Fibre Fractionation and Retention Studies in Twin Wire Former (With Hard Wood and Bagasse Furnish)

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ABSTRACT

A study of fiber fraction and retention on Newsprint machine (Twin-wire former) at the Mysore Paper Mills Ltd. was under taken as part of the paper machine performance studies. The fiber fractionation and retention studies results are compared with the fiber fractionation and retention study results of Tamil Nadu Newsprint & Papers Ltd. where bagasse is the main furnish.

One area of particular interest was to study the fibre/fines retention on twin wire former. Bauer-McNect fibre size classifier has been used in this study to obtain fractionation profiles of stuff box, machine head box tray water and couch sheet samples. From the data obtained in this studies the retention of total solids, fibre fraction and fines fraction has been calculated.

Since the actual value of retention on total solids basis is of little importance, because it is influenced by both fibre/fines ratio in the head box and sheet, a comprehensive retention calculation has been made which would help to find the ways for improving paper machine performance.

INTRODUCTION :

The subject wet end retention is not new to the Paper Industry. Good filler and fines retention enhance the economic advantages of the entire paper making operation. Retention exploits the inherent potential of pulp fines and filler fines used in paper making process, reduces material degradation by recycling, reduces felt filling, increases the strength properties of the paper made, reduces the overall load on saveall.

Good retention is also important in abating environmental pollution. Increasing the retention, thus, become a primary factor in the search for a better cost yield balance.

Considerable importance is being given for achieving high retention, while designing the new type of formers for manufacturing various grades of paper.

IMPORTANCE OF FINES IN PAPER MAKING :

Fibres and fines distribution in paper making stock affects the efficiency of the paper machine at many places. The measurement of fines and controlling the fines in paper making system is gaining much importance in recent years for judging the machine performance and in balancing the various paper properties.

All paper making stocks contain, in addition to fiber varying quantities of fines particles. These fines are derived from variety of sources[2] small cells present in the original raw material, debris detached from fiber while chipping, cooking and defibering in the paper machine section and filler fines[3].

All material that passes through the 200 mesh screen is termed as fines fraction. The material held back by the 200 mesh screen is termed as fiber fraction. Ash test is being used to distinguish the difference between pulp fines and filler fines. The fiber/fines fractionation data at head box and sheet shows the retention of fiber fraction and fines fraction during the sheet forming process. Britt and co-workers have done extensive research work on this subject (3, 4, 5, 6, 7, 8). The major change fines fraction level in the head box indicates the change in retention.

ADVANTAGES OF INCREASED FIRST PASS RETENTION :

(a) Due to high retention, head box freeness is increased fines content in the head box reduced and formation improved in the final sheet.

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(b) The reduction of fines in the system results faster drainage rate and increased machine speed.

(c) Reduction of fines content in the back water reduces the load on polydisc filter and also reduces felt filling.

(d) In the mills using deinked furnish, the investment required to clear up the mills effluent will be reduced due to the lower load on back water and reduced BOD load.

ADVANTAGES OF FINES IN PAPER MAKING :

The particular paper properties which are affected by the fines retention are density, opacity, porosity, two sidedness and tensile strength. Density is generally increased and porosity is decreased, because the void space between the fibers is filled by the fines. But the porosity may be increased if the stock is highly flocked.

The increase in fines content in the sheet increases the opacity. Two sidedness is reduced when the sheet contains more fines. The effect upon tensile strength varies with the type of furnish.

FACTORS AFFECTING RETENTION :

Some of the many factors which directly affects the retention are :

(a) pulping time (b) Fiber species (c) Forming zone configuration (d) Head box design (e) Machine speed (f) Additives used (g) Forming fabrics design etc.

Sheet formation, drainage and fines retention is a process involving both mechanical and chemical forces. The mechanical (or) hydrodynamic force includes speed of the machine, forming zone configuration, furnish condition (long fiber short fiber furnish), basis weight, forming fabric design etc. The other force chemical or colloidal force includes surface properties of the suspended solids, such as residues from bleaching operation in pulping, foam pitch killing agents and starch in paper machine section.

The first part of this paper discusses the various types of twin-wire formers and the effect of forming zone configuration on fines retention. The second part discuss the importance of fiber fractionation, and retention studies on Mysore Newsprint and Tamilnadu Newsprint Paper Machine.

CLASSIFICATION OF TWIN-WIRE FORMERS

The twin-wire formers are normally directed in the following catagories :

(a) Blade formers —Bel-baie II, Verti forma
(b) Roll formers —Papriforma
(c) Hybrid formers —Sym-former, Duo-Former —F.
(d) Hybrid formers for Top wire retrofit —Bel-bond (R) Bel-roll (R)

The basic principle by which water is being removed in twin-wire formers are given below :

(i) Falling drainage rate at a constant drainage pressure (e.g. Roll Formers) Fg. 1.

(ii) Constant drainage rate at an increasing drainage pressure (e.g. Hybrid formers) Fg. 2.

(ili) Pressure pulses caused by stationary drainage elements (e.g.—Blade formers).

FORMATION AND FINES RETENTION ON VARIOUS TYPES OF FORMERS :

BLADE FORMERS :

Blade formers are provided with a stataionary dranage elements in one or both the wires. The pressure pulses caused by the stationary drainage elements creates high shear forces in the stock, thereby obtaining a well formed sheet but normally the retention is inferior to other types of formers.

ROLL FORMERS :

In roll formers, the sheet is formed at a constant drainage pressure and the drainage rate falls exponentially Fig. (1). The drainage pressure nccessary for the dewatering is equal to the wire tension devided by the radius of the roll. The long drainage zone with a relatively low pressure differential across the wire results in high fiber and filler retention on the wire.

HYBRID FORMER :

In Hybrid formers, the sheet is formed in an ideal condition like fourdriner i. e. sheet is formed at a constant drainage rate but with increasing drainage pressure Fig. (2). As there is no pressure pulses caused by the stationary drainage elements like blade former. In Hybrid formers the retention is increased considerably. The sheet made on hybrid former is of good formation and less two sidedness.

FIGURE 1

DRAINAGE RATE & DRAINAGE PRESSURE VS WIRE LENGTH

(ROLL FORMERS)

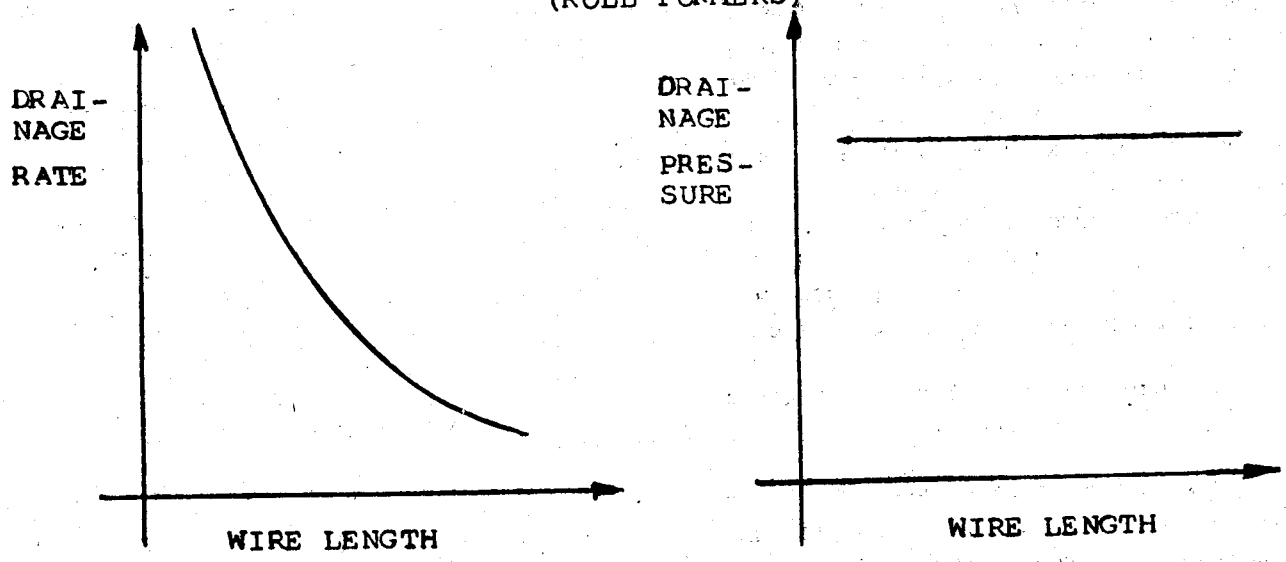
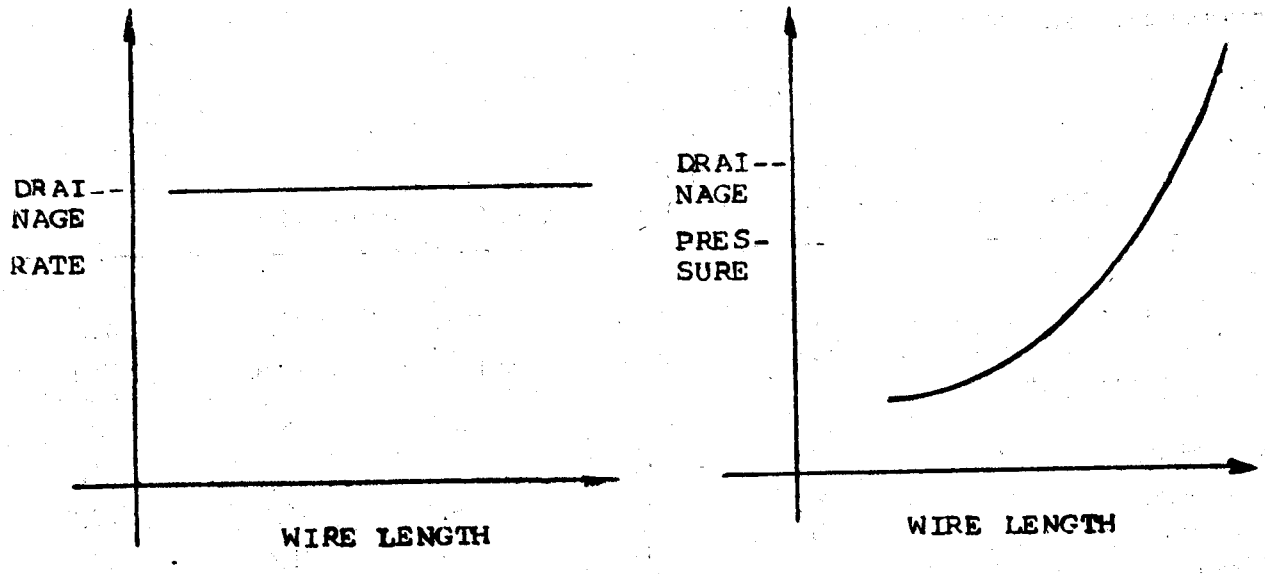


FIGURE 2

DRAINAGE RATE & DRAINAGE PRESSURE VS WIRE LENGTH

(HYBRID FORMERS)



FOUR POINT SAMPLING TECHNIQUE :

Fines fraction can give important information on the performance of the paper machine. The increase in fines content from stuff regulated box to paper machine head box indicates the poor first pass retention. Overall retention of the paper machine is indicated by the comparison of stuff box and paper sheet fines. Britt[7] suggested the four point sampling technique for monitoring paper machine retention performance by means of fines fraction analysis. Simultaneous fines fraction of the samples have taken from stuff regulated box, paper machine head box, tray water and couch sheet.

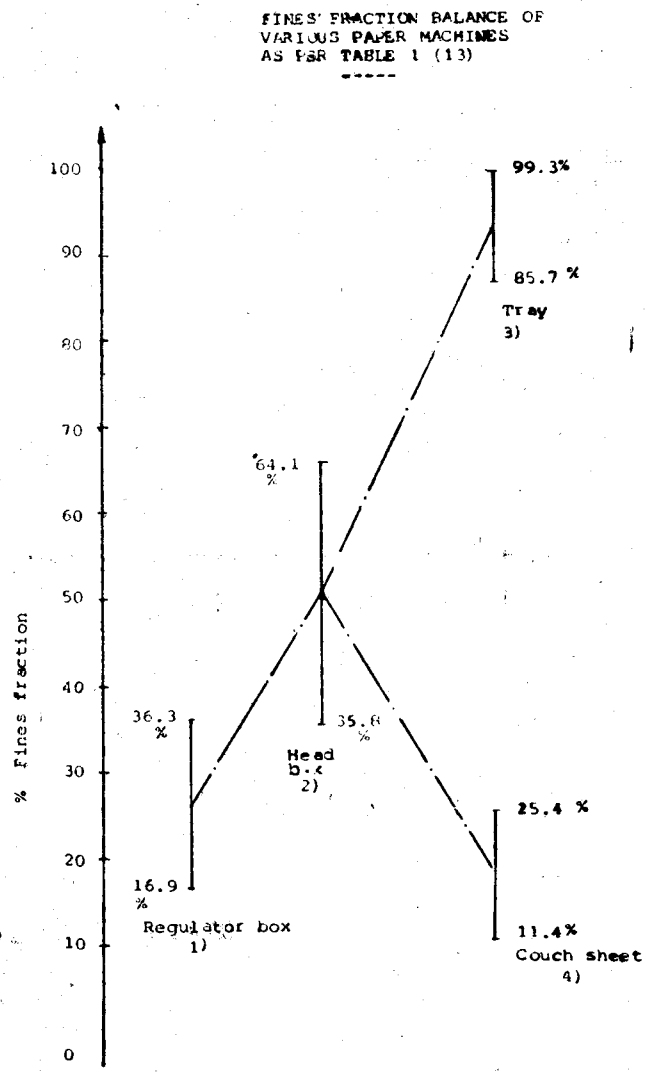
Fig. 4 illustrates the fines fraction balance of various paper machines as per table—I[13].

Fig. 5 shows the fines fraction balance on Mysore Newsprint Machine and Fig. 6 & 7 shows the fines fraction balance of Tamil Nadu Newsprint Machine for Newsprint and Writing aud printing paper respectively.

FIBRE / FINES FRACTIONATION DTERMINATION:

Multi-screen classifiers like Bauer-McNett and Clark have been widely used to determine the distribution of fibers and fines in paper machine stock. Recently single screen classifiers like branch-holl[9] wells-stampt[10] Dynamic drainage jar[11] have come into use for determining the fibers/fines distribution in the stock, which avoids the cumulative error associated with the multiscreen classifiers. Bauer-McNett fiber size classifier

Fig 4



TABLE—1

Fines fraction balance of various paper machines % Fines fraction (13)

Mill	A	B	C	D	E	F	G
Grade	News	News	Recycle	Towel	Tissue	Fine	Reprog
M/c type	Twin wire	Fourd.	Fourd.	Fourd.	Twin wire	Fourd.	Fourd.
Stuff box	35 2	36.3	27 est	26.4	23.7	16.9	29.0
Head box	64.1	49.4	51.6	48 9	83 3	36.3	35.8
Tray	90.9	98 7	93.1	92 9	99.3	85.7	93.9
Sheet	25.0	25.4	24.9	15.3	11.4	11.4	22 6

Fig. 5

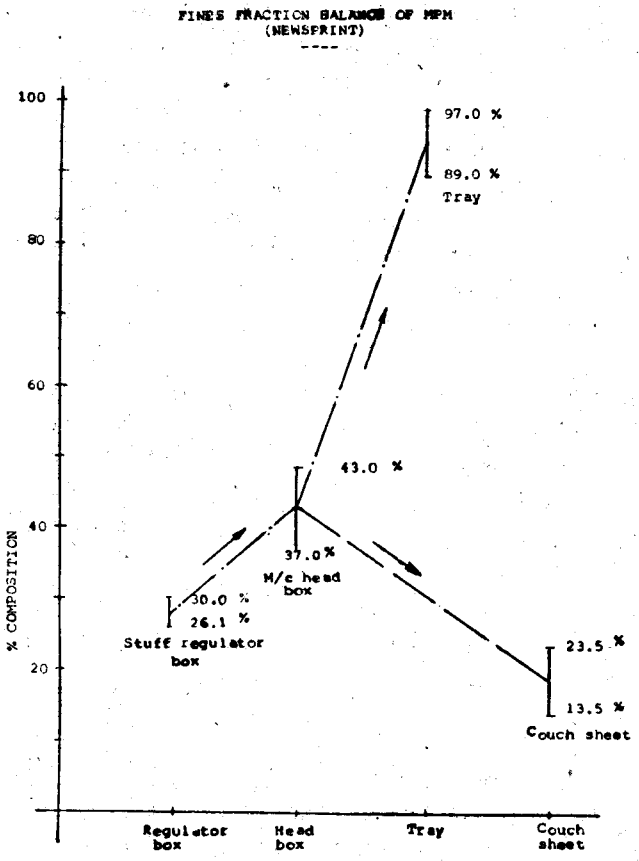


Fig. 6

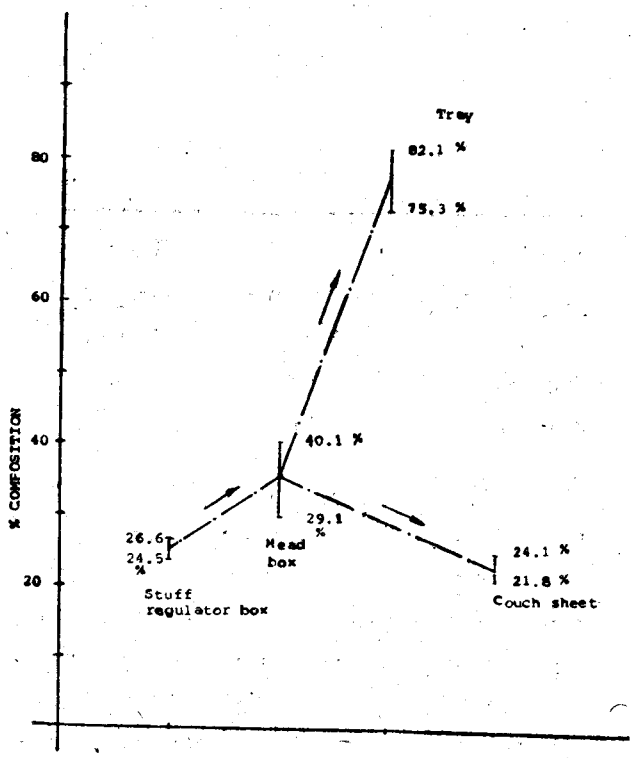
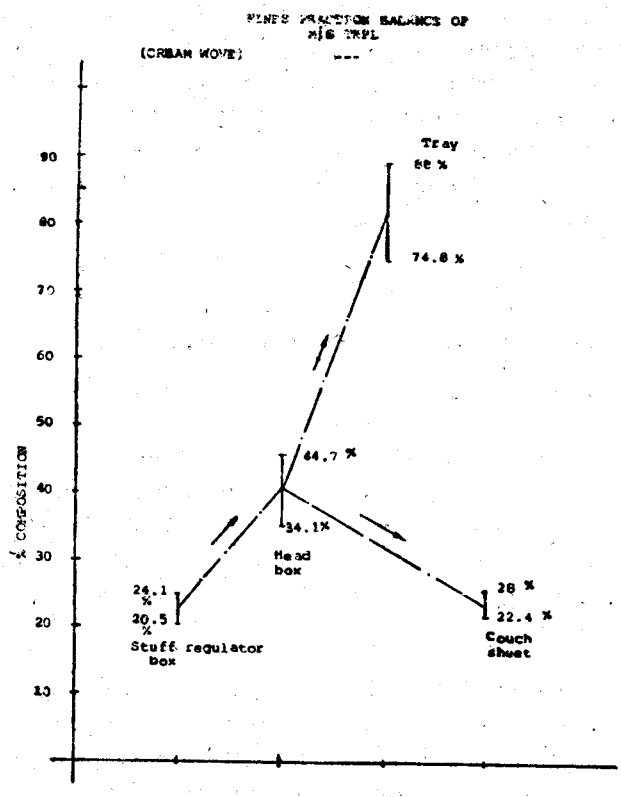


Fig. 7



has been used in this studies for determining the fines fraction analysis of stuff box, machine head box, tray water and couch sheet.

FRACTIONATION OF PAPER MACHINE SAMPLES.

The distribution of fiber and fines from furnish feed to final sheet vary due to many variables like furnish chemistry, machine design, speed, basis weight etc. There is no single franctionation profile available for any machine making specific grade of paper with specific furnish due to the above mentioned variables.

Stuff regulator box : The fractionation profile at stuff regulator box depends on furnish selection and refining.

Machine Head Box : The fractionation profile of paper machine head box differs greatly from the furnish feed and couch sheet because of the recirculation of white water in the machine silo.

Couch Sheet : The fiber-fines fraction in couch sheet is of great importance in consumer point of view. Since the fines content in the sheet determines many paper properties like porosity, smoothness and tensile strength etc. The fractionation profile of couch sheet always normally higher long fiber fraction and less fines than the furnish feed. The idle condition would be equal amount of fines in stuff box and couch sheet.

STUDY OF FIERE FRACTIONATION AND RETENTION CALCULATION :

Retention normally calculated by comparing head box consistency and tray water consistancy. But the retention calculated by the above method, would fail to give the correct values of fiber and fines retention, since it is affected by fiber/fines ratio in the respective samples

It is evident that during the sheet formation, the fiber fraction is almost completely retained (more than 90). Whereas the fines fraction retention vary over a wide range (10%—80%) depending upon the machine design, machine speed, basis weight, wire design, furnish chemistry, fibre-fines ratio etc.

A more complete evaluation of retention can be obtained by the "comprehensive retention system" The head box, tray and couch samples are tested for their fiber content and fines content. Also the consistencies of Head box, tray water are tested. If filler is is present, this is determined by ash test and the fines fraction is divided into pulp fines and filler fines components. The fiber retention is calculated by the equation given below the table III. (b) The fiber component in the sheet is divided by the decimal equivalent of the percent retention of fiber. This gives fiber equivalent, which is the parts by weight of fiber in the head box corresponding to that in the sheet. Since the ratio of fiber/fines in the head box is known the head box fines equivalent is readily calculated or the quantity of fines in the head box to produce equivalent parts by weight in the sheet. Thus the fines retention is readily calculated.

The total solids retention is obtained by dividing 100 by the sum of the fiber and fines head box equivalents.

Table II, gives data from four point sampling on Mysore Newsprint Machine (Paper Machine No. 4 Bel-baie II) For Newsprint and from Tamilnadu Newsprint Machine (Paper M/c 1, Bel-baie II) for Newsprint and Writing and Printing paper.

TABLB—II

Four point sampling on Mysore Newsprint machine & Tamilnadu Newsprint machine

	MPM Newsprint 52 gsm (35% CSAMP in in. by.		MPM newsprint 52 gsm full imported furn.		TNPL newsprint 52 gsm bagasse furnish		TNPL newsprint 52 gsm (bagasse furnish)		TNPL c eamwove 55 gsm (bagasse furnish)		TNPL creamwove (bagasse furnish)	
Sampling point	Cy.	% fines	Cy.	% fines	Cy.	% fines	Cy.	% fines	Cy.	% fines	Cy.	% fines
Stuff		32 20		20.0		26.6		25.6		27.9		22.0
Head	1.02	54.50	0.850	33.7	1 25	40.1	1.26	38.5	1.65	51.0	1.35	38.9
Tray	0.476	97.80	9.262	93.7	0.34	85.8	0.4	75.3	0.64	93.4	0 42	74 8
Sheet		19.60		20 2		24.1		21 8		26.5		24.8

Table III gives the calculation of fiber, fines and filler retention from the data from table II. for MPM News print and Table III (B) gives the calculation of fiber, fines and filler retention from the data from table II for TNPL writing and printing paper.

RESULTS AND CONCLUSIONS :

The distribution of fiber and fines in Paper machine system, is an important parameter for evaluating paper machine performance and controlling some of the properties of the paper made.

There are four different location in paper machine like stuff box, machine head box, tray water and couch sheet. The distribution of fines at these four different locations and the variation of fines fractions from one point to another point is a hand tool to paper makers for evaluating the paper machine performance and for taking remedial measures.

In this study the fiber/fines fractionation profiles of M/s The Mysore Paper Mills Ltd., and M/s Tamilnadu Newsprint & Paper Mills Ltd., has been studied. The purpose of this study is to illustrate the significance of fractionation profiles at four points namely stuff box, machine head box and sheet in twin-wire former (Belbaie II). Fig. 8 & 9 shows the fractionation profiles of M/s The Mysore Paper Mills Ltd for the samples given in Table No. II.

TABLE—III—a

Retention calculations for example sheets : MPM newsprint set no. 1

	Concy.	Composition %			Equivalent parts by weight		
	A	B	C	D	G	H	I
	g/100gm	Total solids	Fiber fran	Fines fran	Total solids	Fiber fran	Fines fran
Head box	1.02	100	45.5	54.5	180.81	82.27	98.54
Tray	0.476	100	2 2	97.80			
Sheet		100	80.4	19.60	100	80.4	19.60
Retn.	(53.3)				55 3	97.73	19.89

Fibre fraction retention : $\frac{(1A \times 1C)-(2A \times 2C)}{(1A \times 1C)} \times 100$

TABLE—III—b

Retention calculations for example sheets :
TNPL data creamwove

	Concy.	Composition %					Equivalent parts by weight				
	A	B	C	D	E	F	G	H	I	J	K
	g/100gm	Total solids	Fiber fran	Fines fran	Pulp fines	Filler fines	Total solids	Fiber fran	Fines fran	Pulp fines	Filler fines
Head box	1 35	100	61.1	38.9	20 2	18.7	141.19	86.27	54.92	28.56	26.37
Tray	0.42	100	25.2	74.8							
Sheet		100	75.2	24.8	17.43	7.37	100	75.2	24.8	17.43	7.37
Retention	(68.89)	—	—	—	—	—	70.83	87.17	45.16	61.05	27.95

The build up of fines fraction in machine headbox from stuff regulator box in Fig 8 is due to poor first pass retention and Fig. 9 shows less buildup of fines fraction due to improved first pass retention and fines retention is also improved.

Fig. 10 & 11 shows the fractionation profiles of M/s Tamilnadu Newsprint & Papers Ltd., for Newsprint and writing and printing paper.

Relatively less long fiber fraction in Newsprint and creamwove of M/s Tamilnadu Newsprint & Papers Ltd. is due to (a) bagasse furnish (b) addition of loading material. The buildup of fines fraction in machine head box for writing and printing paper of M/s Tamilnadu Newsprint and Papers Ltd., compared with the Newsprint is because of the more filler in the system.

Samples from MPM & TNPL shows appreciable differences in long fiber and fines fraction that could reflect on product performance and strength properties of the paper made.

Fig. 8

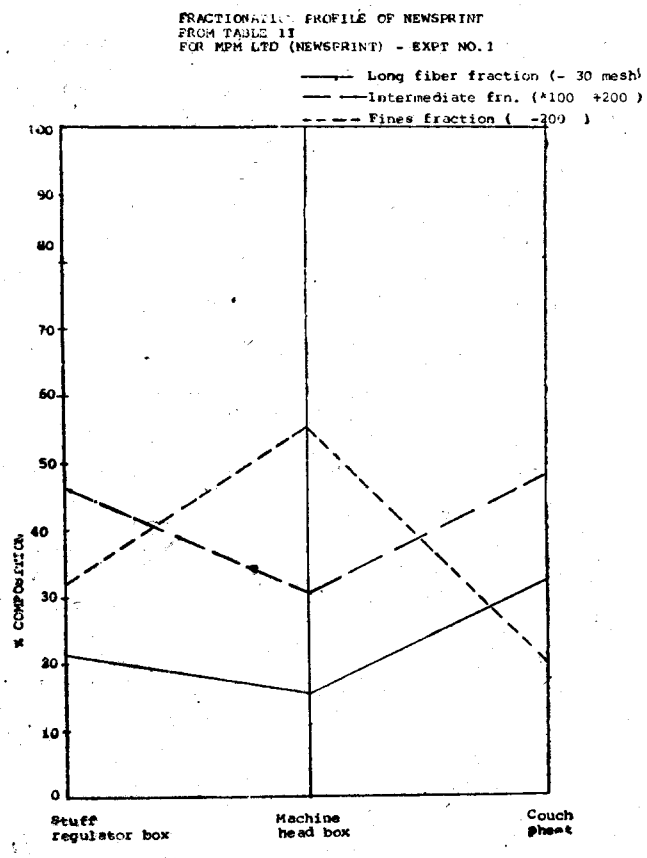


Fig. 9

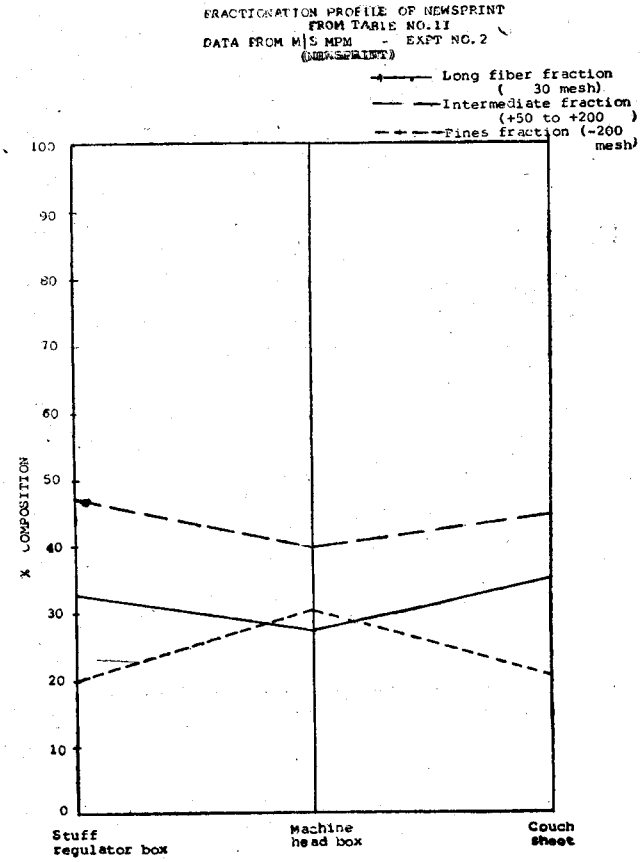


Fig. 10

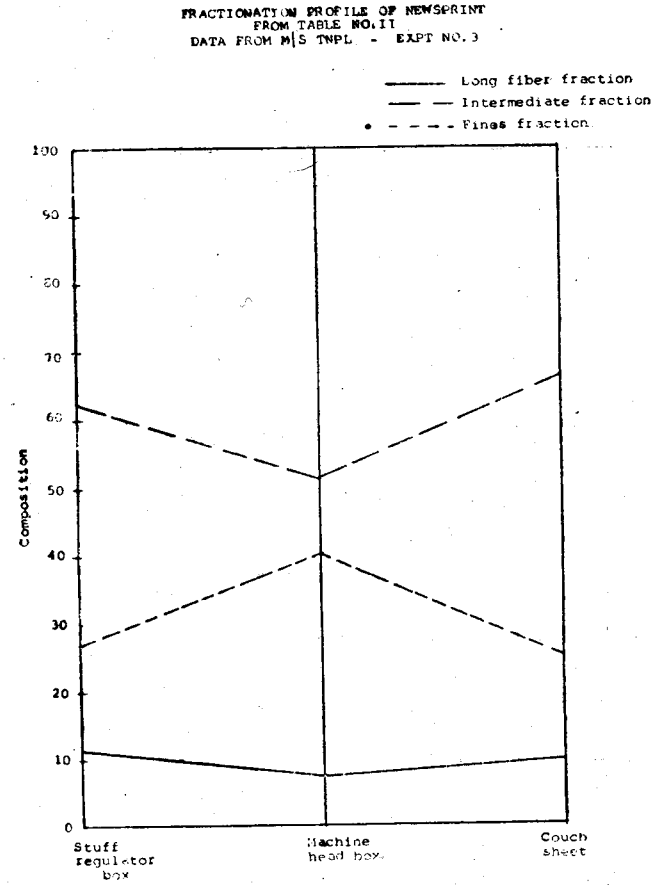


Fig. 11

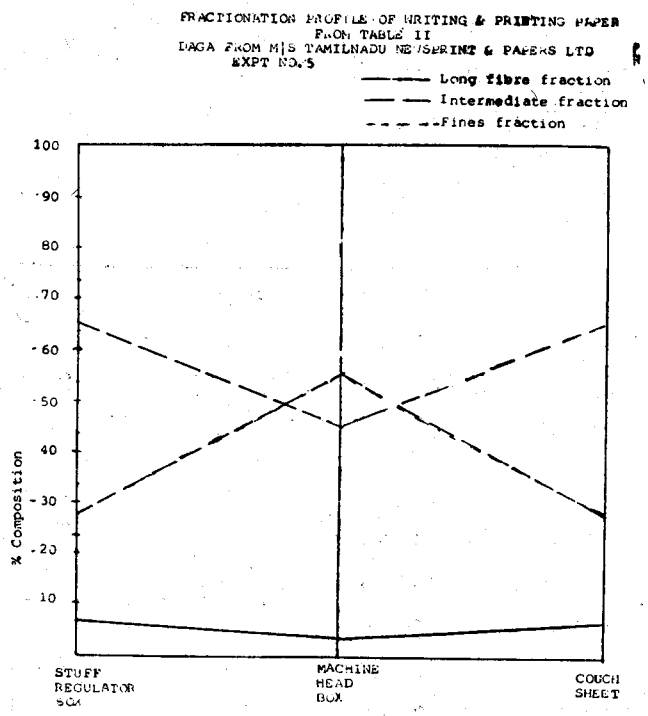


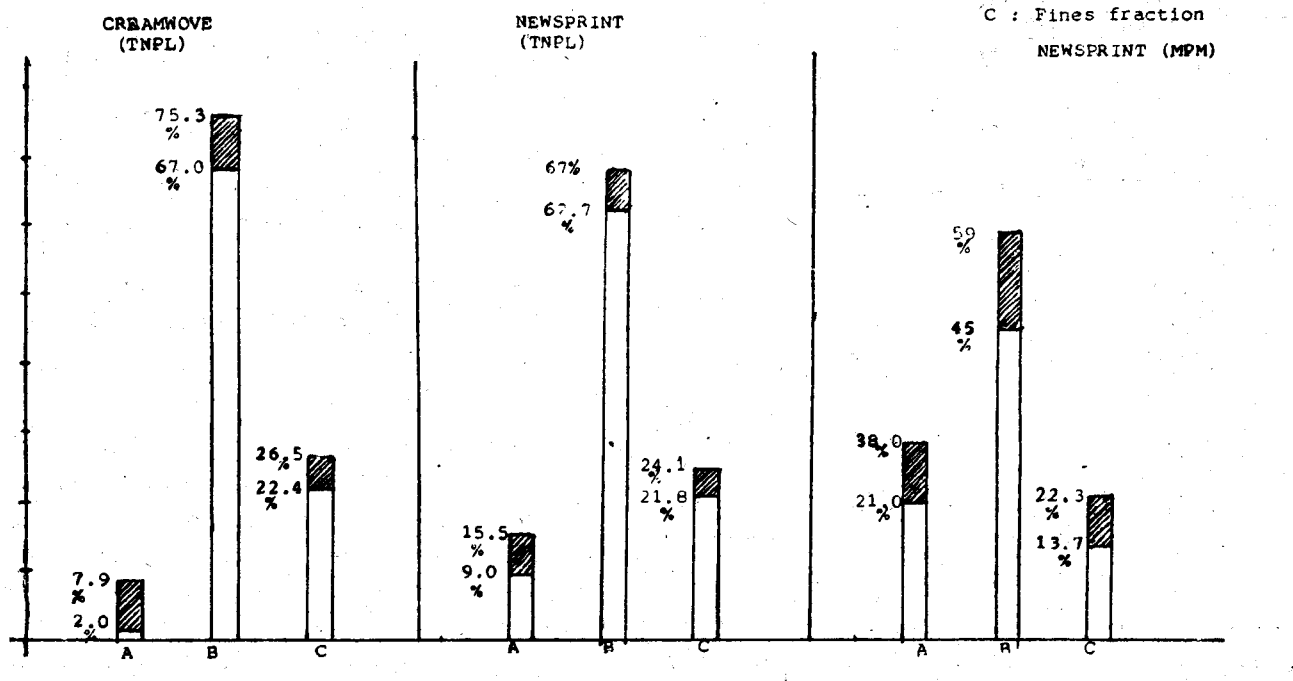
Fig 12 show the fractionation profile of various grades of paper from M/s MPM and M/s TNPL.

From this study, from table No. IV it is evident, that fines retention in M/s TNPL is better (Newsprint 38-44% and creamwove 32%–45%) compared with M/s MPM. The distribution of fines, in other words the fiber to fines ratio at four different locations in paper machine in TNPL system is more or less steady. Whereas, wide fluctuations were observed in MPM system. This is mainly due to unsteady furnish conditions because of power cut and raw material shortage in Karnataka State.

The fines retention in M/s MPM show wide variation (19%-49%) mainly due to unsteady furnish condition Low fines retention observed, in case, if indegeneous mechanical pulp is used, to an extent of 35% in the system and the fines generation by indegeneous mechanical pulp is more as the freeness of the incoming mechanical pulp could not be maintained constant.

Fig.12 -26

FRACTIONATION PROFILES OF VARIOUS GRADES OF PAPER FROM MPM & TNPL.



TABLE—IV

Comprehensive retention calculation

Grade : Newsprint and writing and printing paper

Mill : B, Tamilnadu Newsprint & Papers Ltd

M/c type - Twin wire former Belbaie II

No.	Grade	Retn. on Concy basis %	Total solids Retn %	Fibre fran Retn %	Fines fran Retn %	Pulp fines Retn %	Filler fines Retn %
1	Newsprint	70.31	65.1	91.51	38.3	41.55	19.01
2	,,	72.80	73.86	93.60	44.4	45.80	35.38
3	,,	68.25	68.62	87.25	38.86	42.63	21.20
4	Creamwove	62.40	69.68	91.65	38.06	55.56	27.53
5	,,	66 60	69.15	92.77	39.91	61.19	21.27
6	,,	68.89	70.83	87.17	45.16	61.05	27.95
7	,,	61.21	63.18	94 78	32 83	50 05	23 01

TABLE—V

Comprehensive retention calculation

Grade : Newsprint M/c type : Twin wire former

Mill : Mysore Paper Mills Ltd. Belbaie II

No.	Retn. (Concy Basis) %	Total solids %	Fiber frn. Retn. %	Fines frn. Retn. %
1	62 82	63.77	96 05	20.1
2	53.37	55.3	97.73	19 89
3	60 27	59.37	98.53	17 96
4	52.5	56 50	83 10	25 46
5	59 34	70.90	96 50	30 30
6	60.0	68.70	97.59	33.82
7	63.57	67.90	96.50	31 89
8	63.35	75.40	97.07	29 89
9	69.18	81.40	97.10	48.70
10	59.62	71.50	97.59	34.50
11	53.00	64 47	95.10	31.57
12	54.80	73.98	98.20	42.52

Whereas in M/s TNPL the fines generated by the bagasse pulps and hardwood chemical pulp are less as they are not being re-refined in paper machine section.

From this study the following conclusions has been made :

(1) With high fines retention in the sheet the machine runnability is generally found good for both in MPM and TNPL

(2) For good machine runnablility, it is necesssary to achieve reasonably good fines balance at four stratagic points in the paper machine.

(3) As it is evident from this study, steady furnish condition is an important parameter for achieving good fines retention in paper machine.

This study, however, is not enough to draw firm conclusions, and further studies are required.

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REFERENCES :

1. Nordiska felt Manual 1985 (Forming) 1 3 GB.
2. Tappi CA Report 57, Chapter VIII, 1975.
3. New advances in retention and drainage phenomena during sheet formation—
by KW Britt, State University of New York.
4. Britt K.W. "Paper sheet formation—observation concerning retention—TAPPI 64 (a) : 51 (1981).
5. Britt K.W. "The fines fraction of paper stock" Chapter 8 CA 57 : 89.
6. Unbehind J.E. and Britt K.W. "Retention, drainage and sheet consolidation", I&EC Product research and development 1982 (21) 150 (1982).
7. Britt K.W. "Why bother about first-pass retention of solids on the paper machine—PTJ April 15, 77 P. 36.
8. Britt K.W. "Mechanism of retention during paper formation" TAPPI 56 (10)—46 (1973).
9. Das papier 24 (11)—69 (1970).
10. Wells F.L. and S. Tuimpf R.W. TAPPI 49 (8) 356 (1966).
11. Unbehind J.E.—The dynamic retention/drainage Jar, increasing the credibility of retention measurement TAPPI 60 (7)—110 (1977).