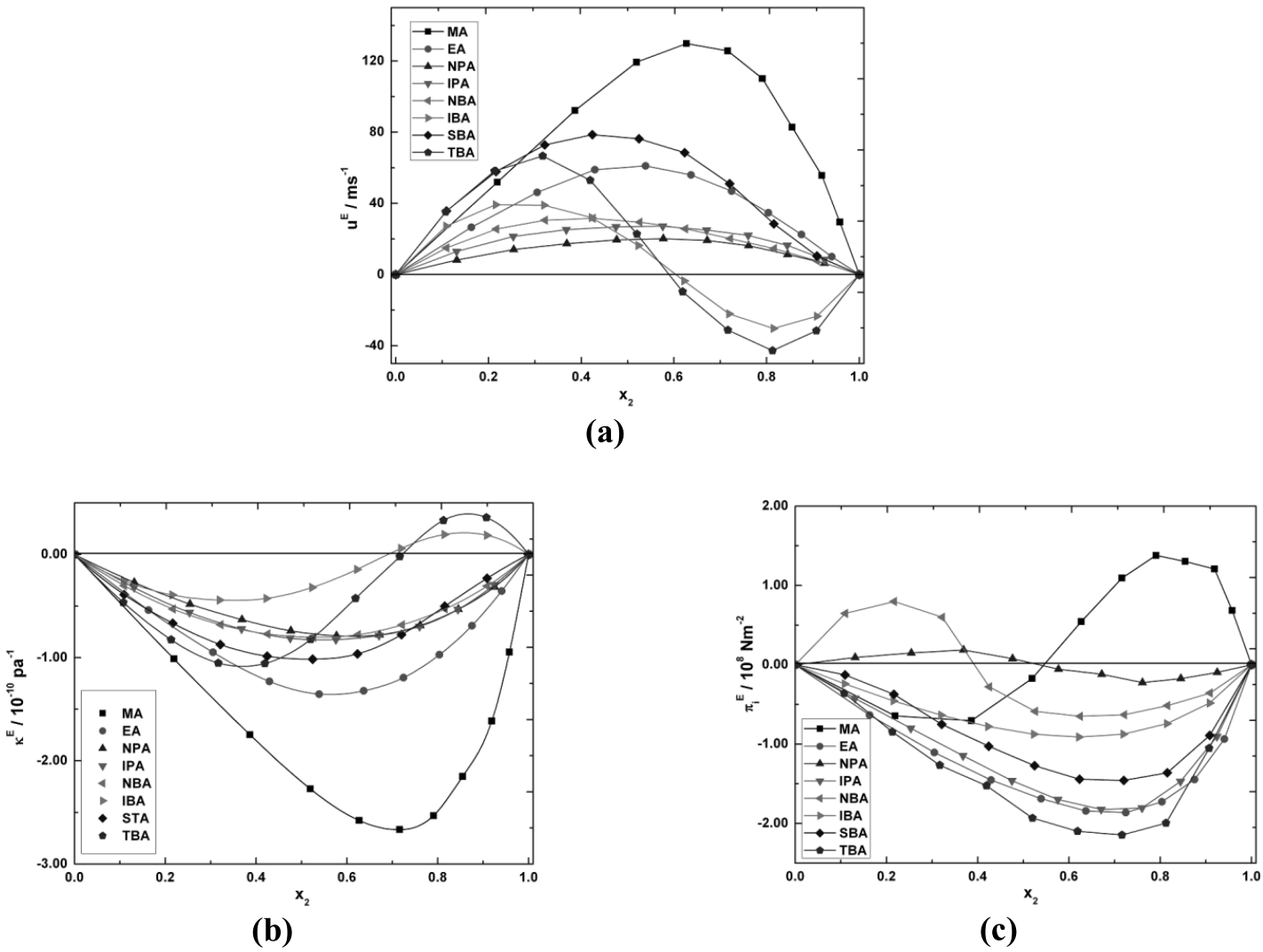

Fig. 2 Plot of excess parameters a) excess velocity b) excess molar volume and c) excess internal pressure versus mole fraction 'x_2' of alcohol for eight binary mixtures of benzaldehyde with alcohols at 303.15 K

PERFORMANCE ANALYSIS OF SORTING ALGORITHM

V.P.Kulalvaimozhi, M.Muthulakshmi, R.Mariselvi, G.Santhana Devi and C.Rajalakshmi

Abstract

An algorithm is a sequence of steps that gives method of solving a problem. It creates the logic of program. As an algorithm is executed, it uses the computer's Central Processing Unit (CPU) to perform operations and its memory to hold the program and data. Sorting means arranging the data in an orderly manner. The main objective is to compare the various sorting algorithms and these sorting algorithms are implemented by using a C++ program also the asymptotic complexity of each sorting algorithm is prepared.

Keywords

Bubble sort, Insertion sort, Selection sort, Shell sort, Merge sort, Quick sort, Heap sort, Binary Tree sort, Address calculation sort, Radix sort.

1. Introduction

Performance analysis refers to the task of determining how much computing time and storage an algorithm requires. The space complexity of a program is the amount of memory it needs to run to completion. The time complexity of a program is the amount of computer time it needs to run to completion. Sorting refers to the operation of arranging data in some given order, such as increasing or decreasing with numerical data or alphabetically with character data. All sorting algorithm apply to specific kind of problems. Some sorting algorithm apply to small number of elements, some sorting algorithm suitable for floating point numbers, some are fit for specific range like (0 1). Some sorting algorithm are used for large number of data, some are used for data with duplicate values. Performance evaluation can be loosely divided into two major phases:

1. Priori estimates
2. Posteriori estimates

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Simply we can refer these as performance analysis and performance measurement respectively.

The complexity of a sorting algorithm measures the running time as a function of the number of n items to be sorted. Each sorting algorithm S will be made up of the following operations, where A_1, A2,....An contain the items to be sorted and B is an auxiliary location.

1) Comparisons which test whether $A_i<A_j$ or test whether $A_i<B$.
2) Interchanges which switch the contents of A_i and A_j or A_i and B.
3) Assignments which set $B=A_i$ and then set $A_j=B$ or $A_j=A_i$.

Generally the complexity function measures only the number of comparisons, since the number of other operations is at most a constant factor of the number of other operations is at most a constant factor of the number of comparisons. Suppose space is fixed for one algorithm then only run time will be considered for obtaining the complexity of algorithm. We take 3 cases for complexity of algorithms.

A) Best case
B) Worst case
C) Average case

Best case: In this case, algorithm searches the element in first time itself. So taking this case for complexity of algorithm doesn't tell too much. Let us take a case of linear search, if it finds the element at first time itself then it behaves as best case.

Worst case: In this case, we find the element at the end or when searching of element fails. Suppose the element for which algorithm is searching is the last element of array or it's not available in array then algorithm behaves as worst case. This case is necessary in the view that algorithm will perform at least up to this efficiency and it will not go for less than this efficiency.

Average case: In this case, the average number of steps but since data can be at an place, so finding exact behavior of algorithm is difficult. As the volume of data increases average of algorithm behaves like worst case of algorithm. Analyzing the average case behavior of algorithm is little bit complex than best and worst case.

2. Sorting Methods

The sorting methods can be divided into two parts.

1. Internal sorting method
2. External sorting method

In an internal sorting method, data is going to be sorted will be in main memory. In an external sorting data will be on auxiliary storage like tape, floppy disk etc.,

2.1. Bubble sort

In the bubble sort, the consecutive elements of the table are compared and if the keys of the two elements are not found in proper order, they are interchanged. It starts from the beginning of the table and continue till the end of the table. As a result of this the element with the largest key will be pushed to the last element's position. After this the second pass is made.The second pass is exactly like the first one except that this time the elements except the last are considered. After the second pass, the next largest element will be pushed down to the next to last position. The second pass is followed by a third and so on until either (n-1) passes have been made or no interchange takes place in a pass. Here n is assumed to be the number of elements in the table.It may be noted that the non occurrence of any interchange in a pass ensures that the table is sorted. Ie, each number slowly bubbles up to its proper position.

Ex;

Consider the following numbers are stored in an array:

Original Array: 32,51,27,85,66,23,13,57

Pass 1 : 32,27,51,66,23,13,57,85

Pass 2 : 27,33,51,23,13,57,66,85

Pass 3 : 27,33,23,13,51,57,66,85

Pass 4 : 27,23,13,33,51,57,66,85

Pass 5 : 23,13,27,33,51,57,66,85

Pass 6 : 13,23,27,33,51,57,66,85

Advantages

1. Straightforward, simple and slow.
2. Stable.
3. Inefficient on large tables.

2.2. Insertion sort

An insertion sort is one that sorts a set of elements by inserting elements into an existing sorted array. Insertion sort uses the least CPU time, the smallest comparions and assignments. In this sort, i^{th} pass we insert the i^{th} element A[i] into its rightful place among A[1],A[2],….A[i-1] which were previously placed in sorted order. After doing this insertion, the elements occupying A[1],……A[i] are in sorted order.

Ex;

Consider the following numbers are stored in an array:

Original Array: 77,33,44,11,88,22,66,55

Pass 1 : 33,77,44,11,88,22,66,55

Pass 2 : 33,44,77,11,88,22,66,55

Pass 3 : 11,33,44,77,88,22,66,55

Pass 4 : 11,22,33,44,77,88,66,55

Pass 5 : 11,22,33,44,55,77,88,66

Pass 6 : 11,22,33,44,55,66,77,88

Advantages

1. Efficient for small list and mostly sorted list.
2. Sort big array slowly.
3. Save memory

2.3. Selection sort

A selection sort is one in which successive elements are selected in order and placed into their proper sorted positions. The elements of the input may have to be preprocessed to make the ordered selection possible. This sort is used to represent the selection of an element and keeping it in sorted order.

Suppose an array A with n elements in memory. The selection sort algorithm for sorting an array A works as follows.

i) To find the smallest element in the list and put in the first position.

ii) To find the second smallest element in the list and put in the second position and so on.

Ex;

Consider the following numbers are stored in an array:

Original Array: 77,33,44,11,88,22,66,55

Pass 1 :11,33,44,77,88,22,66,55

Pass 2 :11,22,44,77,88,33,66,55

Pass 3 :11,22,33,77,88,44,66,55

Pass 4 :11,22,33,44,88,77,66,55

Pass 5 :11,22,33,44,55,77,66,88

Pass 6 :11,22,33,44,55,66,77,88

Advantages

1. Improves the performance of bubble sort and also slow.
2. Unstable but can be implemented as a stable sort.
3. Quite slow for large amount of data.

2.4. Shell sort

Shell sort is also called **Diminishing increment** sort. D.L. Shell proposed an improvement on insertion sort in 1959 named after him as shell sort. This method sorts separate sub files of the original file. These sub files contain every k^{th} element of the original file. The value of k is called an increment.

Ex;

Consider the following numbers are stored in an array:

Original Array: 25,57,48,37,12,92,86,33

Pass 1 : 25,57,33,37,12,92,86,48

Pass 2 : 25,12,33,37,48,92,86,57

Pass 3 : 12,25,33,37,48,57,86,92

Advantages

1. Efficient for large list.
2. It requires relative small amount of memory, extension of insertion sort.
3. Fastest algorithm for small list of elements.
4. More constraints, not stable.

2.5. Merge sort

Merging is the process of combining two or more sorted arrays into a third sorted array. Merge sort is a sorting algorithm that has the nice property elements are to be sorted in non-decreasing order. Given a sequence of n elements a[1],a[2]….a[n], the general idea is to split them in two sets resulting sorted sequences are merged to produce a single sorted sequence of n elements. This is an ideal example of the divide-and-conquer strategy in which the splitting is into two equal-sized sets and the combining operation is the merging of two sorted sets into one.

Ex;

Consider the following numbers are stored in an array:

Original Array: 310,285,179,652,351,423,861,254,450,520

Pass1: 310,285,179,652,351|423,861,254,450,520

Pass 2: 285,310,179|652,351|423,861,254,450,520

Pass 3: 179,285,310|652,351|423,861,250,450,520

Pass 4: 179,285,310|351,652|423,861,250,450,520

Pass 5: 179,285,310,351,652|423,861,250,450,520

Pass 6: 179,285,310,351,652|423,861,250|450,520

Pass 7: 179,285,310,351,652|250,423,861|450,520

Pass 8: 179,285,310,351,652|250,423,861|450,520

Pass 9: 179,285,310,351,652|250,423,450,520,861

Pass 10: 179,285,250,310,351,423,450,520,652,861

Advantages

1. Well for very large list, stable sort.

2. A fast recursive sorting.
3. Both useful for internal and external sorting.
4. It requires an auxiliary array that is as large as the original array to be sorted.

2.6. Quick sort

Quick sort is a sorting algorithm that is based on the fact that it is faster and easier to sort two small lists than one larger one. This algorithm is used to sort a list of data elements significantly faster than any of the common simple sorts. The basic strategy of Quick sort is divide and conquer. In this sort, we divide the original list into two sub lists.

Ex;

Consider the following numbers are stored in an array:

Original array	:	25,57,48,37,12,92,86,33
Pass 1	:	12,25,57,48,37,92,86,33
Pass 2	:	12,25,48,37,33,57,92,86
Pass 3	:	12,25,37,33,48,57,92,86
Pass 4	:	12,25,33,37,48,57,92,86
Pass 5	:	12,25,33,37,48,57,86,92

Advantages

1. Fastest sorting algorithm in practice.
2. Available in many standard libraries.
3. O (log n) space usage.
4. Unstable sort and complex for choosing a good pivot element.

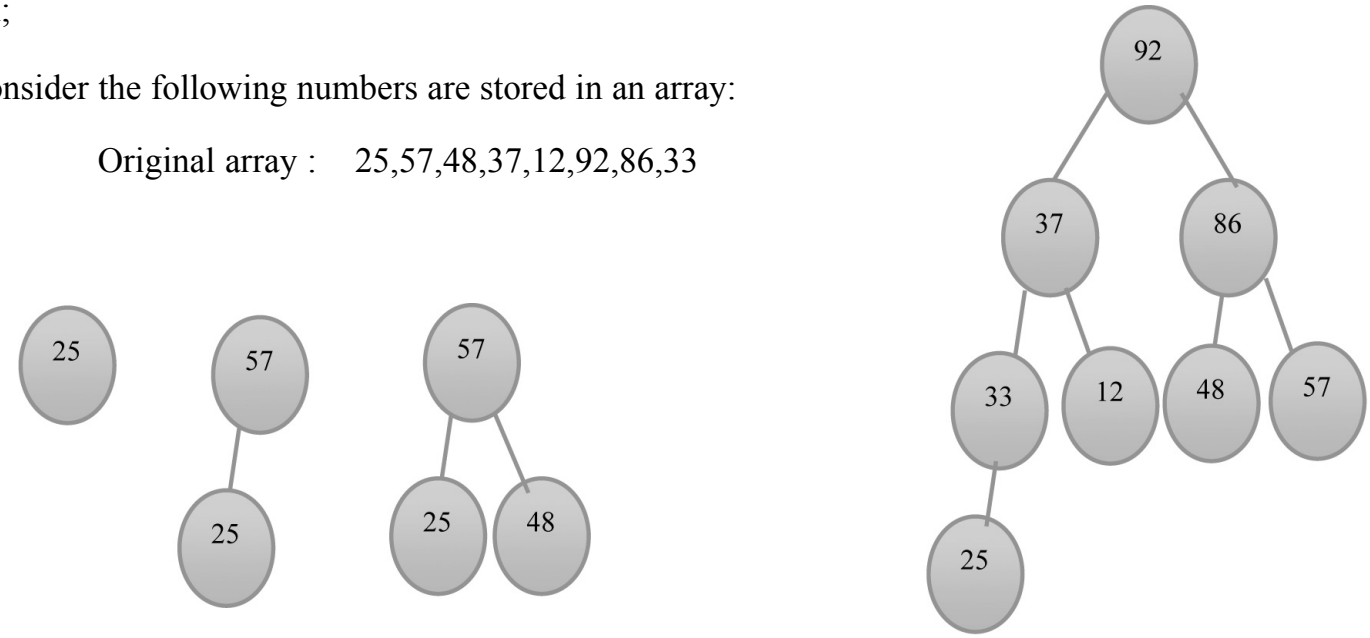
2.7. Heap sort

The heap sort sorting algorithm sorts an array of values that represent a tree with a special property: the heap property. A heap is a complete binary tree and is implemented in array as sequential representation rather than linked representation. A heap is called max heap or descending heap if every node has a value greater than or equal to the value of every child of that node. So in max heap root will keep the highest value.

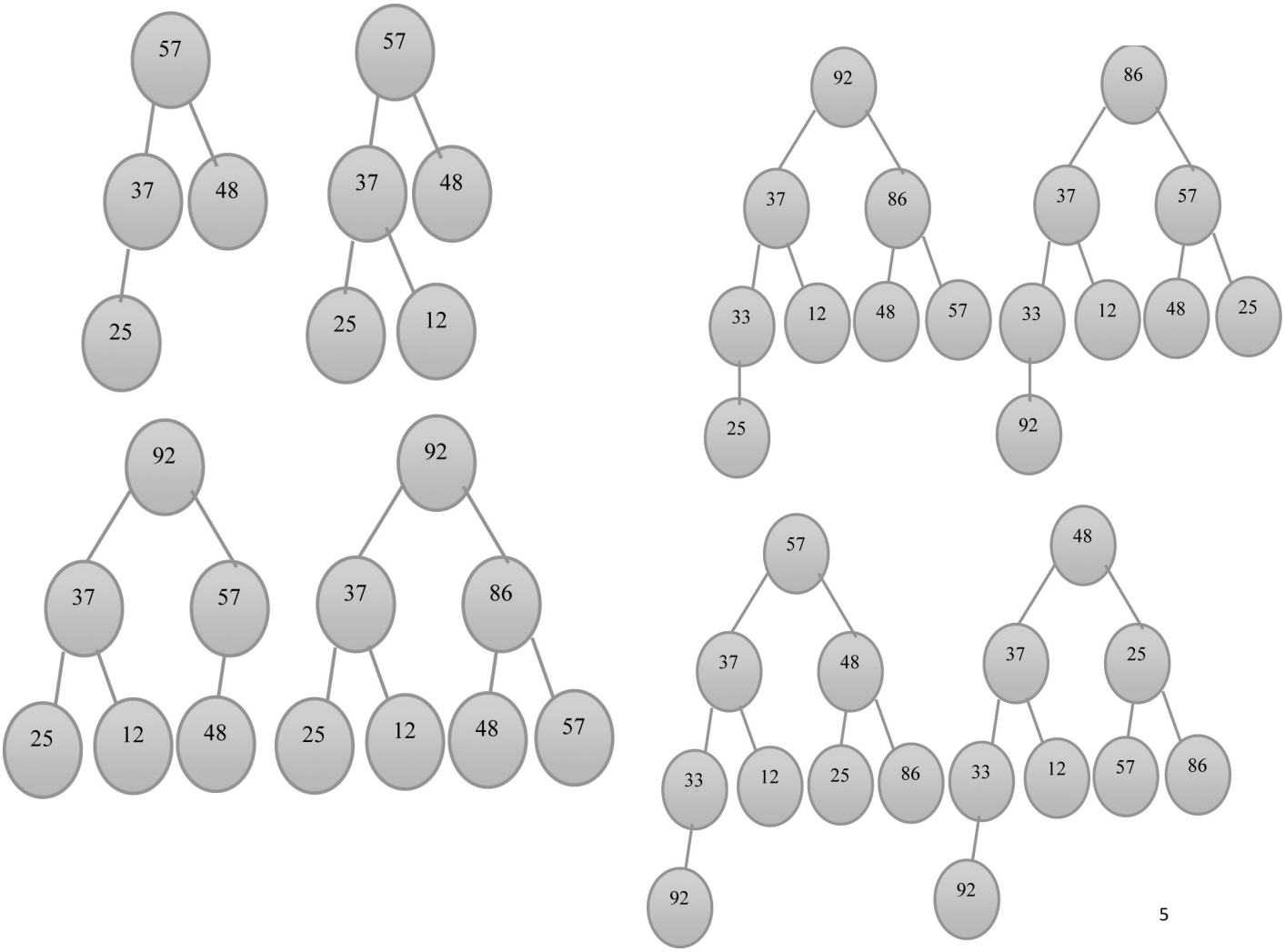
Ex;

Consider the following numbers are stored in an array:

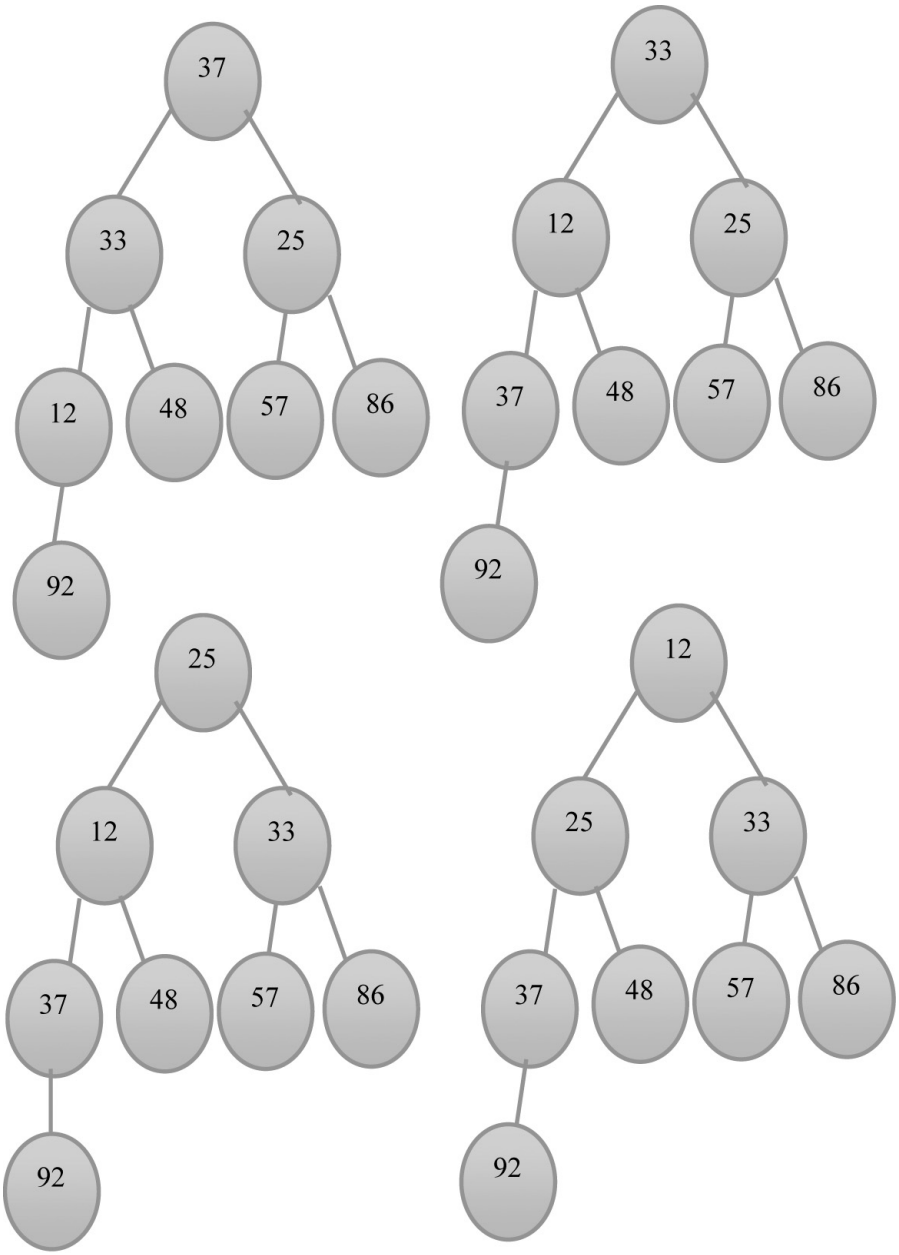
Original array : 25,57,48,37,12,92,86,33



Similarly a heap is called min heap or ascending heap if every node of heap has a value less than or equal to the value of every child node of that node.



5



Advantages

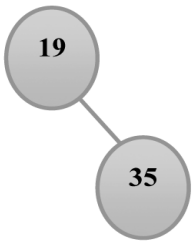
1. More efficient version of selection sort.
2. No need extra buffer.
3. It does not require recursion.
4. Slower than Quick and Merge sorts.

2.8. Binary tree sort

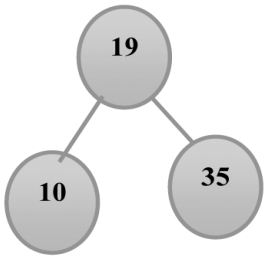
A binary tree is a finite set of nodes. It consists root node with 2 disjoint binary trees called left subtree and right subtree. Each element of the tree is known as node.

Step 1:

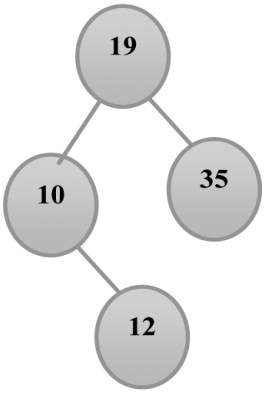
Step 2:



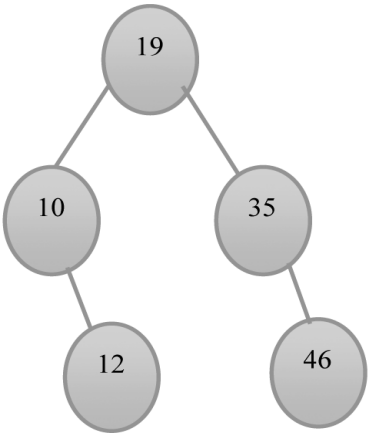
Step 3:



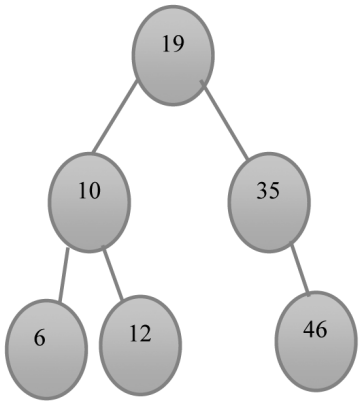
Step 4:



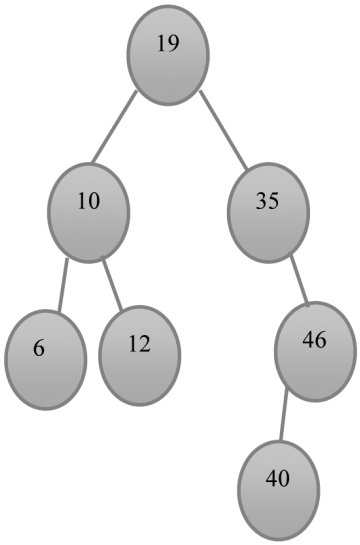
Step 5:



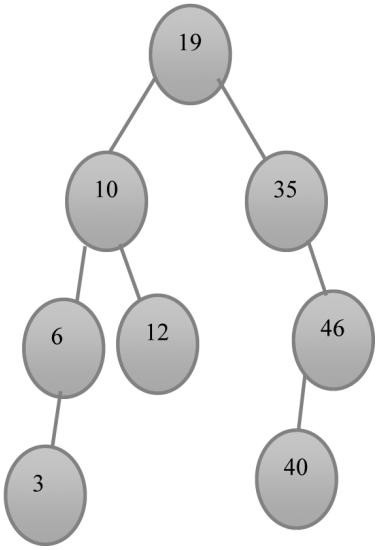
Step 6:



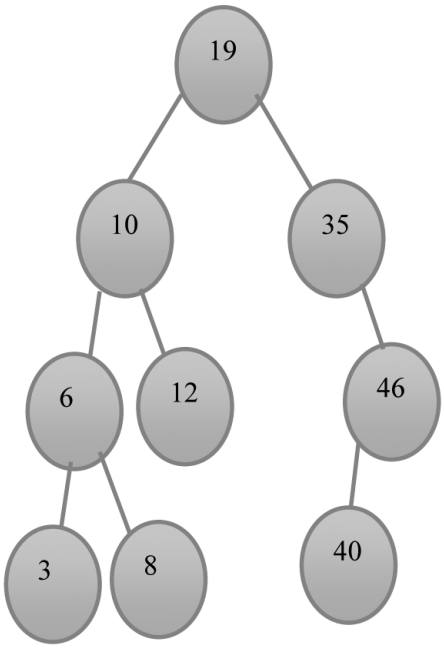
Step 7:



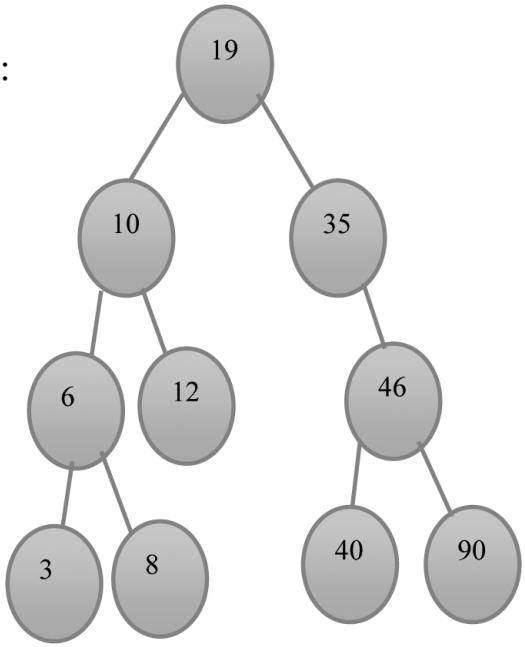
Step 8:



Step 9:



Step 10:



Ex;

Consider the following list of elements:

Advantages

1. Stable
2. It requires extra space for its gaps.

Advantages

1. Stable sort.
2. Variation sort.

Now we have to create the list. Lets create the list based on the function which gives the key as first digit of element. So there will be 10 lists. Here lists are sorted linked lists.

2.9. Address calculation sort

In this method, sorting by hashing technique is used. Here we will use some non decreasing function. Based on this function we will get the key of particular element. If x<y then this non decreasing function will give value f(x) < f(y). Now we will keep the element in sorted linked list corresponding to that particular key. So this sorting is basically based on the address calculated by this function.

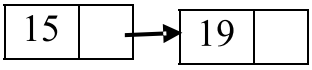
Ex;

Consider the following list of elements:

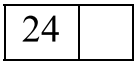
19,24,49,15,45,33,89,66

Array[0] : null

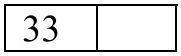
Array[1] :



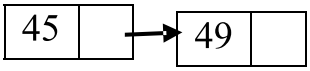
Array[2]:



Array[3]:

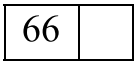


Array[4]:



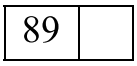
Array[5]→null

Array[6]:



Array[7]→null

Array[8]:



Array[9]→null

Advantages

1. Stable sort.
2. Variation sort.

2.10. Radix sort

The radix sort is based on the values of the actual digits in the positional representation of the numbers being sorted.

Ex;

Consider the following list of numbers:

19,24,49,15,45,33,89,66

First distribution: (separate based on last digit)	Merge
0)	33
1)	24
2)	15
3) 33	45
4) 24	66
5) 15,45	19
6) 66	49
7)	89
8)	
9) 19,49,89	

Second distribution: (separate based on first digit)	Merge
0)	15
1) 15,19	19
2) 24	24
3) 33	33
4) 45,49	45
5)	49
6) 66	66
7)	89
8) 89	
9)	

Advantages

1. Stable, fast.
2. Used in special cases when the key can be used to calculate the address of buckets.

3. Behavior of sorting techniques

Sorting techniques	Average case	Worst case
Bubble	$O(n^2)$	$O(n^2)$
Insertion	$O(n^2)$	$O(n^2)$
Selection	$O(n^2)$	$O(n^2)$
Shell	O(n logn)	O(n log2n)
Merge	O(n logn)	O(n logn)
Quick	O(n logn)	$O(n^2)$
Heap	O(n logn)	O(n logn)
Binary tree	O(n logn)	$O(n^2)$
Address calculation	O(n logn)	$O(n^2)$
Radix	O(n logn)	$O(n^2)$

4. Analysis and discussion

Basically, the number of comparisons is more important. It directly determine the efficiency of a sorting algorithm. The number of comparisons plays a more crucial role in sorting speed. Quicksort is a preferred sorting methods in applications that require a sorting algorithm that is usually very fast, but on occasion can have a longer running time. Research efforts have been made to enhance this algorithm for the worst case scenarios by improving the way the algorithm chooses its pivot element for partitioning. But the hidden constant associated with this improved version of Quicksort is so large that it results in an algorithm worse than Heapsort in every case [Brassard and Bratley, 1996].

5. Conclusion

Every sorting algorithm has some advantages and disadvantages. The “Performance analysis of sorting algorithms” deals and analyze the most commonly used internal sorting algorithms and

evaluate their performance. To sort a list of elements, First of all we analyzed the given problem i.e. the given problem is of which type (small numbers, large values). The time complexity may vary depending upon the sorting algorithm used. Each sorting algorithm follows a unique method to sort an array of numbers either by ascending or descending order. The ultimate goal of this study is to compare the various sorting algorithms and finding out the asymptotic complexity of each sorting algorithm. This study proposed a methodology for the users to select an efficient sorting algorithm. Finally, the reader with a particular problem in mind can choose the best sorting algorithm.

5. References

1. Knuth, D. The Art of Computer Programming Sorting and Searching, 2nd edition, 3. Addison-Wesley, (1998).
2. Wirth, N., 1976. Algorithms + Data Structures = Programs: Prentice-Hall, Inc. Englewood Cliffs, N.J.K.Mehlhorn. Sorting and Searching. Springer Verlag, Berlin, (1984).
3. LaMarca and R. Ladner. The Influence of Caches on the Performance of Sorting. In Proceeding of the ACM/SIAM Symposium on Discrete Algorithms, (January 1997), 370–379.
4. Hoare, C.A.R. Algorithm 64: Quicksort. Comm. ACM 4, 7 (July 1961), 321. 242-250, 242-250.
5. lores, I. Analysis of Internal Computer Sorting. J.ACM 7, 4 (Oct. 1960), 389-409.
6. lores, I. Analysis of Internal Computer Sorting. J.ACM 8, (Jan. 1961), 41-80.
7. Andersson, A. and Nilsson, S. 1994. A New Efficient Radix Sort. In Proceeding of the 35th Annual IEEE Symposium on foundation of Computer Science (1994), 714-721.
8. V. Estivill-Castro and D.Wood. A Survey of Adaptive Sorting Algorithms. Computing Surveys, 24, (1992),441-476.
9. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. Introduction to Algorithms. MIT Press,Cambridge, MA, 2nd edition, 2001.
10. Deependra Kr. Dwivedi *et. al* / VSRD International Journal of CS & IT Vol. 1 (4), 2011, 264-267
11. Robert Lafore " Object oriented programming in turbo C ++ "
12. Ellis Horowitz, Sartaj Sahni, Dinesh Mehta "Fundamentals of Data structures in C+"
13. Baase, S., Computer Algorithms, second edition, Addison-Wesley Publishing, 1996
14. Brassard, G., and P. Bratley, Fundamentals of algorithmics, Prentice-Hall, Englewood Cliffs, NJ, 1996.
15. Data Structures by Seymour Lipschutz and G A Vijayalakshmi Pai (Tata McGraw Hill companies), Indian adapted edition-2006,7 west patel nagar, New Delhi-110063
16. Introduction to Algorithms by Thomas H. Cormen.

MHD TRANSIENT FREE CONVECTION AND CHEMICALLY REACTIVE FLOW PAST A POROUS VERTICAL PLATE WITH RADIATION AND TEMPERATURE GRADIENT DEPENDENT HEAT SOURCE IN SLIP FLOW REGIME WITH SORET EFFECT

S.Anuradha[1] and M.Yegammai[2]

Abstract

An analysis has been carried out to investigate the effects of thermo diffusion (Soret effect) and the influence of the thermal radiation on MHD flow past a moving porous vertical plate of infinite length with time dependent suction in the presence of heat source in a slip flow regime. Slip flow conditions for the velocity and jump in temperature are taken into account in the boundary conditions. A uniform transverse magnetic field is applied. The governing equations of the problem subject to the slip flow boundary conditions are solved analytically using the perturbation method and solutions for velocity, temperature and concentration are obtained, where the plate temperature oscillates with the same frequency as that of variable suction velocity with the Soret effects. The flow phenomenon has been characterized with the help of flow parameters such as velocity, temperature and concentration profiles for different parameters such as thermal Grashof number (Grashof number for heat transfer), solutal Grashof number (Grashof number for mass transfer) , Prandtl number , Schmidt number, Hartmann number, Permeability parameter and Chemical reaction parameter. The velocity, temperature, concentration profiles, Skin – friction, Nusselt number and Schmidt number are shown through graphically.

Keywords

Chemical reaction, Unsteady, Free convection flow, Infinite vertical porous plate, MHD flow, Schmidt number, Skin-friction, Thermo-diffusion, Slip flow, Heat and mass transfer, Perturbation method.

I. Introduction

Free convection arises in the fluid when temperature changes cause density variation leading to buoyancy forces acting on the fluid elements. The most common example of free convection is the

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atmospheric flow which is driven by temperature differences. Sometimes along with the free convection currents caused by difference in temperature the flow is also affected by the differences in concentration or material constitution. This type of flow has applications in many branches of science and engineering. The study of such flow under the influence of magnetic field has attracted the interest of many investigators in view of its application in MHD generators, plasma studies, nuclear reactors, geothermal energy extractions and boundary layer control in the field of aerodynamics.

Sakiadas (1961) first explored the study of boundary layer flow on a continuous moving surface. Viskanta (1963) investigated the effect of transverse magnetic field on heat transfer to an electrically conducting and thermally radiating fluid flowing in a parallel plate channel. Recently, the study of free convective mass transfer flow has become the object of extensive research as the effects of heat transfer along with mass transfer effects are dominant features in many engineering applications such as rocket nozzles, cooling of nuclear reactors, high sinks in turbine blades, high speed aircrafts and their atmospheric reentry, chemical devices and process equipments. Soundalgekar (1979), Soundalgekar (1980) was examined by free convection flow past a semi-infinite vertical plate with mass transfer. In view of the importance of this diffusion-thermo effect, Jha and Singh (1990) presented an analytical study for free convection and mass transfer flow past an infinite vertical plate moving impulsively in its own plane taking Soret effects into account. Unsteady effect on MHD free convective and mass transfer flow through porous medium with constant suction and constant heat flux in rotating system studied by Sharma (2004). But in all these papers thermal diffusion effects have been neglected, whereas in a convective fluid when the flow of mass is caused by a temperature difference, thermal diffusion effects cannot be neglected.

Convection in porous media was reported by Nield and Bejan (1999), Chamkha (2000) studied the thermal radiation and buoyancy effects on hydro magnetic flow over an accelerating permeable surface with heat source or Sink.Hydro magnetic combined heat and mass transfer by natural convection from a permeable surface embedded in a fluid saturated porous medium was studied by Chamkha (2000). The analysis of the nonlinear MHD flow with heat and mass transfer characteristics of an incompressible, viscous, electrically conducting, and Boussinesq fluid on a vertical stretching surface with a chemical reaction and thermal stratification effects was obtained by Kandasamy et al. (2005). The heat and mass transfer characteristics of the natural convection about a vertical surface embedded in a saturated porous medium subjected to a chemical reaction taking into account the Soret and Dufour effect was analyzed by Postelnicu (2007). Magneto hydrodynamic convective heat and mass transfer in a boundary layer slip flow past a vertical permeable plate with thermal radiation and chemical reaction were investigated by Pal and Talukda (2009). Ahmed and Kalita (2009) have

investigated the effect of the thermal diffusion as well as magnetic field on free convection and mass transfer flow through porous medium, taking into account the effect of a of heat source.

Recently, Dulal Pal and Babulal Talukdar (2010) reported perturbation analysis of unsteady magnetohydrodynamic convective heat and mass transfer in a boundary layer slip flow past a vertical permeable plate with thermal radiation and chemical reaction neglecting the Soret effect and slip due to jump in temperature.

The unsteady MHD double diffusive convection for a heat generating fluid with thermal radiation and chemical reaction gain importance and attention in recent years. In view of this, the main object of Ramana Reddy *et al*. (2011) is to study the effect of a first order homogeneous chemical reaction, thermal radiation, heat source and thermal diffusion on the unsteady MHD double diffusive free convection fluid flow past a vertical porous plate in the presence of mass blowing or suction. Ramana Reddy *et al.* (2011) studied the MHD effects as well as Soret effects on the unsteady free convective mass transfer flow past an infinite vertical plate with variable suction, where the plate temperature oscillates with the same frequency as that of variable suction velocity. Thermo diffusion effects on unsteady hydro magnetic free convection flow with heat and mass transfer past a moving vertical plate with time dependent suction and heat source in a slip flow regime was investigated by Anjali Devi and Wilfred Samuel Raj(2011). Bhavana *et al.* (2013) examined the soret effect on free convective unsteady MHD flow over a vertical plate with heat source. Madhusudhana rao *et al.* (2013) discussed on the MHD transient free convection and chemically reactive flow past a porous vertical plate with radiation and temperature gradient dependent heat source in slip flow regime.Sarkar *et al*. (2013) studied the MHD free and forced convective flow of a viscous incompressible electrically conducting fluid in a rotating channel in the presence of a uniform transverse magnetic field on taking induced magnetic field into account. The main objective of the investigation of Ahmed and Sinha (2013) is to study the Soret effects as well as the MHD effects on the unsteady mixed convective mass transfer flow past an infinite vertical porous plate with variable suction. Sarada and Shanker (2013) investigated the onset of the effects of soret and dufour on an unsteady MHD free convection flow past a vertical porous plate in the presence of suction or injection.

Mohammad shah alam *et al.* (2013) analyzed heat and mass transfer in MHD free convection flow over an inclined plate with hall current. MHD free convection flow. past a vertical infinite porous plate in the presence of transverse magnetic field with constant heat flux was carried out by Rogers Omboga amenya *et al*. (2013).Recently Akindele michael okedoye (2013) carried out his investigation to find an analytical solution of MHD free convective heat and mass transfer flow in a porous medium. Recently Uwanta and Hamza (2014) reported on unsteady natural convection flow

of reactive hydro magnetic fluid in a moving vertical channel. The object of the present paper is to study the MHD effects as well as Soret effects on unsteady MHD free convection flow of a viscous fluid past a vertical porous plate embedded with porous medium in presence of chemical reaction. The governing equations are solved by Perturbation Technique. The effects of various governing parameters on the velocity, temperature, concentration, skin – friction coefficient, Nusselt number and Sherwood number are shown in figures and discussed in detail.

II. Formulation of the Problem

Consider two dimensional unsteady flow of a laminar, incompressible, viscous, electrically conducting and heat generation/absorption fluid past a semi-infinite vertical moving porous plate embedded in a uniform porous medium and subjected to a uniform transverse magnetic field in the presence of a pressure gradient has been considered with free convection, thermal diffusion (Soret effect) and thermal radiation effects taking in to an account. Further the flow is considered in presence of temperature gradient dependent heat source and effect of radiation and chemical reaction. According to the coordinate system the x axis is taken along the porous plate in the upward direction and y axis normal to it. The fluid is assumed to be a gray, absorbing-emitting but non-scattering medium. Unsteady flow of an incompressible, electrically conducting viscous fluid past an infinite vertical porous plate under the influence of a uniform transverse magnetic field is considered. Here the origin of the co-ordinate system is taken to be at any point of the plate. The polarization effects are assumed to be negligible and hence the electric field is also negligible. In the analysis the magnetic Reynolds number is taken to be small so that the induced magnetic field is neglected. Likewise for small velocity the viscous dissipation and Darcy's dissipation are neglected. The flow in the medium is entirely due to buoyancy force caused by temperature difference between the porous plate and the fluid. Under the above assumptions, the equations governing the conservation of mass (continuity), momentum, energy and concentration can be written as follows:

$$\frac{\partial v'}{\partial y'} = 0 \tag{1}$$

$$\frac{\partial u'}{\partial t'} + v'\frac{\partial u'}{\partial y'} = g\beta_1(T' - T_\infty') + g\beta_2(C' - C_\infty') + \upsilon\frac{\partial^2 u'}{\partial y'^2} - \frac{\upsilon}{k'(t)}u' - \frac{\sigma B_0^{\,2}}{\rho}u \tag{2}$$

$$\frac{\partial T'}{\partial t'} + v'\frac{\partial T'}{\partial y'} = \frac{K_T}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} - \frac{1}{\rho C_p}\frac{\partial q_r}{\partial y'} + \frac{Q'}{\rho C_p}\frac{\partial T}{\partial y} \tag{3}$$

$$\frac{\partial C'}{\partial t'} + v'\frac{\partial C'}{\partial y'} = D\frac{\partial^2 C'}{\partial y'^2} - K_c'(C' - C_\infty') + \frac{D_m K_T}{T_m}\frac{\partial^2 T'}{\partial y'^2} \tag{4}$$

The boundary conditions relevant to the problem are,

$$u' = L_1\left(\frac{\partial u'}{\partial y'}\right), \quad T' = T_w', \quad C' = C_w' \quad \text{at} \quad y' = 0$$

$$u' \to 0, \quad T' \to T_\infty', \quad C' \to C_\infty' \quad \text{as} \quad y' \to \infty \tag{5}$$

Where u' and v' are the components of velocity along x-axis and y-axis directions, t is the time, g is the acceleration due to gravity, β_1 and β_2 are the coefficients of volume expansion, υ is the kinematic viscosity, $k'(t)$ is the permeability of the porous medium, ρ is the density of the fluid, σ is the electrical conductivity of the fluid, B_0 is the uniform magnetic field, T' is the temperature , K_T is the thermal conductivity, C_p is the specific heat at constant pressure, q_r is the radioactive heat flux, Q' is the heat source, T_w' is the temperature of the wall as well as the temperature of the fluid at the plate, T_∞' is the temperature of the fluid far away from the plate, $L_1 = \left(\frac{2-m_1}{m_1}\right)$ being the mean free path where m_1 is the maxwell's reflection coefficient, C' is the concentration, D is the density, K_c' is chemical reaction parameter and C_∞' is the concentration of the wall as well as the concentration of the fluid at the plate.The equation of continuity (1) yields that v' is either a constant or some function of time, hence we assume that

$$v' = -v_0'(1 + \varepsilon e^{-n't'}) \tag{6}$$

Where $v_0' > 0$ is the suction velocity at the plate and n' is a positive constant. The negative sign indicates that the suction velocity acts towards the plate. Consider the fluid which is optically thin with a relatively low density and radioactive heat flux is given as follows

$$\frac{\partial q_r}{\partial y'} = 4(T' - T_\infty')I \tag{7}$$

Where I is the absorption coefficient at the plate.The Permeability $k'(t)$ of the porous medium is considered in the following form

$$k'(t) = k_0'(1 + \varepsilon e^{-n't'}) \tag{8}$$

On introducing the following dimensionless quantities and variables

$$u = \frac{u'}{v_0'},$$

$$y = \frac{y'v_0'}{\upsilon}, \; n = \frac{4\upsilon n'}{v_o'^2}, \; G_r = \frac{g\beta\upsilon(T_w' - T_\infty')}{v_0'^3}, \; G_m = \frac{g\beta\upsilon(C_w' - C_\infty')}{v_0'^3}, \; t = \frac{v_0'^2 t'}{4\upsilon}, \; M = \frac{\sigma B_0^2 \upsilon}{v_0'^3}, \; T = \frac{T' - T_\infty'}{T_w' - T_\infty'}, \; C = \frac{C' - C_\infty'}{C_w' - C_\infty'}, \; K_0 = \frac{K_0' v_0^2}{\upsilon^2},$$

$$K_c = \frac{K_c'\upsilon}{v_0'^2}, \; R = \frac{4\upsilon I}{\rho C_p v_0'^2}, \; S_c = \frac{\upsilon}{D}, \; H = \frac{Q'\upsilon}{\rho C_p v_0'^2 (T_w' - T_\infty')}, \; P_r = \frac{\rho\upsilon C_p}{KT}. \tag{9}$$

Then substituting from equation (2) to (4) and taking in to account equation (6) we obtain the non-dimensional form of the governing equations as follows:

$$\frac{1}{4}\frac{\partial u}{\partial t}-(1+\varepsilon e^{-nt})\frac{\partial u}{\partial t}=G_r T+G_m C+\frac{\partial^2 u}{\partial y^2}-\left[M+\frac{1}{K_0(1+\varepsilon e^{-nt})}\right]u \tag{10}$$

$$\frac{1}{4}\frac{\partial T}{\partial t}-(1+\varepsilon e^{-nt})\frac{\partial T}{\partial y}=\frac{1}{P_r}\frac{\partial^2 T}{\partial y^2}-RT+H\frac{\partial T}{\partial y} \tag{11}$$

$$\frac{1}{4}\frac{\partial C}{\partial t}-(1+\varepsilon e^{-nt})\frac{\partial C}{\partial y}=\frac{1}{S_c}\frac{\partial^2 C}{\partial y^2}-K_c C+S_r\frac{\partial^2 T}{\partial y^2} \tag{12}$$

Where Gr is the thermal Grashof number, Gm is solutal Grashof number , Pr is Prandtl number, M is the magnetic field parameter, Sc is Schmidt number , Sr is the Soret number, R is the radiation parameter respectively.The dimensionless form of the boundary condition (5) become

$u=h\left(\frac{\partial u}{\partial y}\right)$, T=1, C=1 at y=0

$u\to 0,\quad T\to 0,\quad C\to 0$ at $y\to\infty$ (13)

Where $h=\frac{L_1 v_0'^2}{\upsilon}$.

III. Solution Of The Problem

In order to reduce the above system of partial differential equations to a system of ordinary equations in dimensionless form, we follow the procedure given by Gersten and Gross[14].Therefore the expressions for velocity, temperature and concentration are assumed in the following form.

$$u(y,t)=u_0(y)+\varepsilon u_1(y)e^{-nt} \tag{14}$$

$$T(y,t)=T_0(y)+\varepsilon T_1(y)e^{-nt} \tag{15}$$

$$C(y,t)=C_0(y)+\varepsilon C_1(y)e^{-nt} \tag{16}$$

Where u_0, T_0 and C_0 are mean velocity,mean temperature and mean concentration respectively.

Substituting above expressions (14),(15),(16) in the equations (10),(11) (12) and equating the coefficient of $\varepsilon^0, \varepsilon^1$ (neglecting ε^2 terms etc.,), we obtain the following set of ordinary differential equations.

$$u_0''(y)+u_0'(y)-M_1 u_0(y)=-G_r T_0(y)-G_m C_0(y) \tag{17}$$

$$u_1''(y)+u_1'(y)-M_2 u_1(y)=-\frac{1}{K_0}u_0(y)-u_0'(y)-G_r T_1(y)-G_m C_1(y) \tag{18}$$

$$T_0''(y)+(1+H)P_r T_0'(y)-RP_r T_0(y)=0 \tag{19}$$

$$T_1''(y)+(1+H)P_rT_1'(y)-(R-\frac{n}{4})P_rT_1(y)=-P_rT_0'(y) \quad (20)$$

$$C_0''(y)+S_cC_0'(y)-S_cK_cC_0(y)+S_cS_rT_0''(y)=0 \quad (21)$$

$$C_1''(y)+S_cC_1'(y)-(K_c-\frac{n}{4})S_cC_1(y)=-S_cC_0'(y)-S_cS_rT_1''(y) \quad (22)$$

Where $M_1=M+\frac{1}{K_0}$ and $M_2=M+\frac{1}{K_0}-\frac{n}{4}$

And the boundary conditions (13) reduce to

$u_0=hu_0',u_1=hu_1',T_0=1,T_1=0,C_0=1,C_1=0$ at y=0

$u_0\to 0,u_1\to 0,T_0\to 0,T_1\to 0,C_0\to 0,C_1\to 0$ as $y\to\infty$

The equations from (17) to (22) are second order linear differential equations with constant coefficients. The solutions of these paired equations under the corresponding boundary conditions (23) are,

$$T_0(y)=e^{-m_2y} \quad (24)$$

$$T_1(y)=C_5(e^{-m_2y}-e^{-m_8y}) \quad (25)$$

$$C_0(y)=B_2e^{-m_4y}+C_1e^{-m_2y} \quad (26)$$

$$C_1(y)=B_5e^{-m_{10}y}+C_6e^{-m_4y}+C_7e^{-m_2y}+C_8e^{-m_8y}+C_9e^{-m_2y} \quad (27)$$

$$u_0(y)=B_3e^{-m_6y}+C_2e^{-m_2y}+C_3e^{-m_4y}+C_4e^{-m_2y} \quad (28)$$

$$u_1(y)=B_6e^{-m_{12}y}+C_{10}e^{-m_6y}+C_{11}e^{-m_2y}+C_{12}e^{-m_4y}+C_{13}e^{-m_2y}+C_{14}e^{-m_6y}+C_{15}e^{-m_2y}+C_{16}e^{-m_4y}$$
$$+C_{17}e^{-m_2y}+C_{18}e^{-m_8y}+C_{19}e^{-m_2y}+C_{20}e^{-m_{10}y}+C_{21}e^{-m_4y}+C_{22}e^{-m_2y}+C_{23}e^{-m_8y}+C_{24}e^{-m_2y} \quad (29)$$

Where the constants are given in the appendix,Introducing (28) and (29) in (14),the velocity field u(y,t) is

$$u(y,t)=(B_3e^{-m_6y}+C_2e^{-m_2y}+C_3e^{-m_4y}+C_4e^{-m_2y})+\varepsilon(B_6e^{-m_{12}y}+C_{10}e^{-m_6y}+C_{11}e^{-m_2y}+C_{12}e^{-m_4y}$$
$$+C_{13}e^{-m_2y}+C_{14}e^{-m_6y}+C_{15}e^{-m_2y}+C_{16}e^{-m_4y}+C_{17}e^{-m_2y}+C_{18}e^{-m_8y}+C_{19}e^{-m_2y}+C_{20}e^{-m_{10}y}+C_{21}e^{-m_4y}$$
$$+C_{22}e^{-m_2y}+C_{23}e^{-m_8y}+C_{24}e^{-m_2y})e^{-nt} \quad (30)$$

Introducing (24) and (25) in (15), the temperature field T(y,t) is,

$$T(y,t)=(e^{-m_2y})+\varepsilon C_5(e^{-m_2y}-e^{-m_8y})e^{-nt} \quad (31)$$

Also introducing (26) and (27) in (16),the concentration field C(y,t) is

$$C(y,t)=(B_2e^{-m_4y}+C_1e^{-m_2y})+\varepsilon(B_5e^{-m_{10}y}+C_6e^{-m_4y}+C_7e^{-m_2y}+C_8e^{-m_8y}+C_9e^{-m_2y})e^{-nt} \quad (32)$$

SKIN FRICTION:

The expression for the skin-friction (τ) at the plate is,

$$\tau = \left(\frac{du}{dy}\right)_{y=0} = \left(\frac{du_0}{dy}\right)_{y=0} + \varepsilon \left(\frac{du_1}{dy}\right)_{y=0} e^{-nt}$$

$$= A_{11} + \varepsilon A_{12} e^{-nt} \quad (33)$$

RATE OF HEAT TRANSFER

The expression for the rate of heat transfer interms of Nusselt number (N_u) is, $N_u = \left(\frac{dT}{dy}\right)_{y=0} = \left(\frac{dT_0}{dy}\right)_{y=0} + \varepsilon \left(\frac{dT_1}{dy}\right)_{y=0} e^{-nt}$

$$= -m_2 + \varepsilon A_{13} e^{-nt} \quad (34)$$

RATE OF MASS TRANSFER

The expression for the rate of mass transfer interms of Sherwood number (S_h) is, $S_h = \left(\frac{dC}{dy}\right)_{y=0} = \left(\frac{dC_0}{dy}\right)_{y=0} + \varepsilon \left(\frac{dC_1}{dy}\right)_{y=0} e^{-nt}$

$$= A_{14} + \varepsilon A_{15} e^{-nt} \quad (35)$$

V. Results and Discussion

To assess the physical depth of the problem, the effects of various parameters like slip parameter h, Grashof number Gr, Magnetic parameter M, Permeability of Porous medium, Heat source parameter H, Radiation parameter R, Chemical reaction parameter Kc, Modified Grashof number Gm on Velocity distribution, Temperature distribution and Concentration distribution are studied in figures 1-15, while keeping the other parameters as constants. The variations in skin friction, the rate of heat transfer in the form of Nusselt number and the rate of mass transfer in the form of Sherwood number are studied in figures 16-22.

- Figure 1 depicts the velocity profiles with the variations in slip parameter h, it is observed that the significance of the velocity is high near the plate and there after it decreases and reaches to the stationery position at the other side of the plate. As expected velocity increases with an increase in slip parameter h.In figure 2 the velocity increases as Modified Grashof number Gm increases.
- The effects of Grashof number Gr on velocity distribution are presented in figure 3. From this figure it is noticed velocity increases as an increase in Gr. The influence of heat source

parameter over velocity distribution is presented in figure 4. It is observed that the heat source parameter increases the velocity; however the effect is less significant.

- In figure 5 the velocity increases as Permeability of Porous medium Ko increases.In figure 6 the velocity decreases as chemical reaction parameter Kc increases.Figure 7 elucidates the influence of Prandtl number over the velocity distribution. As Prandtl number increases the velocity decreases.From figure 8 it is observed that the velocity decreases as Radiation parameter R increases.

- The Schmidt number effect over nondimensional velocity profiles is demonstrated in figure 9. Schmidt number has the same effect as Prandtl number. But the interesting fact is that Schmidt number has more prominent effect than Prandtl number over the velocity.In the figures 10,11 the Temperature distribution decreases as Heat source parameter H and Radiation parameter R increase respectively.

- Increasing the Prandtl number decreases the temperature of the flow field and is seen in figure 12. Also it is interesting to see that the thermal boundary layer thickness is reduced due to increase in Prandtl number.

- The variation in concentration due to variation of heat source parameter is observed in figure 13. The heat source parameter decreases the concentration upto certain values of y and then increases, however the effect is less significant.In the figures 14, 15 the Concentration decreases as chemical reaction parameter Kc and Schmidt number Sc increase respectively.

- The variation of skin friction coefficient for differentGm, Gr is elucidated in figure16, 17. The effect of Grashof number and modified Grashof number is to decrease the skin friction coefficient.

- Figure 18 brings out the significance of heat source parameter over the skin friction coefficient. The heat source parameter increases the skin friction coefficient however, the effect is less significant.The slip parameter decreases the skin friction coefficient which is seen in figure 19.

- Figure 20 displays skin friction coefficient for different values of Schmidt number. The influence of Schmidt number is to decrease the skin friction coefficient.

- The impact of Heat Source parameter *H and* Radiation parameter R over the dimensionless rate of heat transfer against *Pr* is vivid through figures 21 and 22. Similar effect was observed when both H and R increases i.e., the dimensionless rate of heat transfer is suppressed by the slip parameter due to jump in temperature and the effect of heat source parameter reduces the dimensionless rate of heat transfer.

V. Conclusions

The unsteady MHD free convection flow past a moving vertical plate with heat and mass transfer in a slip flow regime with time dependent suction and heat source is investigated. The governing equations of the problem are solved using perturbation technique and the solutions for velocity, temperature, concentration, skin friction coefficient, dimensionless rate of heat and mass transfer are obtained. The numerical values are calculated by fixing certain values for the pertinent parameters involved in the problem.From the solutions cited in the previous section and from the results and discussion, the following conclusion is arrived. In general, the effects of non dimensional parameters over velocity, skin friction coefficient, temperature, dimensionless rate of heat transfer, concentration and dimensionless rate of mass transfer are promising.

- The effect of velocity ratio parameter is to accelerate the velocity and decrease the skin friction coefficient.The Prandtl number has the same effect on velocity, skin friction coefficient and temperature so as to decrease for increase in Prandtl number. It is noted that Prandtl number has both increasing and decreasing effect over concentration.
- The influence of Schmidt number over the velocity, concentration and skin friction coefficient is to decrease it, whereas it has both increasing and decreasing effect over the dimensionless rate of mass transfer.
- The heat source parameter enhances the velocity, temperature and skin friction coefficient. The effect of heat source parameter on dimensionless rate of heat and mass transfer are different in nature. As H increases the dimensionless rate of heat transfer decreases. It has both increasing and decreasing effect over the concentration.

The significant effect of slip parameter due to velocity is to accelerate the velocity and decrease the skin friction coefficient effectively .

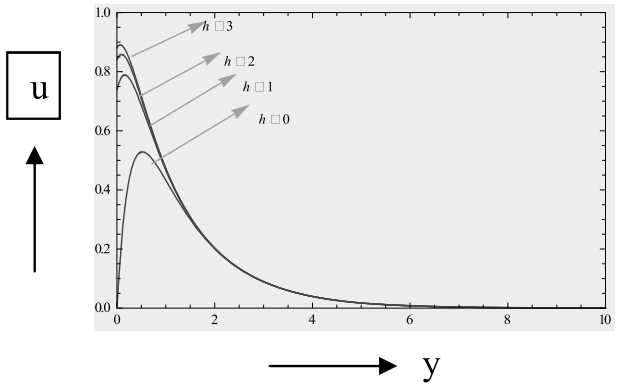


Fig 1 : Effects of slip parameter h onvelocity

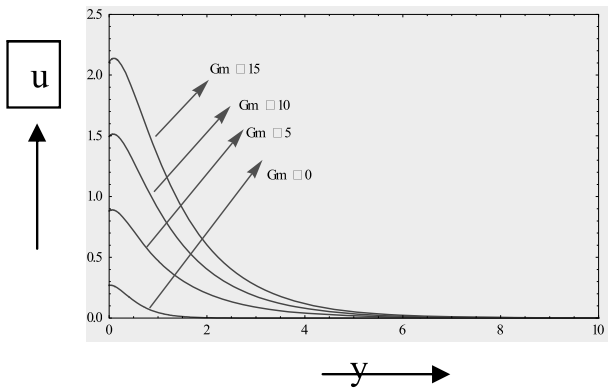


Fig 2 : Effects of modified Grashof number Gm on velocity

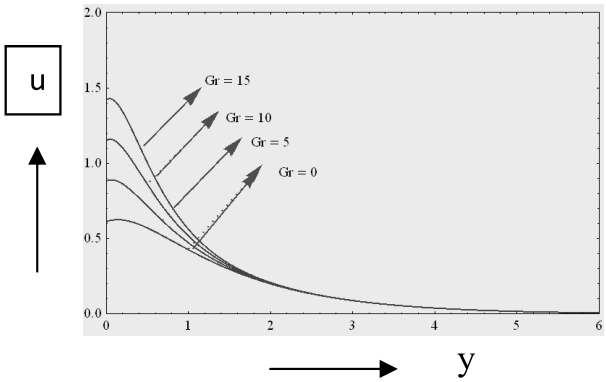


Fig 3: Effects of Grashof number Gr on velocity

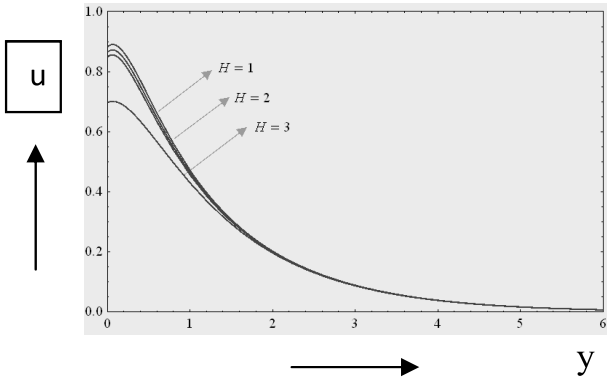


Fig 4: Effects of Heat source parameter H on velocity

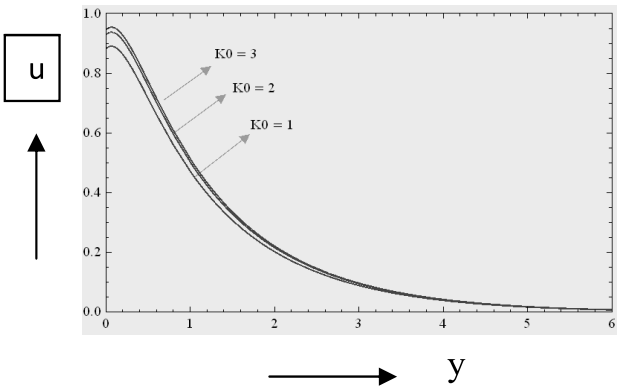
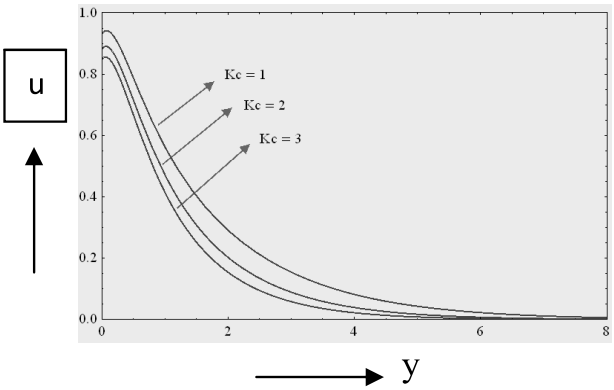


Fig 5: Effects of Permeability of Porous medium K_0 on velocity



6: Effects of Chemical reaction parameter Kc

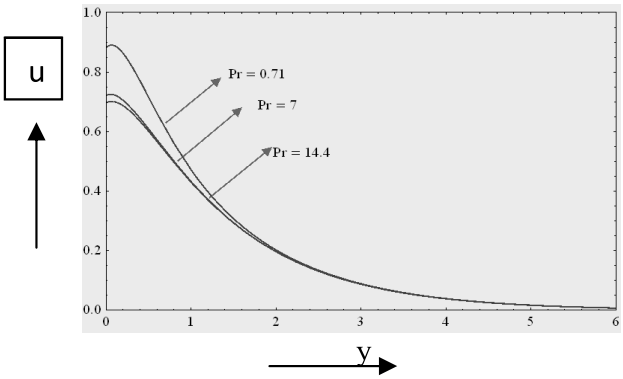


Fig 7: Effects of Prandtl number Pr on velocity

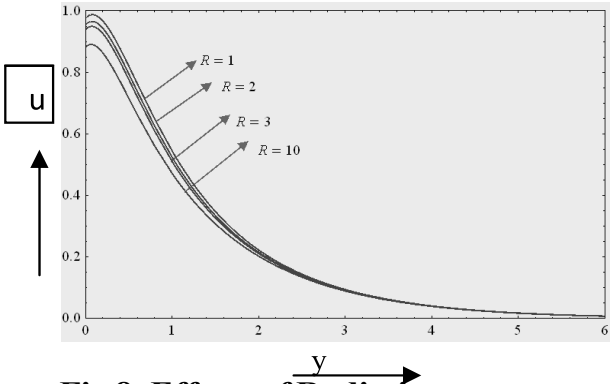


Fig 8: Effects of Radiation parameter R on velocity

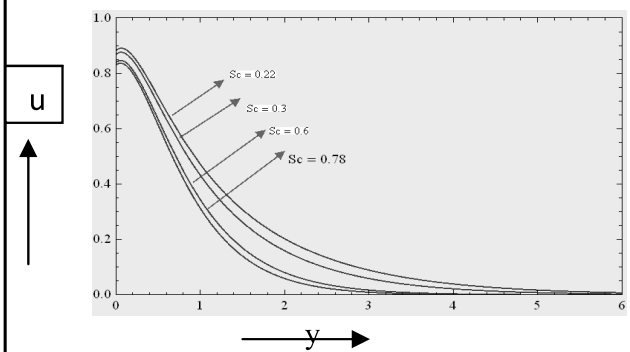


Fig 9: Effects of Schimidt number Sc on velocity

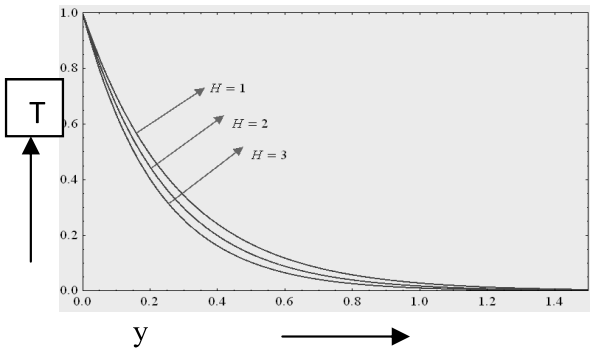


Fig 10: Effects of Heat source parameter H on Temperature

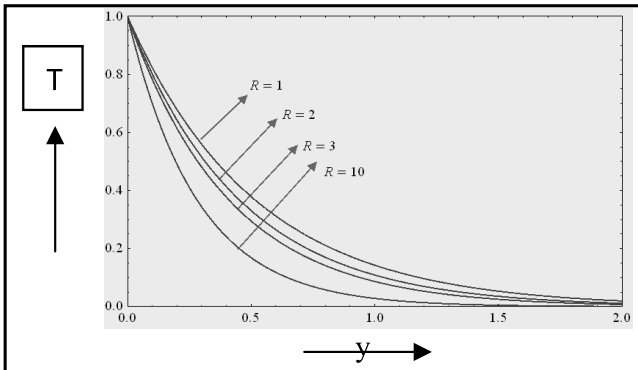


Fig 11: Effects of Radiation parameter R on Temperature

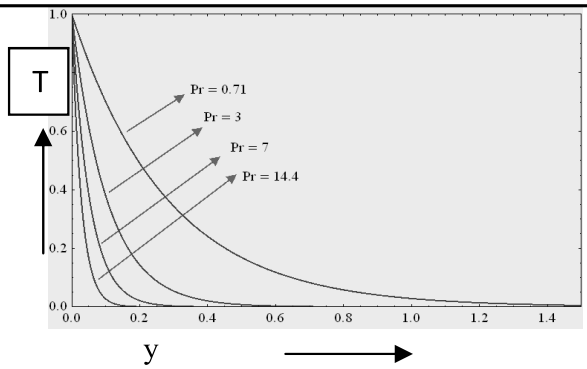


Fig 12: Effects of Prandtl number Pr on Temperature

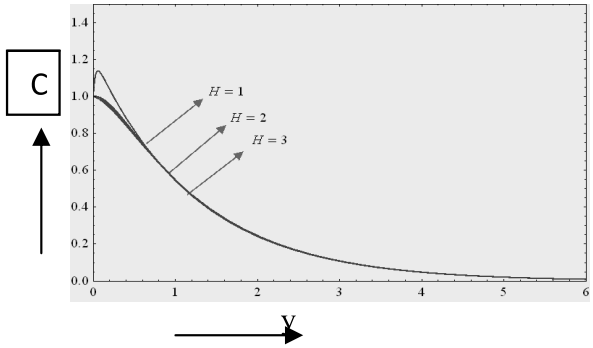


Fig 13: Effects of Heat source parameter H on Concentration

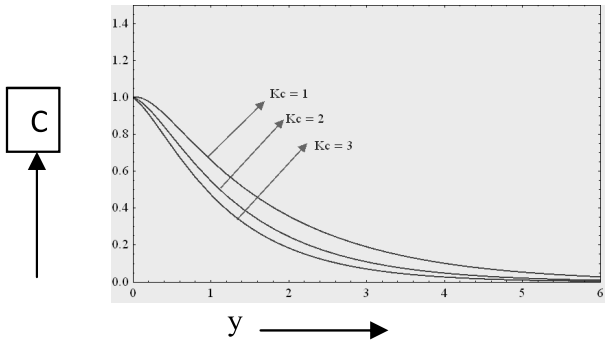


Fig 14: Effects of Chemical reaction parameter Kc

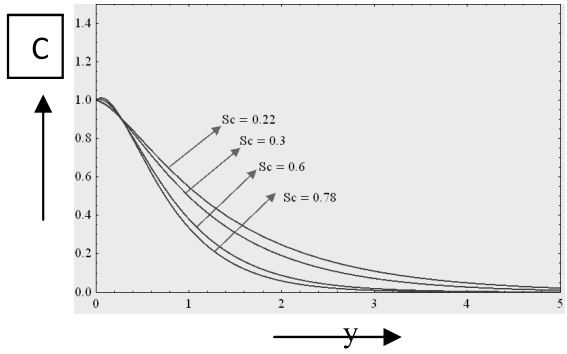


Fig 15: Effects of Schimidt number Sc on Concentration

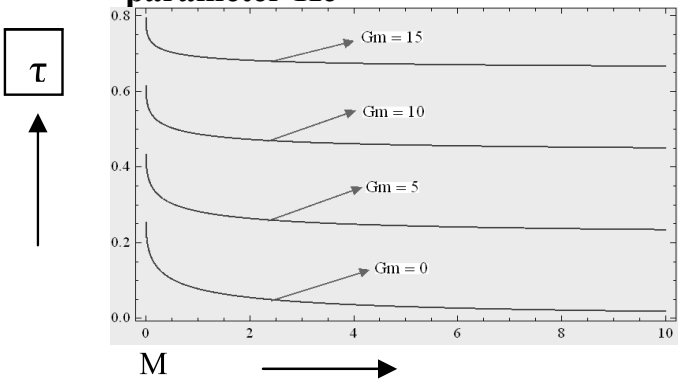


Fig 16: Skin friction coefficient for various values of Gm

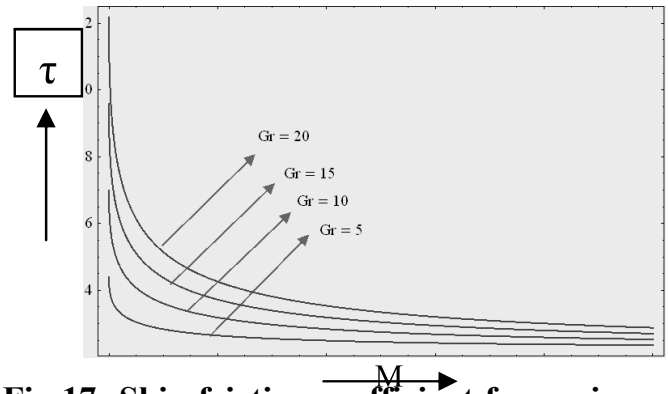


Fig 17: Skin friction coefficient for various values of Gr

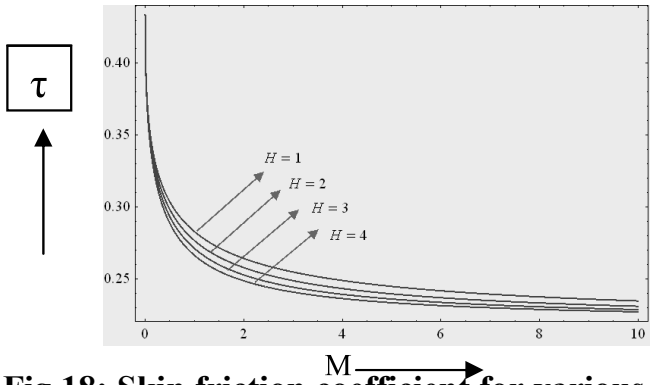


Fig 18: Skin friction coefficient for various values of H

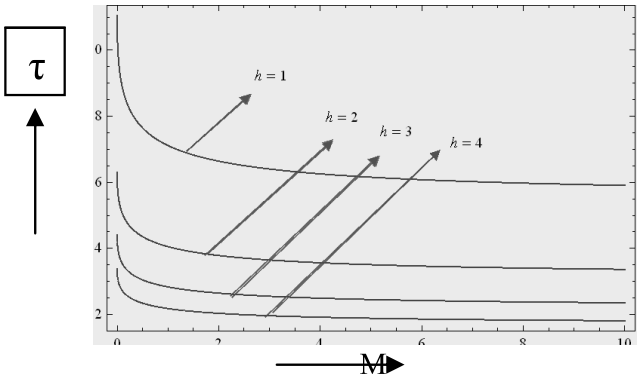


Fig 19: Skin friction coefficient for various values of h

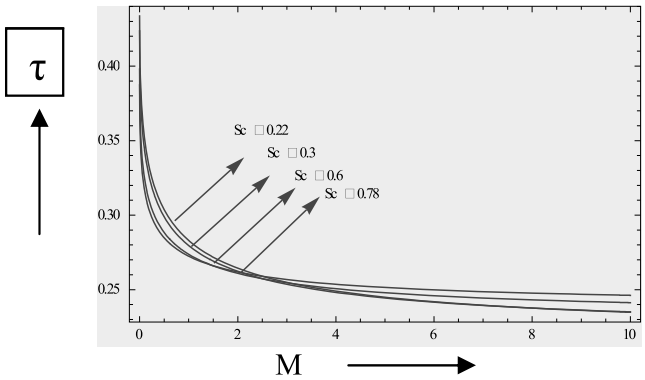


Fig 20: Skin friction coefficient for various values of Sc

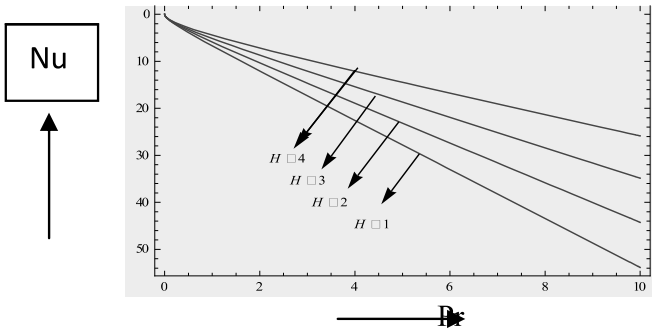


Fig 21: Rate of heat transfer for various values of H

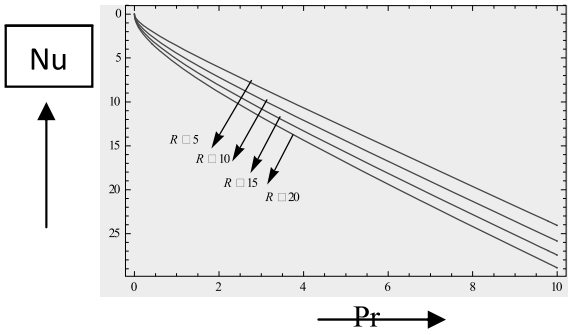


Fig 22: Rate of heat transfer for various values of R

References

1. **Ahmed N. and Kalita H.(2009),** *Soret and Magnetic field effects on a transient free convection flow through a porous medium bounded by a uniformly moving infinite vertical porous plate in presence of heat source*, *Int. J. of Appl. Math and Mech.* **8**(16): pp. 1-21 .

2. Akindele **Michael Okedoye (2013),** *Analytical Solution of MHD Free Convective Heat and Mass Transfer Flow in a Porous Medium*, The *Pacific Journal of Science and Technology,* Volume 14, Number 2.

3. **Anjali Devi S.P. and Wilfred Samuel Raj J.(2011)**, *Thermo diffusion effects on unsteady hydro magnetic free convection flow with heat and mass transfer past a moving vertical plate with time dependent suction and heat source in a slip flow regime* , *Int. J. of Appl. Math and Mech.* pp**.** 20-51.

4. **Bhavana M., Chennakesavaiah D., Sudhakaraiah A. (2013)**, *The soret effect on free convective unsteady MHD flow over a vertical plate with heat source*, International journal of innovative research in science, Engineering and Technology, *vol. 2, issue 5.*

5. **Chamkha AJ.(2000),** *Thermal radiation and buoyancy effects on hydro magnetic flow over an accelerating permeable surface with heat source or Sink*, International Journal of Heat and Mass Transfer 38, pp.1699-1712.

6. **Chamaka A.J. (2000),** *Hydro magnetic combined heat and mass transfer by natural convection from a permeable surface embedded in a fluid saturated porous medium, ,Int. J. Num.Methods for heat and fluid flow, 10(5),pp. 455-476.*

7. **Chamkha A.J.(2000)**, *Khaled A.R., Hydromagnetic combined heat and mass transfer by natural convection from a permeable surface embedded in fluid saturated porous medium", International Journal of Numerical methods for Heat and Fluid Flow, 10(5), pp. 455-476.*

8. **Chamkha A.J. (2003),** *MHD flow of a uniformly stretched vertical permeable surface in the presence of heat generation/absorption and a chemical reaction, Int.Commun. Heat mass transfer, 30, (No.3),* pp.*413-422.*

9. **Dulal Pal and Babulal Talukdar (2010*),*** *Perturbation analysis of unsteady magnetohydrodynamic convective heat and mass transfer in a boundary layer slip flow past a vertical permeable plate with thermal radiation and chemical reaction. Commun Nonlinear Sci Numer Simulat, **15**(7), pp.1813.*

10. **Jha BK and Singh AK. (1990),** *Soret effects on free-convection and mass transfer flow in the Stokes problem for an infinite vertical plate, Astrophys. Space Sci. 173: 251.*

11. **Kandasamy, R., Periasamy, K., and Prabhu, K. K. S.(2005),** *Chemical reaction, heat and mass transfer on MHD flow over a vertical stretching surface with heat source and thermal stratification effects: Int. J. Heat Mass Transfer 48, PP.4557–4561. .*

12. **Madhusudhana Rao B., Viswanatha Reddy G.,Raju M.C. and Varma S.V.K**.(**2013**), *MHD transient free convection and chemically reactive flow past a porous vertical plate with radiation and temperature gradient dependent heat source in slip flow regime*, *IOSR Journal of Applied Physics (IOSR-JAP) , Volume 3, Issue 6 ,* pp. *22-32 .*

13. **Mohammad Shah Alam, Mohammad Ali, Md. Delowar Hossain (2013)**, *Heat and Mass Transfer in MHD Free Convection Flow over an Inclined Plate with Hall Current*, The International Journal Of Engineering And Science (IJES) ,Volume 2 ,Issue 7 , pp. 81-88.

14. **Nield DA and Bejan A. (1999)**, *Convection in porous media*, 2nd edn, Springer, Newyork.

15. **Pal, D. and Talukda, B. (2009).** *Perturbation analysis of unsteady Magneto hydrodynamic convective heat and mass transfer in a boundary layer slip flow past a vertical permeable plate with thermal radiation and chemical reaction: Communications in Nonlinear Science and Numerical Simulation ,In Press, Corrected Proof, Available online 17 July 2009.*

16. **Postelnicu A. (2007),** *Influence of chemical reaction on heat and mass transfer by natural convection from vertical surfaces in porou s media considering Soret and Dufour effects: Heat and Mass Transfer 43,* pp.*595–602 .*

17. **Ramana Reddy G.V., Ramana Murthy Ch.V. and Bhaskar Reddy N.(2011),** *MHD flow over a vertical moving porous plate with heat generation by considering double diffusive convection ,Int. J. of Appl. Math and Mech.* 7 (4): pp.53-69.

18. **Ramana Reddy G.V., Ramana Murthy Ch.V. and Bhaskar Reddy N.(2011)**, *Unsteady MHD free convective mass transfer flow past an infinite vertical porous plate with variable suction and soret effect, Int. J. of Appl. Math and Mech.* **7** (21): pp.70-84.

19. **Rogers Omboga Amenya, Johanna Kibet Sigey, Jaconiah Abonyo Okelo and James Mariita Okwoyo (2013)**, *MHD Free Convection Flow past a Vertical Infinite Porous Plate in the Presence of Transverse Magnetic Field with Constant Heat Flux*, International Journal of Science and Research (IJSR), Volume 2, Issue 10.

20. **Sakiadis, B.C.(1961)** , *Boundary layer behavior on continuous solid surfaces*, *American Institute of Chemical Engineering Journal (AIChE)* 7, pp.26-28.

21. **Sarada K. and Shanker B.(2013)**, *The effect of chemical reaction on an unsteady MHD free convection flow past an infinite vertical porous plate with variable suction*, International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.2, pp.725-735.

22. **Sarkar B.C., Das S. and Jana R.N.(2013)**, *MHD Free and Forced Convective Flow in a Rotating Channel*, *International Journal of Computer Applications , Volume 74, No.18,* pp. *0975 – 8887.*

23. **Sharma PK. (2004),** *Un steady effect on MHD free convective and mass transfer flow through porous medium with constant suction and constant heat flux in rotating system. Acta Ciencia Indica Mathematics. 30(4): pp. 873-880.*

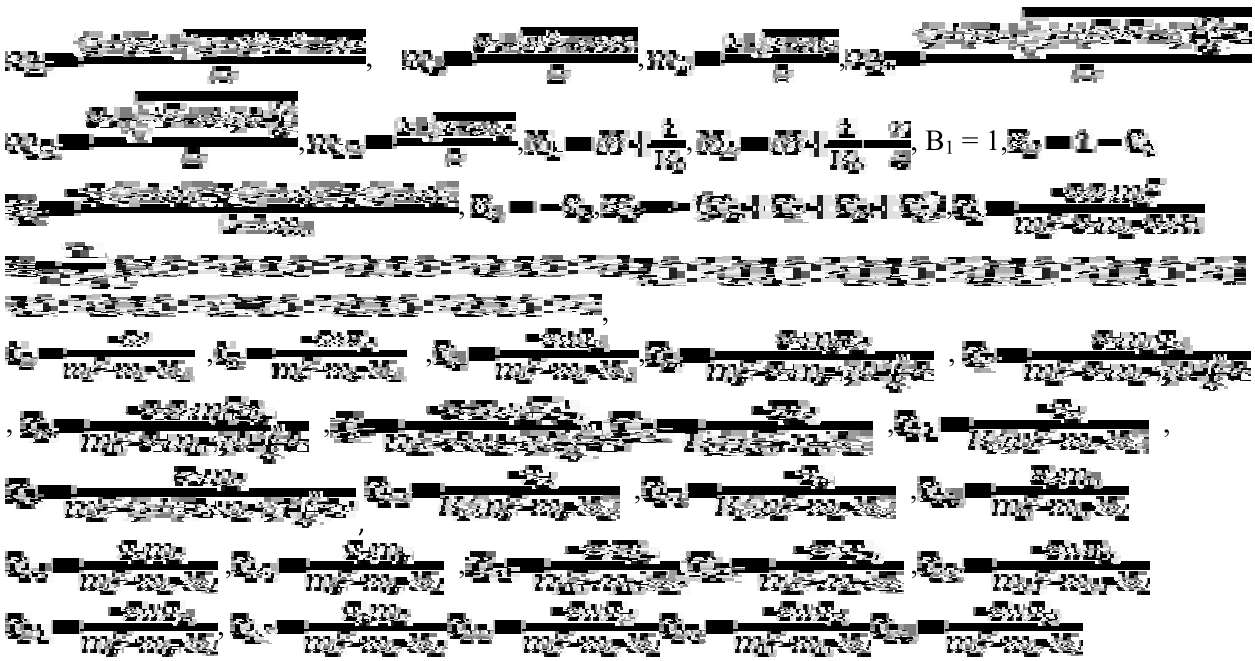
24. **Soundalgekar VM. (1979),** *Effects of mass transfer an d free convection currents on the flow past an impulsively started vertical plate, J. Appl. Mech. Trans. ASME, 46: 757.*

25. **Soundalgekar, VM and Ganesan P. (1980),** *Transient free convective flow past a semi-infinite vertical plate with mass transfer. Reg. J. Energy Heat and Mass Transfer, 2(1): 83.*

26. **Uwanta I.J. and Hamza M.M.(2014),***Unsteady natural convection flow of reactive hydro magnetic fluid in a moving vertical channel***,** International Journal of Energy & Technology , pp. 1-7 **.**

27. **Viskanta R (1963)**, *Effect of transverse magnetic field on heat transfer to an electrically conducting and thermally radiating fluid flowing in a parallel plate channel*, Angew. Mathematics and Physics 14, pp. 353-368.

Appendix



PERFORMANCE ANALYSIS OF TEXTURE CLASSIFICATION USING UNIVARIATE AND MULTIVARIATE LOCAL FEATURES

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Abstract

Textures are replications, symmetries and combinations of various basic patterns or local functions, usually with some random variation. Texture is seen in almost all engineered materials, and it can have a great influence on material properties. Texture analysis is important in many applications of computer image analysis for classification, detection or segmentation of images based on local spatial patterns of intensity or color. In texture classification the goal is to assign an unknown sample image to one of a set of known texture classes.

Keywords

Texture classification, LBP, LTP, MLBP, Texture analysis.

Introduction

A large number of techniques have been devised for describing, classifying and retrieving texture images. Techniques based on LBP coding and its variants are among the most successful methods reported in literature these few decades [1], [2].

Texture analysis [3] is important in many applications of computer image analysis for classification or segmentation of images based on local spatial variations of intensity or color. Textures are replications, symmetries and combinations of various basic patterns or local functions, usually with some random variation. Textures have the implicit strength [4] that they are based on intuitive notions of visual similarity. This means that they are particularly useful for searching visual databases and other human computer interaction applications. However, since the notion of texture is tied to

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the human semantic meaning, computational descriptions have been broad, vague and sometimes conflicting. A successful classification or segmentation requires an efficient description of image texture. Important applications include industrial and biomedical surface inspection, for example for defects and disease, ground classification and segmentation of satellite or aerial imagery, segmentation of textured regions in document analysis, and content-based access to image databases. However, despite many potential areas of application for texture analysis in industry there is only a limited number of successful examples. A major problem is that textures in the real world are often not uniform, due to changes in orientation, scale or other visual appearance. In addition, the degree of computational complexity of many of the proposed texture measures is very high.

Classification [5] refers to as assigning a physical object or incident into one of a set of predefined categories. In texture classification the goal is to assign an unknown sample image to one of a set of known texture classes. Texture classification is one of the four problem domains in the field of texture analysis.

In this paper texture classification with three algorithms is LBP, LTP and MLBP texture models for comparative study using Supervised Segmentation of texture images

Section-II of this paper describes Texture models used while Section-III lists the experiments conducted along with the results while Section-IV deals with performance evaluation. Section-V states the discussions and conclusion and the last section lists out the references.

I. Texture Models Used

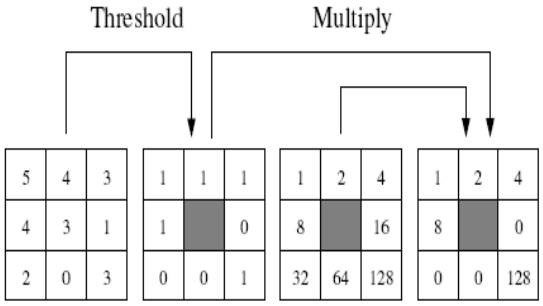
This section covers the steps to be performed in each of the three texture models used in this paper.

A.LBP Texture Model

Ojala et al. [10], proposed LBP features which is initially designed for texture classification [6], [7]. The LBP operator is a theoretically simple yet very powerful method of analyzing textures. The local binary pattern (LBP) texture operator was first introduced as a complementary measure for local image contrast1. The first incarnation of the operator worked with the eight-neighbours of a pixel, using the value of the center pixel as a threshold. An LBP code for a neighbourhood was produced by multiplying the threshold values with weights given to the corresponding pixels, and summing up the result (Fig: 1).

LBP is computationally simple yet very efficient local texture operator [8]. These features are invariant to monotonic gray scale changes it was supplemented by an independent measure of

local contrast. Fig. 1 shows how the contrast measure (C) was derived. The average of the gray levels below the center pixel is subtracted from that of the gray levels above (or equal to) the center pixel. Two dimensional distributions of the LBP and local contrast measures were used as features. The operator was called LBP/C, and very good discrimination rates were reported with textures selected from the photographic album of Brodatz [9].



LBP = 1+2+4+8+128 = 143

C = (5+4+3+4+3)/5 - (1+2+0)/3 = 2.8

Fig: 1. Calculating the Original LBP Code and a Contrast Measure.

The LBP method can be regarded as a truly unifying approach. Instead of trying to explain texture formation on a pixel level, local patterns are formed. Each pixel is labelled with the code of the texture primitive that best matches the local neighbourhood. Thus each LBP code can be regarded as a micro-texton. Local primitives detected by the LBP include spots, flat areas, edges, edge ends, and curves and so on. Some examples are shown in Fig: 2 with the LBP8, R operator. In the figure, ones are represented as white circles, and zeros are black.

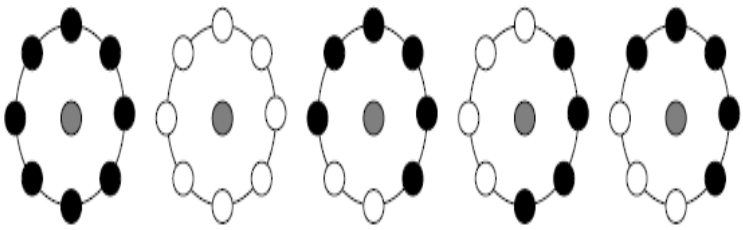
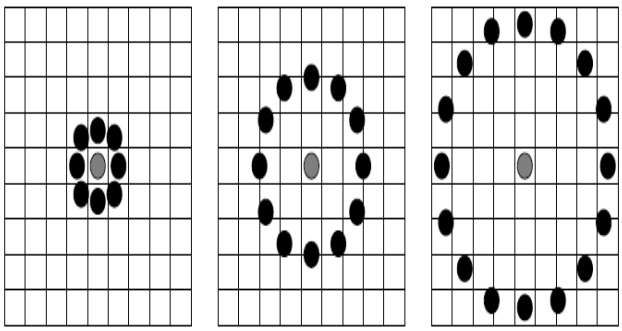


Fig: 2. Different Texture Primitives Detected By the LBP.

The LBP operator is first derived from a general definition of texture in a local neighbourhood. The non-parametric classification principle used in conjunction with the operator. A number of extensions to the LBP texture operator are also presented. In a rotation invariant version is derived,

and the number of rotation invariant codes is reduced by introducing the concept of uniformity.

The derivation of the LBP follows that represented by Ojala et al.[10]. Due to the lack of a universally accepted definition of texture, the derivation must start with a custom one. Let us therefore define texture T in a local neighbourhood of a gray-scale image as the joint distribution of the gray levels of P + 1 (P > 0) image pixels: T = t(gc, g0, . . . , gP”1),([1]) where gc corresponds to the gray value of the centre pixel of a local neighbourhood. gp(p = 0, . . . , P “ 1) correspond to the gray values of P equally spaced pixels on a circle of radius R (R > 0) that form a circularly symmetric set of neighbours. This set of P +1 pixels is later denoted by GP. In a digital image domain, the coordinates of the neighbours gp are given by (xc+Rcos(2π/P), yc”Rsin(2π/P)), where (xc, yc) are the coordinates of the center pixel. Fig. 3 illustrates three circularly symmetric neighbour sets for different values of P and R. The values of neighbours that do not fall exactly on pixels are estimated by bilinear interpolation. Since correlation between pixels decreases with distance, much of the textural information in an image can be obtained from local neighbourhoods.[16]



P=8, R=1.0 P=12,=2.5 P=16, R=4.0

Fig: 3. Circularly Symmetric Neighbours Sets. Samples That Do Not Exactly Match The Pixel Grid Are Obtained Via Interpolation.

If the value of the center pixel is subtracted from the values of the neighbours, the local texture can be represented — without losing information — as a joint distribution of the value of the center pixel and the difference

$$T = t(gc, g0 - gc, \ldots, gP\text{-}1 - gc). \quad (2)$$

Assuming that the differences are independent of gc, the distribution can be

factorized:

$$T \cong t(gc)t(g0 - gc, \ldots, gP\text{-}1 - gc). \quad (3)$$

In practice, the independence assumption may not always hold true. Due to the limited nature of the values in digital images, very high or very low values of gc will obviously narrow down the range of possible differences. However, accepting the possible small loss of information allows one to achieve invariance with respect to shifts in the gray scale.

Since t(gc) describes the overall luminance of an image, which is unrelated to local image texture, it does not provide useful information for texture analysis. Therefore, much of the information about the textural characteristics in the original joint distribution (Eq. 2) is preserved in the joint difference distribution20:

$$T \cong t(g0-gc,\ldots.gP-1-gc). \qquad (4)$$

The P"dimensional difference distribution records the occurrences of different texture patterns in the neighbourhood of each pixel. For constant or slowly varying regions, the differences cluster near zero. On a spot, all differences are relatively large. On an edge, differences in some directions are larger than in others. Although invariant against gray scale shifts, the differences are affected by scaling to achieve invariance with respect to any monotonic transformation of the gray scale, only the signs of the differences are considered:

$$T \cong t(s(g0-gc),\ldots,s(gP-1-gc)), \qquad (5)$$

Where

$$s(x)=\begin{cases}1 & x>0\\ 0 & x<0.\end{cases} \qquad (6)$$

Now, a binomial weight 2p is assigned to each sign s(gp - gc), transforming the differences in a neighbourhood into a unique LBP code. The code characterizes the local image texture around (xc, yc):

$$LBP_{P,R}(xc, yc) = \sum_{P=0}^{P-1} s(gp-gc)2p \qquad (7)$$

In practice, Eq. 7 means that the signs of the differences in a neighbourhood are interpreted as a P-bit binary number, resulting in 2^P distinct values for the LBP code. The local gray-scale distribution, i.e. texture, can thus be approximately described with a 2^P bin discrete distribution of LBP codes:

$$T \cong t(LBPP,R(xc,yc)). \qquad (8)$$

B. Ltb Texture Model

Conventional LBP is extended to a three – valued code called as LTP. It preserves more textural information than LBP. It was proposed by Suruliandi and Ramar [11] for texture analysis. This descriptor perceives the number of transitions or discontinuities in the circular presentation of the patterns. When such transitions are found to follow a rhythmic pattern, they are recorded as uniform LTP.

Extending the LBP operator to operate on ternary pattern instead of binary pattern will reveal the local texture information in more detail. The proposed method permits of detect the number of transition or discontinuities in the circular presentation of the patterns. When such transitions are found to follow a rhythmic pattern, they are recorded as uniform 'Local Texture Patterns (LTP)' and are assigned with unique labels. All other non uniform patterns will be grouped under one category. These uniforms LTP correspond to the micro textural primitives of an image. Hence a local image texture can be described by means of the LTP. The occurrence frequency of LTP over the larger region of an image will reveal the textural characteristics of the image and it will be used as a global image descriptor.

The local image texture information can be extracted from a neighbourhood of 3*3 local regions. Let gc, g1, g2, …, g8 be the pixel values of a local region where gc is the value of the central pixel and g1, g2, …, g8 are the pixel values of its 8 neighbourhood. Let the pattern unit P, between gc and its neighbour gi(i=1, 2, …, 8) be defined as

$$P(g,gc)=\begin{cases}0 & \text{if } gi<(gc-\Delta g)\\ 1 & \text{if } (gc-\Delta g)\leq gi\leq(gc+\Delta g)\ i=1,2,3,\ldots,8\\ 9 & \text{if } gi>(gc+\Delta g)\end{cases} \quad (9)$$

where Δg is a small positive value that represents desirable gray value and its importance in forming the uniform patterns. The values for P can be any three distinct values and here it is selected as 0, 1 and 9 in order to make the pattern labelling process easier and have no other importance. The gray-scale invariance is achieved by means of determining the P value by comparison instead of using their exact values. The P value will not be affected by shift in the gray values. Fig.4 illustrates the method of calculating the P values along the border of a 3*3 local region and it's Pattern String. The Pattern String can be formed from the Pattern Unit matrix by collecting the P values starting from any position. If each neighbour is assigned with any one of the three P values, the total number of combinations in eight such neighbours will form 3^8 =6561 local texture patterns, which can be labelled from 0 to 6560.

123	110	113
117	120	135
130	125	128

(a)

1	0	0
1		9
9	9	9

(b)

00999911

(c)

Fig.4. Example for calculating P value Pattern String

(a) 3*3 local region (b) Pattern Units matrix for Δg=4 (c) Pattern String

Hence a local image texture can be described by a pattern label that corresponds to the combination of pattern units. The global image texture can be described by a histogram of 6561 bins that represents the occurrence frequency of local texture patterns over larger area of the image. In this representation scheme, it is observed in the histogram, only few bins are filled with more occurrence values and remaining bins are either empty or filled with few occurrence values. Further, it is noted that the local image texture descriptor is rotational variant. Hence it is decided to identify the rotational invariant patterns which really contribute to the description of local image texture.

It is observed that certain local texture patterns are covering the vast majority of all 3*3 local regions present in the textures. The interesting features about these patterns are, they are the fundamental properties of the textures and they have a uniform circular structure that contains very few spatial transitions. To define such uniform circular patterns, a uniformity measure 'U' which corresponds to the number of spatial transitions circularly in the pattern String is defined as

$$U=s(P(g_8,g_c),P(g_1,g_c))+\sum_{i=2}^{8} s(P(gi,gc),P(gi-1,gc))$$

Where

$$S(X,Y)=\begin{cases}1 & \text{if } |X-Y|>0 \\ 0 & \text{otherwise}\end{cases} \qquad (10)$$

For example, the Pattern String 00119999 has U value of 3 and the Pattern String 11111111 has U value of 0.(See Table 1 for more examples). The case U=0 means all the Pattern Units are same. The case U=1 will never occur. U=2 is the case where the Pattern Units are filled with only 2 values (0&1or 0&9or 1&9) in a uniform circular fashion. U=3 is the case where the Pattern Units are filled with all the 3 values (0,1&9) in a uniform circular fashion. For the case U>=4, Pattern Units are filled with 2 or 3 values in a non_ uniform fashion. The patterns with at most U value of 3 shall be treated as 'uniform'.

The following rotational and gray-scale shift invariant LTP operator is proposed for describing local image texture.

$$LTP=\begin{cases}\sum_{i=1}^{8} P(gi,gc) & \text{if } U<3\\ 73 & \text{otherwise}\end{cases} \qquad (11)$$

Total number of bins required for LTP is 72[8]. Here also, the uniform pattern concept is initiated to condense the number of bins. Uniformity measure U defined in Eq.(9) can be used to find the uniform and non-uniform patterns. The pattern string having $U \leq 3$ are considered as uniform and are represented by 45 bins (3 bins for $U = 0$, 21 bins for $U = 2$ and 21 bins for $U = 3$). The patterns having $U > 4$ are termed as non-uniform and are distinguished by a single bin. Hence uniform LTP requires only 46 bins.

For U=0 there exist 3 LTP (0, 8and 72), for U=2 there are 21 LTP (1to 7,9,16,18 ,24,27,32,36,40,45,48,54,56,63 and 64) for U=3 there exist another 21 LTP(10to 15,19to 23,28to 31,37to39,46,47and 55). All other non-uniform patterns are grouped under one label 73. The pattern strings such as 000019000 and 00091000 are considered rotate right equivalent and both patterns will generate the same LTP. Therefore, the total number of LTP is 46. Since there are few holes in the LTP numbering scheme, they are relabelled to form continuous numbering from 1 to 46 using a lookup table. LTP for some pattern Strings are shown in Table 1.

Table: 1. Global Image Texture Description by Pattern Spectrum

Pattern String	U	LTP	Relabelled LTP	Uniform
00000000	0	0	1	Yes
11111111	0	8	9	Yes
99999999	0	72	45	Yes

Pattern String	U	LTP	Relabelled LTP	Uniform
00100000	2	1	2	Yes
00009999	2	36	31	Yes
99991111	2	40	35	Yes
91000000	3	10	11	Yes
11190000	3	12	12	Yes
09991110	3	30	28	Yes
01110110	4	73	46	No
01990100	5	73	46	No
10011010	6	73	46	No
01090190	7	73	46	No

It is proposed here, a new global image texture description based on a spectrum (i.e., one dimensional histogram). The spectrum used the previously defined LTP as the measure to describe the global texture. It is expected that the statistics of the occurrence frequency of all the LTP over a whole image should reveal the texture information of the image to be analyzed. The occurrence frequency of all the LTP is termed as 'Pattern Spectrum', with the abscissa indicating the LTP code and the ordinate representing its occurrence frequency. In the Pattern Spectrum, an increase in the percentage of texture components in an image will result in a tendency of form a particular distribution pattern of LTP.

C. Mlbp Texture Model

The *LBP c, j texture* measure allows a texture description of a single band. Most remote sensing images, however, consist of multiple bands. Including multiple bands might improve segmentation considerably, as a combination of bands provides more spectral information for identification of different land cover types.

In their psychophysical study Poirson and Wandell (1996) showed that color and pattern information are processed separately by the human visual system. Mojsilovic *et al.* (2000) extracted color-based information from the luminance and chrominance color components. The achromatic

pattern component was utilized as texture pattern information. Another approach was that of Panjwani and Healey (1995) which captured spatial interactions both within and between color bands with Markov random fields (MRFs). More recently, Pietikäinen *et al.* (2002) showed that the powerful LBP texture measure can also be applied to color images. They processed color information and texture information separately and obtained good classification results for color texture images.

Most research on color texture focused on images of different materials with a clear texture. In standard color images, the pattern in different bands is often highly correlated. This makes it possible to summarize pattern information in a single band and process it separately from color information. In remote sensing images, however, information is recorded from different parts of the spectrum. Therefore, textures in these bands are not necessarily similar. In between band relations should be taken into account when looking at multivariate texture measures for remotely tely sensed imagery. The *c*, *j LBP* texture measure is a robust, rotation invariant and flexible texture measure. An extension to the multivariate case is expected to provide good segmentation results.

In this study, a new multivariate texture measure is introduced and implemented. It is based on the univariate *c*, *j LBP* measure. The Multivariate Local Binary Pattern operator, *c MLBP* describes local pixel relations in three bands. In addition to the spatial interactions of pixels within one band, interactions between bands are considered. Thus, the neighbourhood set for a pixel consists of the local neighbours in all three bands (Fig: 5). The local threshold is taken from these bands, which makes up a total of nine different combinations. This results in the following operator for a local color texture description

$$\begin{aligned}\text{MLBPc}=&\\ &sign(gib1-gcb1)+sign(gib2-gcb1)+sign(gib3-gcb1)+\\ &\sum_{i=0}^{P-1}sign(gib1-gcb2)+sign(gib2-gcb2)+sign(gib3-gcb3))+\\ &sign(gib1-gcb3)+sign(gib2-gcb3)+sign(\end{aligned}$$

where *b1* is the first band, *b2* is the second band, and *b3* is the third band. The first part of the equation calculates LBP values for the center pixel of the first band based on relations with the neighbours in the first band and the two other bands. The second part of the equation calculates LBP values for the center pixel of the second band and the third part of equation 9 calculates LBP values for the center pixel of the third band. Each of the three central pixels is, therefore, compared with neighbourhood pixels in the other bands. *C MLBP* is not just a summation of *c*, *j LBP* of individual bands; it also models pixel relations between bands. These cross-relations can be important in the distinction of different color textures. A total of nine LBP values is obtained and summed to derive *c*

MLBP. The color texture measure is the histogram of *c MLBP* occurrence, computed over an image or a region of an image. This single distribution contains $P \times 32$ bins (e.g. $P = 8$ results in 72 bins).

MLBP c measures the binary color pattern of a texture. To complete this measure with contrast and variance information we included the color histogram, *RGB-3D*. Each 8-bit band 15 is quantized into 32 levels by dividing the pixel values on each band by 8, resulting in a three-dimensional histogram with 323 entries. The two histograms of *c MLBP* and *RGB-3D* are used to segment a three-band image into objects. In the top down hierarchical splitting process we calculate *c MLBP* and *RGB-3D* histograms for every image block. G-statistic values are calculated to test for similarity between image block and reference texture histograms. For two *c MLBP* and *RGB-3D* histograms, two G-statistic values are obtained. These values are summed to derive a single similarity measure.

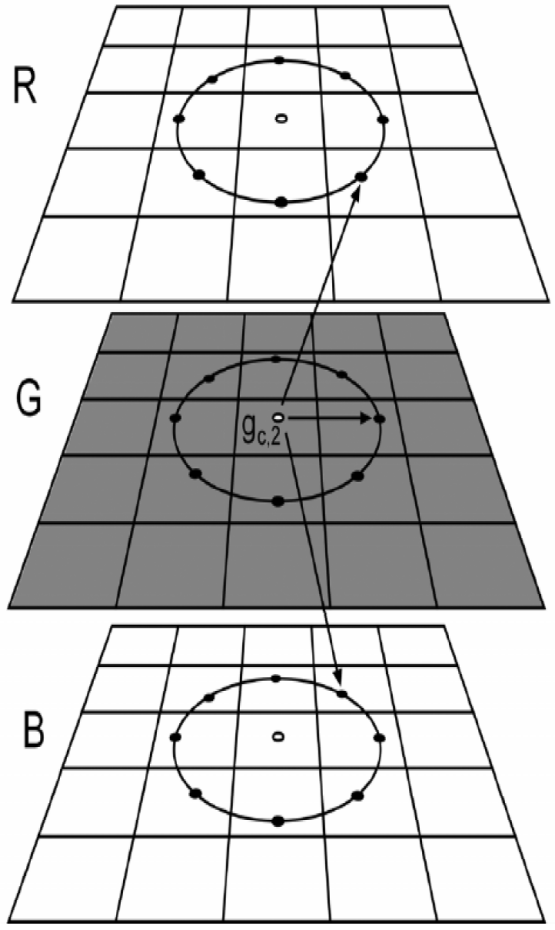


Fig: 5.MLBP describes local pixel relations of three bands

Based on this measure, uncertainty values are calculated using equation 7 and texture labels are assigned to image blocks to form objects.

I. Experimental Result

A. Experimental Data

In this application the texture samples of Brodatz's collection is chosen for the comparative study on classification. Four set of class are taken. Such as Wood, Canvas, Water and Grass. For each class, the 20 samples are chosen form that half is used for training and the half is used for testing.

Sample Textures

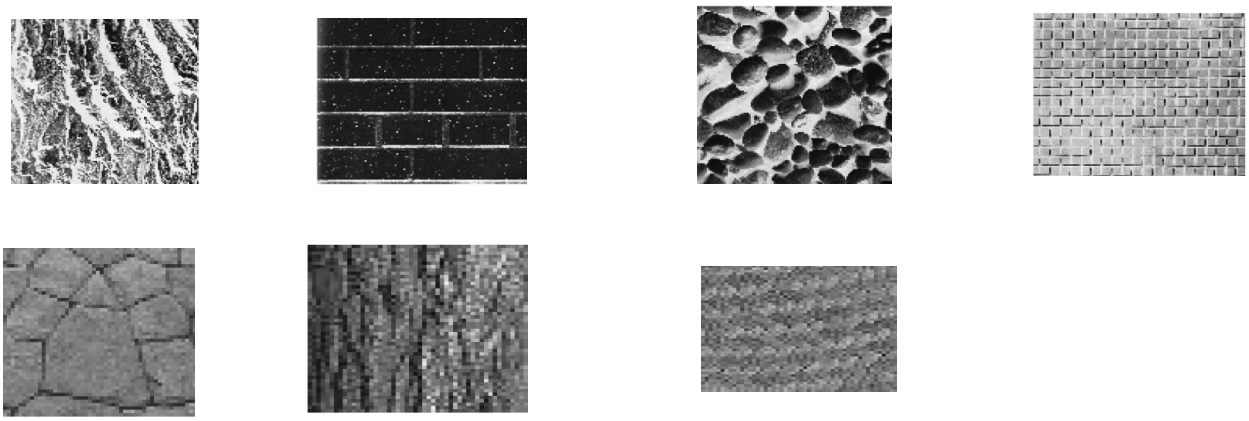


Fig: 6 .Sample Textures

This system aims to make texture classification with some statistical method. This system is implemented with the help of mat lab. The three algorithms LBP, LTP, MLBP Transform are properly implemented for the texture classification on Bordatz's album of four set of class. B1 –wood, B2-canvas, B3-Water, B4-Grass.

B. Experiment –I - **Local Binary Pattern**

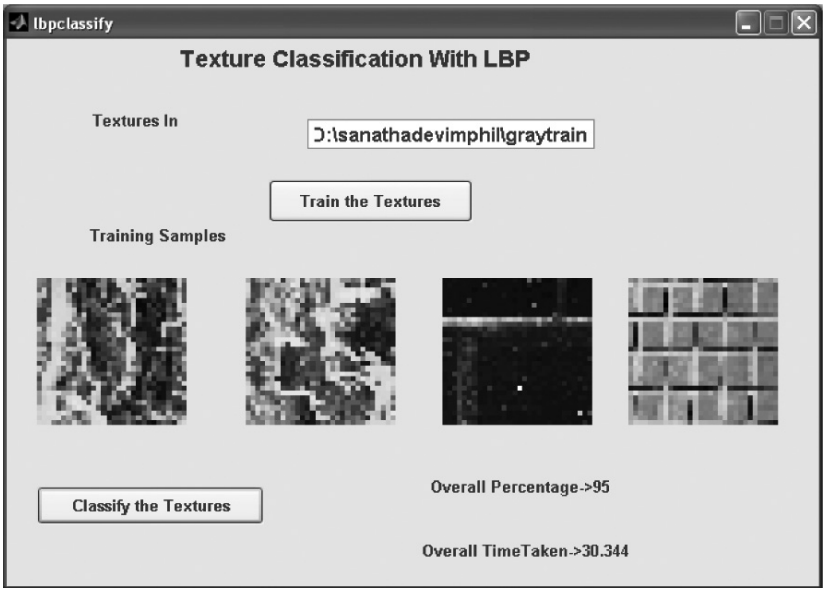


Fig: 7. LBP Classification Process

C. Experiment –II **-Local Texture Pattern**

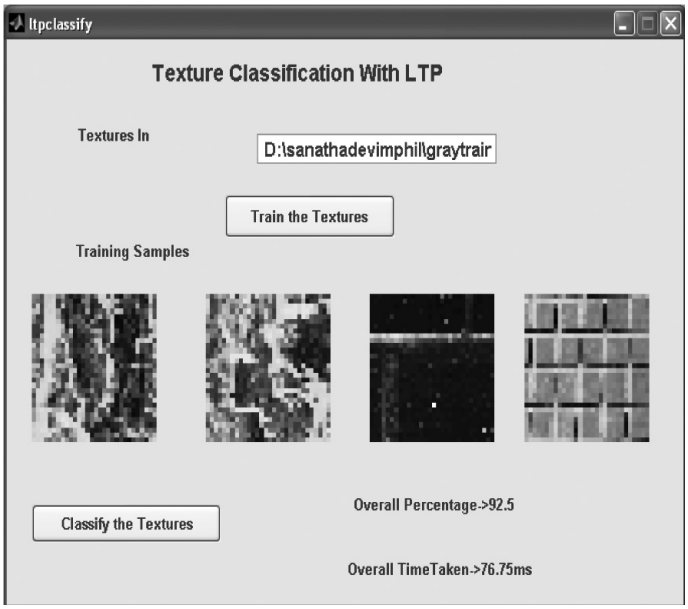


Fig: 8. LTP Classification Process

D. Experiment –III- **Multivariate Local binary pattern**

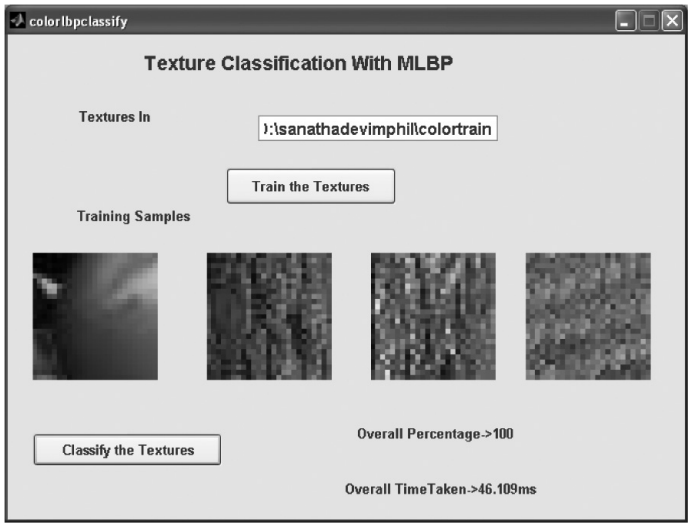


Fig: 9. MLBP Classification

III. PERFORMANCE EVALUATION

Analysis Result

From the classification rate analysis, we can conclude the LBP method perform better for rock, canvas, water and wood texture compared to LBP. But in the case of LTP the bin size is reduced

as much as needed. In this system four classes are used for analysis, the rate of classification will vary according to the feature vector, class variation and level of decomposition.

The time consumption is reasonable for all methods but the LBP time consumption is better compare to LTP and MLBP. The MLBP plays its great role on color texture classification.

Classification Rate Analysis on the Comparative Study

Texture Method	Classification Rate
LTP	92.5%
LBP	95%
MLBP	100%
Classification rate of 4 classes of 64 samples for training and 64 for testing	

Table:2 Fig: 10. Chart for classification Rate Analysis

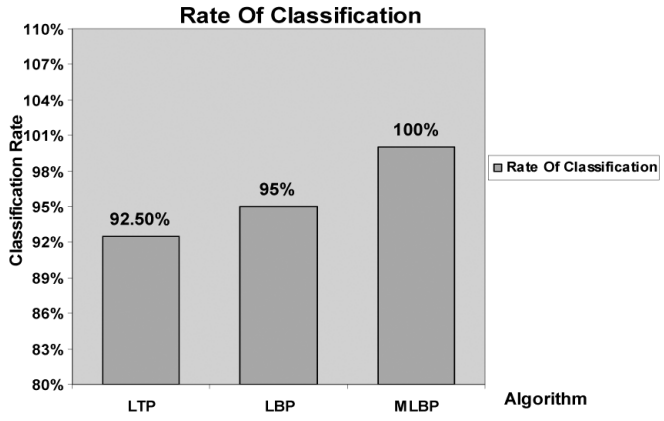


Fig: 10. Chart for classification Rate Analysis

Time consumption on single Class

Texture Method	Elapsed Time in Milliseconds
LTP	76.75
LBP	30.344
MLBP	46.109

Table: 3. Time Consumption Table

IV. Discussion And Conclusion

This application is proposes a comparative study on texture classification rate among three local texture features based algorithms. This system provides clear study on the area of texture classification. All the algorithms are properly implemented with the help of mat lab features. This system properly maintains the data collection for the texture as different groups. This application takes groups of texture under grass, canvas, wood and water.

In classification experiments, the present generalized methods are analyzed according to its classification rate. The rotation invariant texture feature of LBP method performs well on the gray scale textures. The bin size is properly reduced by the local texture pattern. For the color image the multivariate textural features are used for classification.

References

1. T. Ojala, M. Pietikäinen, and D. Harwood, (1996) A comparative study of texture measures with classification based on feature distributions, Pattern Recognition, vol. 29, pp. 51-59.
2. T. Ojala, M. Pietikäinen, and T.Mäenpää, (2000) Gray scale and rotation invariant texture classification with local binary patterns, in Proc. The 6th European Conference on Computer Vision-Part I, pp. 404-420, London: Springer-Verlag, UK.
3. R.W.Conners and C.A.Harlow, (1980) A Theoretical Comparison of Texture Algorithms ,IEEE Trans on pattern Analysis and Machine Intelligence, 2(3), 204-222
4. 1.J. Beck, A. Sutter, and R. Ivry, (1987) Spatial frequency channels and perceptual grouping in texture segregation. CVGIP, 37.
5. R.Chellappa and S.Chatterjee, (1985), Classification of Textures Using Gaussian Markov Random Fields., IEEE Trans on Acoustic Speech Signal Processing,33(4), 959-963.
6. Timo Ahonen, Adbenour Hadid and Matti Pietikainen.,(2006) Face description with Local Binary Pattern: Applications to Face Recognition , IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 28, No. 12, pp. 2037-2041.
7. Timo Ojala, Matti Pietikainen and David Harwood, (1996), A comparative study of texture measures with classification based on featured distributions, Pattern Recognition, Vol. 29, No. 1, pp. 51-59.
8. A. Suruliandi, K. Meena and R. Reena Rose , (2013), An illumination invariant texture based face recognition, ictact journal on image and video processing, , volume: 04, issue: 02 pp. 709-716.
9. Tranden. (2009). [Online]. Available: http://www.ux.uis.no/~tranden/brodatz.html,
10. Timo Ojala, Matti Pietikainen, Topi Maenpaa,(2001) , A Generalized Local Binary Pattern Operator for Multiresolution Gray Scale and Rotation Invariant Texture Classification, Proceedings of 2nd International Conference.

11. A. Suruliandi and K. Ramar, , (2008) , Local Texture Patterns – A Univariate model for classification of Images", Proceedings of 16th International Conference on Advanced Computing and Communications, pp. 32-39.

12. B. Poirson and B. Wandell. , (1996) Pattern-color separable pathways predict sensitivity to simple colored patterns. Vision Research, 36(4):515–526.

13. A. Mojsilovic, J. Kovacevic, D. Kall, R. Safranek, and S. Ganapathy.(2000), Matching and retrieval based on the vocabulary and grammar of color patterns. IEEE Transactions on Image Processing, 9(1):38–54.

14. D. Panjwani and G. Healey,(1995) Unsupervised segmentation of textured color images. IEEE Transactions on Pattern Analysis and Machine Intelligence, 17(10):939–954.

15. T. Ojala, M. Pietik¨ainen, T. M¨aenp¨a¨a, J. Viertola, J. Kyll¨onen, and S. Huovinen. Outex (2002), new framework for empirical evaluation of texture analysis algorithms. In 16th International Conference on Pattern Recognition, Qu´ebec, Canada.

16. M.Pietikainen et al, (2011), computer vision using local binary patterns, computational imaging and vision 40, springer -verlag london limited.

CHARACTERIZATION OF DUAL COPAIR INTEGERS

Selvam Avadayappan and **M. Bhuvaneshwari**

Abstract

Two pairs of integers (a, b) and (c, d) are said to be copairs if the sum of their product with their sum equals that of other, that is, a + b + ab = c + d + cd. (a, b) and (c, d) are said to be dual copairs if both have same difference between their product and their sum, that is, if a + b + cd = c + d + ab. In this paper, we derive the relationship between copairs and dual copairs. Also we characterize and enumerate all such dual copairs.

Keywords

Copairs, dual copairs

AMS Subject Classification code: 11 A (Primary)

1 Introduction

Notations and terminology, used in this paper, are as in [1]. By (a, b), we mean an unordered pair a and b. For any integer $n \geq 1$, let $\varphi(n)$ denote the Euler totient function which is defined as the number of factors of n including 1 and n. For example, $\varphi(8) = 4$ and $\varphi(17) = 2$. Generally for any $n = p_1^{n_1} p_2^{n_2} \ldots p_m^{n_m}$, $\varphi(n) = (n_1 + 1)(n_2 + 1) \ldots (n_m + 1)$. It is easy to note that the factors a and $\frac{n}{a}$ of n form a pair such that their product is n. If n is not a perfect square, $\varphi(n)$ will be even and there will be exactly $\frac{\varphi(n)}{2}$ such pairs. For any perfect square n, $\varphi(n)$ will be odd and there will be $\frac{\varphi(n)+1}{2}$ such pairs. Note that in this case $\sqrt{n}$ pairs with itself. In general, for any n, we can find $\left\lceil \frac{\varphi(n)}{2} \right\rceil$ pairs of integers (a, b) such that ab = n.

Classification of numbers according to their peculiar behaviour is an interesting job right from the Pythagorean period till today. Some of the interesting categories of numbers

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which have been classified so far are amicable numbers or friendly numbers[4,5], prime numbers, perfect numbers, sociable numbers[4], pentagonal numbers, solitary numbers. In that sequence, Selvam Avadayappan et al [3] introduced a new type of pairs of integers called copairs.

Two pairs of integers (a, b) and (c, d) with the property that the sum of their product with their sum equals that of other, that is, a + b + ab = c + d + cd are called *copairs*. Some examples of such copairs are (3, 11) and (5, 7), (4, 15) and (7, 9), (2, 7) and (3, 5). In [3], a formula to generate infinite number of copairs has been established. Characterisation and enumeration of all such copairs have been done in [2]. In fact it has been proved that,

Theorem 1.1 For any composite number n, there exists exactly $\binom{2p}{2}$ copairs (a, b) and (c, d) such that a + b + ab = n - 1 = c + d + cd, where $p = \left\lceil \frac{\varphi(n)}{2} \right\rceil$.

Theorem 1.2 For any prime n, there do not exist any copairs of same parity such that a + b + ab = n - 1 = c + d + cd.

Based on this idea, we define dual copairs and characterise them in this paper. The pair of integers (a, b) and (c, d) are said to be dual copairs if both have same difference between their product and their sum. In other words, (a, b) and (c, d) are said to be dual copair if a + b + cd = c + d + ab. Some examples of such dual copairs are (5, 13) and (7, 9), (6, 17) and (9, 11), (4, 9) and (5, 7). Here, we derive the relationship between copairs and dual copairs and in addition we enumerate all such dual copairs.

2 Dual copair of integers

Let I denote the set of all integers. Define a binary relation * on I such that a * b = ab – (a + b). Suppose M denote the set of unordered pairs of the elements of I. Now if we define a relation ρ on M such that (a, b) ρ (c, d) if and only if a * b = c * d, that is, if and only if (a, b) and (c, d) are dual copairs, then it is easy to verify that ρ is an equivalence relation on M. Therefore ρ partitions M into equivalence classes. Let M_k denote the equivalence class with dual copairs (a, b) and (c, d) such that a * b = c * d = k. The number of elements in each equivalence class M_k is calculated in the following theorem.

Theorem 2.1 Each M_k contains exactly 2p dual copairs where $p = \left\lceil \frac{\varphi(|k+1|)}{2} \right\rceil$.

Proof For any pair of integers $(a, b) \in M_k$, $a * b = k$ and hence $ab - (a + b) = k$. Therefore $(a - 1)(b - 1) = k + 1$. Hence the problem of determining the size of M_k is equivalent to finding the number of factors of $k + 1$. Let $P = \{(a', b') / a', b' \in Z \text{ and } a' b' = |k+1|\}$. Then $| P | = | M_k | = 2 \left\lceil \frac{\varphi(|k+1|)}{2} \right\rceil = 2p$.

Theorem 2.2 For any integer $k \neq -1$ and $k \neq -m^2 + 1$ (where $m > 1$), there exist exactly $\binom{2p}{2}$ dual copairs (a, b) and (c, d) such that $a * b = k = c * d$, where $p = \left\lceil \frac{\varphi(|k+1|)}{2} \right\rceil$.

Proof Let k be any integer other than -1 and not of the form $-m^2 + 1$. Let $P = \{(a', b')/a', b' \in Z \text{ and } a' b' = |k+1|\}$. Then $M_k = \{(a, b) / a = a' + 1 \text{ and } b = b' + 1, \text{ for } (a', b') \in P\}$. It is clear that the required dual copairs are any two arbitrary pairs (a, b) and (c, d) belonging to M_k. Since $|M_k| = 2p$, where $p = \left\lceil \frac{\varphi(|k+1|)}{2} \right\rceil$, (Theorem 2.1), clearly there are $\binom{2p}{2}$ such dual copairs.

It is clear that the theorem is not valid for $k = -1$, since 0 has no factors.

Note that when k is of the form $-m^2 + 1$, M_k contains only $2p - 1$ dual copairs such that $a * b = c * d = k + 1$, since we are considering only unordered pair of factors and hence $(-m, m)$ and $(m, -m)$ are one and the same. Therefore when $k = -m^2 + 1$ (for some $m > 1$), there exist exactly $\binom{2p-1}{2}$ dual copairs (a, b) and (c, d) such that $a * b = k = c * d$, where $p = \left\lceil \frac{\varphi(|k+1|)}{2} \right\rceil$.

For instance, when $k = 63$, $\varphi(|k + 1|) = \varphi(2^6) = 7$. Here $P = \{(1, 64), (2, 32), (4, 16), (8, 8), (-1, -64), (-2, -32), (-4, -16), (-8,-8)\}$ and $M_k = \{(2, 65), (3, 33), (5, 17), (9, 9), (0, -63), (-1, -31), (-3, -15), (-7, -7)\}$ which gives $\binom{8}{2} = 28$ dual copairs (a, b) and (c, d) such that $a * b = 63 = c * d$.

When $k = -65$, $\varphi(|-2^6|) = 7$. In this case, $P = \{(1, -64), (2, -32), (4, -16), (8, -8), (-1, 64), (-2, 32), (-4, 16)\}$ and $M_k = \{(2, -63), (3, -31), (5, -15), (9, -7), (0, 65), (-1, 33), (-3, 17)\}$ which gives $\binom{7}{2} = 21$ dual copairs (a, b) and (c, d) such that $a * b = -65 = c * d$.

Theorem 2.3 Any two integers (a, b) and (c, d) are dual copairs if and only if $(a - 2, b - 2)$ and $(c - 2, d - 2)$ are copairs.

Proof Let (a, b) and (c, d) are dual copairs. Then $ab - (a + b) = cd - (c + d)$. Now, $(a - 2)(b - 2) + a - 2 + b - 2 = ab - (a + b) = cd - (c + d) = (c - 2)(d - 2) + c - 2 + d - 2$. Hence $(a - 2, b - 2)$ and $(c - 2, d - 2)$ are copairs. In a similar manner, we can easily verify the converse part.

References

1. Tom M.Apostal, Introduction to Analytic Number Theory, Springer International Student Edition (1989).
2. Selvam Avadayappan and M.Bhuvaneshwari, *Characterization of copair integers,* Journal of Modern Science, Vol.4- No.1, 45-47, February 2012.
3. Selvam Avadayappan, S.Chelian and P.Santhi, *Two pairs of Integers – copairs*, Ultra Science, Vol.21(1)M,(2009), 31-34.
4. H. Cohen, *On amicable and sociable numbers,* Math. Comp. **24** (1970), pp. 423-429.
5. Costello, Patrick, *New Amicable Pairs Of Type (2; 2) And Type (3; 2)*, Mathematics of computation (American Mathematical Society) **72** (241): 489–497, April 2007.

FORM IV

Statement about ownership and other particulars

1.	Place of publication	Chennai
2.	Periodicity of its publication	biannually
3.	Printer's Name	D.RAMANATHAN
	Nationality	Indian
	Address	Alamu Printing Works, 9/5, Iyyah Street, Royapettah, Chennai - 600 014
4.	Publisher's Name	Prof. Dr.Karu.Nagarajan
	Nationality	Indian
	Address	Tamil Nadu State Council for Higher Education Lady Wellington College Campus, Chennai - 600 005
5.	Editor's name	Prof. Dr.Karu.Nagarajan
	Nationality	Indian
	Address	Tamil Nadu State Council for Higher Education Lady Wellington College Campus, Chennai - 600 005

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Published by Prof. Dr.Karu.Nagarajan, Member Secretary, on behalf of Tamil Nadu State Council for Higher Education from Lady Wellington College Campus, Kamarajar Salai, Chennai 600 005 and printed by Thiru D. Ramanathan, at Alamu Printing Works, 9/5, Iyyah Street, Royapettah, Chennai - 600 014. **Editor : Prof. Dr.Karu.Nagarajan**

Registered with Registrar of News Papers in India vide Registration No. TNBIL/2009/29041

ISSN 2277-7628