Effect of Dispersion, Washing, And Floatation ON Ink Removal And Properties

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ABSTRACT:- Recycling, as we are all aware, has been aptly coined as the buzz word in the paper industry for this quarter of the century. Most of the industrial research is now being dedicated to this field. Recycling offers a viable option to not only the small scale financially constrained industry but also to the large scale industry. This paper summarizes the whole recycling process presently prevalent in the Indian Paper Industry. Experimental work has been conducted at the Institute of Paper Technology, Saharanpur and on the basis of the results in terms of ink quantity, brightness and strength properties, a suitable combination of processes was suggested for implementation. For newsprint, floatation offered a greater advantage over washing for ink removal, whereas, for mixed waste, either process made a substantial change in the ink content. This can be attributed to the variation in the ink characteristics in the mixed waste. For newsprint, the best recycling sequence is Dispersion followed by Floatation using a dispersant in neutral medium. For mixed waste, high degree of dispersion (greater °SR) followed by Washing deinking proved to be the best process for ink removal.

KEYWORDS:- Dispersion, floatation, washing, deinking, disperger, kneader, dispersant, surfactant.

INTRODUCTION

Recycled fiber is often considered a lower quality raw material, and it is generally the practice that a given grade of wastepaper is used to produce a lower grade of finished paper. It is the intention of this article to show that waste paper can be recycled, without extra bleaching, into the same grade of paper and that the recycled pulp can even have same cleanness as the original pulp used to make the input paper.

The recycling of paper for the production of white and printing paper (newsprint, magazine paper, LWC, etc.) requires two major steps:

(i) Detaching of ink, contaminants from the base paper

(ii) Removal of ink, contaminants.

The detatching of ink is carried out through pulping of waste preferably with chemicals. The process is generally carried out in pulper at 5-6% consistency. The consistency has a marked effect on the detatching of the ink, however the time of slushing is also found to have its role in the ink detachment. Time of more than 50 minutes has sometimes given yellowness to the pulp. Once the ink has been detached, it is recommended to treat

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the stock to disperse the ink from the surface of fibers. The dispersion at this stage is applied more to the fibers to make the subsequent removal of ink easy. Dispersion has become an important part of todays deinking system. Many terms like DISPERSER, DISPERGER, KNEADER are in use to name the equipments used for the dispersion. Dispersion is a mechanical treatment of fiberous stock to breakup or separate various contaminants so that they are not optically disturbing in product and do not interfere the paper making operation or quality of the paper produced.

Dispersion can be done at ambient temperature or elevated temperature. In this series of experiments the dispersion was carried out at ambient temperature.

The second phase of deinking is the removal of ink from the stock fibers. There are two different techniques employed

(i) Floatation
(ii) Washing

The principle of floatation is to produce abundant foam in the stock which collects the ink and carries it away to the top of the liquid. By removing this foam, ink is eliminated from the stock. To obtain the desired foam, soap is added to the stock just before the floatation and the stock is aerated whilst agitating it. Floatation is made conventionally at about 1% consistency.

Washing is based on the difference in size existing between ink particles and fibers . Working consistencies are 1-20 % according to the type of unit. Ink particles are taken away with the water. Water with ink is not to be recirculated and for higher yields, and better cleanliness counter current wash system in three stages is usually employed.

The advantages of washing process are:

(i) Inorganic fillers are quite well removed. This can be an advantage for some grades of paper, but can also be a disadvantage for normal writing printing grades as fillers contribute to opacity and ink receptivity.

(ii) This method allows to copeup easily with the variations of raw materials. Such cases are too frequent in almost all grades of waste papers, especially in mixed waste paper.

(iii) Capital investment and consumption of soap are slightly reduced when floatation follows.

The only disadvantage of washing is high consumption of water (30 to 90 m^3/T) and slightly lower yield of pulp as compared to floatation, depending on extent of washing and the type of furnish.

EXPERIMENTAL SETUP AND PROCEDURES

Raw Materials

An experimental set up was designed to evaluate the effect of dispersion, washing and floatation on the ink removal and properties of paper produced. The grades of waste papers used for experimentation are

(i) Newsprint

To ensure only newsprint from mechanical pulp, common newspapers were used and the portions of the glazed newsprint or white printing were sorted out.

(ii) Mixed Waste Paper

A mixed waste was prepared with following proportions(AD mass basis) of various grades:

Glazed Newsprint/Magazine - 43%, Laser Printed Material - 32.5%, Coloured Printing-12%, Copies & Hand written Papers - 10%, Coloured Coated waste - 2.5 %.

Experimental Stages

The stages of experiment adopted with variables were:

(i) SOAKING

Soaking was carried out for pulping/slushing in the laboratory disintegrator. The time of soaking for the two types of waste papers was kept different in view of the time required for good soaking. The variables recorded for soaking stage were:

pH at the start and the end of soaking
Time of Soaking
Consistency

(ii) SLUSHING

Slushing was done in standard laboratory disintegrator. The number of revolutions and time of slushing was kept constant throughout the experiments on a particular grade of waste paper. The variables recorded for slushing were:

Consistency
pH at start and end of stage
Revolutions/Time of slushing
Final Slowness °SR

(iii) DISPERSION

Disperson was carried out in **Laboratory Refiner**. The dispersion was done in few passes in refiner and the data recorded were:

Consistency
Number of passes
pH
Slowness °SR

(iv) WASHING

Washing was carried out on laboratory buchner funnel. The parameters recorded were

Starting Consistency
Volume of water used
Whether any dispersant used before washing

(v) FLOATATION

Floatation was carried out in a laboratory stock divider.

The parameters recorded were;

Consistency during floatation
Time
Surfactant added

(vi) LABORATORY SHEET MAKING AND TESTING

Standard laboratory sheets were prepared on the Circular sheet former without recirculation. Sheets were dried under ambient/ conditioned atmosphere and were tested for various properties for the analysis of the experimental stages on ink removal and properties of the paper produced. Standard proceedures were followed for testing of laboratory sheets. Technibrite Eric 950 was used for computing the residual ink content in the sheets.

Legends

The following codes were used in our experiments:

N- Newsprint
AN- Newsprint in Alkaline medium
MW- Mixed waste.
AMW- Mixed waste in Alkaline Medium.

RESULTS AND DISCUSSION

Part 1

Discussion based on the effect of Dispersion. Washing and Floatation on the Brightness and the quantity of ink.

Effect of Washing: Newsprint and Mixed waste:

The main interest of the papermaker is to develop the bonding ability of the fibers. not just freeness. because freeness does not necessarily reflect the strength of the fibers. Soaking followed by Slushing is a well known recycled fiber regeneration process, which invigorates the fiber by enhancing its bonding ability to certain extent. but not enough. Therefore somewhat more intensive treatment-Refining. or a more broader term. Dispersion - is needed to redevelop the fibers intrinsic bonding ability. Refining creates fibrils in the fiber. but in this process renders the fiber more prone to structural modifications than the virgin fiber. Negative effects such as too high an increase in the drainage resistance, excessive cutting of the fibers and reduction in the tear can be avoided by selection of proper equipment and conditions of refining.

Our refining consistency varied between 2.5 to 3.5%. a typical low consistency refining. but a widespread practice since it consumes lower energy. allows for easier transportation (because of better flow properties) and lower water consumption during subsequent stages of washing and floatation. Here the basis of comparison are three-fold.

(1) The process adopted (Washing or Floatation).

(2) the pH of the slurry and

(3) finally. the use of chemicals during dispersion.

Dispersion distributes the ink particles from the fiber structure, and when this slurry of about 0.5% cy. is put to washing, it is the lumps of ink and contraries that are washed off immediately (the heavier particles remain at the bottom of the slurry and have an immediate acces to the perforations).

The lighter ink particles, are not provided with adequate passage through the thick mat formed. So they persist in the slurry of 20 gm OD fiber even when Displacement washed with 1500 ml fresh water. It did not prove effective because of the thickness of the mat formed.

Deinking washing using a Dispersant did bring in a substantial change (Table 2). The ink particles should be small enough so they can be removed through perforations and hydrophilic enough so as to drain easily. Particle size below 10μ is ideal for wash deinking. Wash deinking with a dispersant enables to keep the mesh size small enough to keep the fiber loss under control. The Brightness also increased and the ink content went down by about 10.25% in case of Newsprint. With Mixed waste the ink quantity reduction was about 40% and 12.2 % in Neutral and Alkaline medium respectively.

Table-1

Parameters Taken Constant For Newsprint Waste

Parameter	Soaking	Slushing	Dispersion	Washing	Floatation
Sample OD wt in gms	100	100	100	20	20
pH (#1)	N/10.2	N/10.2	N/10.2	N/10.2	N/10.2
Cy (%)	3.5	3.5	2-3.5 (#2)	0.5(#3)	0.5
Temp.	Amb	Amb	Amb	Amb	Amb
Vol. of water. (ml)	2752	--	--	1500	--
Time of op/ No. of rev/ No. of passes	20min	5000rev	5passes	--	5min

#1- Slushing was done either in neutral pH(N) or at an alkaline pH of about 10.2.

#3- Initial consistency of washing was 0.5% with 20g OD. The pulp was washed with 1500 ml fresh water.

#2- To clean the refiner and to facilitate the flow of pulp. water was added during refining. The amount of water added varied from batch to batch hence the variation in cy.

Table-2

Experimental Results For Newsprint Waste

CODE	OPN SEQ	SLUSH	DISPERS	WASH	FLOAT	B_{inf}	IR_{inf}	Ink Qty ppm
		°SR	°SR	Chem	Chem			
NO1	S_oS_lD	35	40	--	--	43.0	55.8	1577
NO2	S_oS_lDW	35	40	NO	--	44.5	56.5	1513
NO3	$S_oS_lDW_d$	35	44	YES	--	45.2	57.3	1434
NO4	S_oS_lDF	35	40	NO	--	48.0	56.3	1411
NO5	$S_oS_lDF_d$	35	44	--	YES	48.9	58.2	1353
N12	$S_oS_lW_d$	40	--	YES	--	44.8	55.0	1652
N13	$S_oS_lF_d$	40	--	--	YES	48.4	57.5	1414
N14	S_oS_l	40	--	--	--			
ANO1	S_oS_lD	39	50	--	--	42.8	53.7	1797
ANO2	S_oS_lDW	39	50	No	--	43.2	54.7	1683
ANO3	$S_oS_lDW_d$	39	50	YES	--	45.0	56.5	1506
ANO4	S_oS_lDF	39	50	--	NO	45.3	56.0	1561
ANO5	$S_oS_lDF_d$	39	50	--	YES	47.6	57.8	1392
AN12	S_oS_lW	38	--	YES	--	46.0	57.1	1450
AN13	$S_oS_lF_d$	38	--	--	YES	47.0	58.0	1382
AN14	S_oS_l	38	--	--	--	45.4	56.3	1523
AN15	$S_oS_lD(5)WF$	41	47	NO	NO	42.5	59.2	1267
AN16	$S_oS_lD(10)WF$	41	53	NO	NO	44.5	59.5	1243
AN17	$S_oS_lD_c(5)WF$	41	47	YES	YES	43.4	58.5	1329
AN18	$S_oS_lD_c(10)WF$	41	53	YES	YES	44.3	57.8	1391

S_o - Soaking
S_l - Slushing
D - Dispersion
D_c - Dispersion with peroxide and silicate
W - Washing without dipersant
W_d - Washing with dispersant
F - Floatation without dispersant
F_d - Floatation with dispersant

In alkaline pH, the freeness decrease was remarkable (pH close to 10.2) (Table 2). Dispersion resulted in a °SR of 50. Precautions were taken to prevent alkali darkening by properly regulating the pH. Sodium hydroxide swells the fiber which results in a greater water retention by the fiber leading to a higher °SR for the same amount of refining. A greater water retention clearly explains a higher ink quantity retention after dispersion. Wash deinking in alkaline medium decrease the ink quantity substantially and washing using dispersant (sodium hexa meta phosphate) decrease the quantity further more. This can be explained considering the structure of the swollen fiber. When swollen structures come into contact they leave intermediate fissures in between, permitting an easy passage of smaller ink particles, thus the mat formed in this case has a greater bulk compared to the previous case. Greater bulk leads to more pronounced channels for the flow of ink particles leading to an effective and efficient washing.

Effect of Floatation:

Ink, collector chemicals and air bubbles are the three most important components of the floatation cell configuration. Collector chemicals bring together the ink particles that have been dislodged by the bruising action of the disperser. These collected particles must come in contact with the air bubbles so that they can be skimmed off eventually. The ideal particle size for floatation deinking is 10-100 μ. At a consistency of 0.5% the ink forms microprecipitates which associate with the air bubble and are carried to the top. A major problem we encountered by using the stock divider as the floatation cell was the large loss of fiber along with the bubbles. The amount of fiber loss remained convincingly below that of washing but still it was an unhealthy characteristic. Another factor which can be attributed to the less but still it was an unhealthy characteristic. Another factor which can be attributed to the less effectiveness of our floatation experiment was the point of addition of chemicals. It has been recommended that the chemicals should come along with the air into the cell. We could not attain this in the stock divider. Floatation, however, proved to be more effective in case of newsprint in both neutral (14.4 % ink removal) and alkaline medium (23% ink removal) (Table 2). The decrease in ink quantity was 220 ppm and 400 ppm in neutral and alkaline medium respectively. In mixed waste also the floatation was effective, albiet, not as satisfactory. This result cannot be refuted since there is a marked influence of the ink characteristics on the effectiveness of flotation. Mixed waste contained an appreciable quantity of flexographic and xerographic inks which are water based. The reason why flexo remains a menace for floatation is

Table-3

Parameters Taken Constant For Mixed Waste

Parameter	Soaking	Slushing	Dispersion	Washing	Floatation
Sample OD wt in gms	100	100	100	10	10
pH (#1)	N/10.2	N/10.2	N/10.2	N/10.2	N/10.2
Cy (%)	3.5	3.5	2-3.5 (#2)	0.5(#3)	0.5
Temp.	Amb	Amb	Amb	Amb	Amb
Vol. of water. (ml)	2850	--	--	1500	--
Time of op/ No. of rev/ No. of passes	60min	200rev	5passes	--	5min

#1- Slushing was done either in neutral pH(N) or at an alkaline pH of about 10.2.

#3- Initial consistency of washing was 0.5% with 20g OD. The pulp was washed with 1500 ml fresh water.

#2- To clean the refiner and to facilitate the flow of pulp, water was added during refining. The amount of water added varied from batch to batch hence the variation in cy.

(a) The particle size after dispersion is about 0.2-1.0 μ, which is why at times the washing process is more effective, refer results (Table 4.).

(b) The ink is water based and remains with the water.

The percent reduction in ink quantity was about 33% and 23% in neutral and alkaline medium respectively. The brightness varied with the ink quantity (Table 4.)

Effect of Washing on Strength Properties:

Refining, be it medium or low consistency, invariably increases the strength of the paper. For recycled paper, it has already been proved that refining is the perfect prelude to making paper of better strength properties.

Here, instead of using the term refining, we

Table-4

Experimental Results On Mixed Waste

CODE	OPN SEQ	SLUSH	DISPERS	WASH	FLOAT	B_{inf}	IR_{inf}	Ink Qty ppm
		°SR	°SR	Chem	Chem			
MNO1	S_oS_lD	21	26	--	--	54.1	64.9	906
MWO2	S_oS_lDW	21	26	NO	--	56.7	64.3	894
MWO3	$S_oS_lDW_d$	21	26	YES	--	65.0	71.0	545
MWO4	S_oS_lDF	21	26	--	NO	57.0	66.0	791
MWO5	$S_oS_lDF_d$	21	26	--	YES	56.8	67.6	701
MWO5*	$S_oS_lDF_d$	21	36	--	YES	65.0	70.0	607
MW12	$S_oS_lW_d$	21	--	YES	--	Ink patches, measurement not possible		
MW13	$S_oS_lF_d$	21	--	--	YES			
MW14	S_oS_l	21	--	--	--			
AMWO1	S_oS_lD	26	39	--	--	55.0	65.2	835
AMWO2	S_oS_lDW	26	39	No	--	54.0	65.7	802
AMWO3	$S_oS_lDW_d$	26	39	YES	--	56.0	66.0	784
AMWO4	S_oS_lDF	26	39	--	NO	60.6	67.6	700
AMWO5	$S_oS_lDF_d$	26	39	--	YES	60.0	68.5	652
AMW12	S_oS_lW	28	--	YES	--	55.7	63.5	941
AMW13	$S_oS_lF_d$	28	--	--	YES	62.1	69.4	581
AMW14	S_oS_l	28	--	--	--	56.3	66.3	772
AMW15+	$S_oS_lD(5)WF$	38	51	NO	NO	55.1	64.8	860
AMW16+	$S_oS_lD(10)WF$	38	61	NO	NO	56.0	65.0	846
AMW17+	$S_oS_lD_c(5)WF$	38	51	YES	YES	56.5	65.2	831
AMW18+	$S_oS_lD_c(10)WF$	38	61	YES	YES	58.1	66.0	770

S_o - Soaking
S_l - Slushing
D - Dispersion
D_c - Dispersion with peroxide and silicate
W - Washing without dipersant
W_d - Washing with dispersant
F - Floatation without dispersant
F_d - Floatation with dispersant
MWO5* - Sequence with 10 passes during dispersion
AMW15-18+ - Sequences with Hydrogen peroxide and Sod. Silicate alongwith the dispersant.

use the word more relevant to recycling, Dispersion, which not only gives a brief insight into the process but also conveys it precisely. After soaking and slushing, the ink particles are still adhering to the fiber surface and their obdurate behaviour cannot be disparaged till the time we act on a fiber or fiber cluster specifically. This calls for the use of a refiner which will help in providing the requisite bruising action without actually inflicting any harm on the intrinsic strength of the fiber. This process would not only reactivate the fiber but also create a diaspora of two homogenous mediums, the fibers and the ink suspension. The size of the ink particles, however, will entirely depend on the type as well as the energy expended during dispersion.

Strength properties are entirely dependent on the relative bonding area of the fibers. The refining action, an aspect of dispersion, creates fibrils on the fiber surface which results in a higher RBA. So sheet will certainly have greater overall strength. But the extent to which we can enhance this strength will not be successfully attained till the time we remove the ink particles. These ink particles fill up the interstices between the fibers thereby behaving as an obstacle for perfect fiber to fiber contact during sheet formation. It is imperative that the strength properties will certainly go down if we have improper contact between fibers. Simply washing (deinking washing) the dispersed slurry did not result in any improvement in the strength property.

INFERENCES: Optimum sequence and conditions for achieving Brightness from Newsprint waste

(1) The sequences of NO4, NO5, ANO5 and N13 have given the Brightness levels required for Newsprint; thus these sequences are suitable for Newsprint production from newsprint waste with proper Brightness.

(2) Sequence NO5 is the best for giving the final sheet Brightness of 49% (ISO)

(3) Except for the sequence of N12, all other sequences revealed that neutral pH conditions for Newsprint give better Brightness results than similar sequences in Alkaline pH.

A conclusion can be drawn that Newsprint waste gives better Brightness when recycled under Neutral pH.

(4) NO2, NO3 and N12 did not give a better Brightness. Thus a conclusion can be drawn that for Newsprint inks Washing is not a good process step for achieving required brightness.

(5) Flotation, however, is a better process step to remove Newsprint inks. This is evident from the sequences having flotation like NO5, NO4 and N13.

(6) Brightness achieved by sequences AN15, AN16, AN17 and AN18 is comparatively low, further confirming that presence of an alkali does not yield higher brightness.

INFERENCES: Optimum sequence and conditions for better removal of ink from Newsprint waste

Analysing for the residual ink quantity, the effect of the sequences is apparently the same and is in concurrence with the results of Brightness vs sequence relationship.

(1) NO5 gives least residual ink in the final sheet formed.

(2) NO4, NO5, AN05 and N13 sequences give minimum value of ink quantity in the final sheet.

(3) Residual ink in N12 is high, conforming that acceptable ink removal results are not achieved through Washing.

(4) All the sequences having Washing gave greater ink quantity in the final sheet.

(5) AN16 gave the least amount of residual ink, although the Brightness level is low (44.5%). Lower Brightness can be attributed to the alkaline pH conditions which normally occurs in pulps due to the development of chromophoric groups.

Thus for brightness level and residual ink content, sequences of NO4, NO5, AN05 and N13 are the best for newsprint waste.

INFERENCES: Optimum sequence and conditions for achieving Brightness from Mixed waste paper

(1) The best Brightness levels are achieved for sequences MW03 and MW05* revealing that both Washing and Flotation are equally effective in achieving satisfactory Brightness levels for Mixed waste. This is unlike the Newsprint response which yielded better brightness by flotation. The response of newsprint waste for washing was poor.

(2) Mixed waste appear to behave better in alkaline conditions. This is evident from the brightness results for sequence AMW13, AMW05, and AMW04. Thus flotation as a process step is good enough to achieve brightness in the range of 60-62 % (ISO) although washing takes preference.

(3) Washing and flotation have similar effect as is evident from brightness levels achieved by MW02 and MW04

(4) The effect of pH on brightness achievement for mixed waste is related to washing or flotation. For sequences having washing- MW02 and MW03, the neutral pH gives better brightness as compared to alkaline pH conditions. Whereas for sequences having flotation - AMW04 & AMW05, the alkaline pH conditions seems to yield better brightness.

INFERENCES: Optimum sequence and conditions for better removal of ink from Mixed waste paper

(1) Sequence MW03 and MW05* gave the least

amount of residual ink in the final sheet.

(2) Surprisingly, although brightness of MW03 & MW05 sequences is same, the residual ink for MW05 is slightly more than for MW03. Which means that ten passes of dispersion distributed the ink to still smaller particles such that their effect on brightness was reduced although the quantity of ink remained more.

(3) The alkaline pH sequence AMW13 also resulted in minimum amount of residual ink.

(4) Washing seems to be a better option for ink removal and few results of flotation gave very poor ink removal. For sequences MW05 the results are better.

It can be concluded that mixed waste having wide variety of ink, requires stringent dispersing stages for better ink removal. This must be true as coated papers, papers with dry strength additives and alike will offer better ink binding which will consequently require sever dispersion conditions to disperse ink for effective removal at flotation.

(5) For alkaline process conditions the ink removal is in general poorer to neutral conditions.

Thus for mixed waste paper treatment, sequences MW03 & MW05* (higher dispersion treatment) are the best for achieving brightness with minimum residual ink content.

STRENGTH ANALYSIS OF LABORATORY SHEETS FROM NEWSPRINT WASTE (Refer Table 5)

The laboratory sheets were dried in conditioned atmosphere and tested as per standards. The process stages have marked effect on the strength of the final sheet as is evident from strength values against treatment sequences.

In case of newsprint, one major observation is the deviation in the development of Tensile and Burst strength. The sequences yielding sheets of highest Breaking length did not necessarily gave the highest Burst factor.

(1) Highest burst was achieved for sequence AN01 under alkaline conditions whereas highest Breaking length value was given by NO4, AN03, and AN18.

(2) NO4, NO5, AN05 and N13 seuqences which gave the best brightness values (well in range of newsprint brightness requirements of 48-49% ISO) did not give the same response to tensile and burst development.

Out of the above sequences NO4 gave good breaking length of 2970 m whereas the sequences NO5 and AN05 sheets gave the breaking length in the range of 1945 and 2157 m, a substantial difference.

The reduced breaking length for NO5 and AN05 is probably due to the use of dispersant in flotation stage resulting in substantial loss of hydrated fines which otherwise could have developed bonding.

(3) Burst factor is not so important for newsprint grades of paper. The sample NO4 gave good burst factor (16.5) although highest burst achievable was 17.5 by NO3 and AN02, which are necessarily washing sequences.

Table-5

Strength Properties of Newsprint Waste and Mixed Waste Laboratory Sheets

CODE	B.L.(m)	B.F.	T.F.	CODE	B.L.(m)	B.F.	T.F.
NO1	2290	14.1	56.0	MWO1	2085	13.7	57.2
ANO1	2350	18.8	79.8	AMWO1	2463	16.3	77.2
NO2	2117	13.7	75.8	MWO2	1404	8.2	58.7
ANO2	2425	17.4	64.5	AMWO2	2101	11.7	47.2
NO3	2744	17.3	61.2	MWO3	1752	11.2	72.4
ANO3	2920	15.9	71.3	AMWO3	2756	15.3	78.7
NO4	2970	16.6	60.6	MWO4	2488	13.2	69.3
ANO4	2535	13.7	60.0	AMWO4	2620	16,3	83.7
NO5	1945	10.8	65.0	MWO5	2351	12.6	61.6
ANO5	2157	14.7	68.0	AMWO5	2355	11.8	67,8
AN15	1628	13.4	53.8	AMW15	2916	16.7	71.8
AN16	2790	14.8	64.3	AMW16	2387	14.5	68.4
IN17	2593	15.7	56.0	AMW17	2080	13.6	71.0
AN18	2996	15.7	60.8	AMW18	1238	10.3	73.8
N12	2408	11.2	61.2	MW12	2359	13.8	87.1
N13	2694	16.2	61.5	MW14	2432	13.1	65.5
AN12	1882	11.1	65.6	AMW12	2543	13.0	75.4
AN13	2512	15.4	70.3	AMW13	2438	14.5	70.9
AN14	2144	14.5	79.0	AMW14	2528	14.2	63.6
				MWO5*	2170	10.2	50.0

It is evident that use of dispersant in washing probably does not affect loss of hydrated fines as much as in case of flotation.

(4) The values of tear factor obtained on the laboratory sheets appears appreciable high as compared to the value obtained on machine made papers. This is due to random orientation obtained in laboratory sheet former.

(5) The development of tear is better in sheets prepared from alkaline treatment conditions, although for these sheets the brightness and residual ink contents are not satisfactory. Considering brightness level and residual ink content alongwith tearing strength, the sequence AN05 appears best suited.

STRENGTH ANALYSIS OF LABORATORY SHEETS FROM MIXED -WASTE (Refer Table 5)

It is surprising that although mixed-waste is expected to contain on an average, better quality of fibers, the maximum breaking length of final laboratory sheet was still the same as newsprint, 2960 m, and the burst factor even lower (16.5) than achieved maximum by newsprint (17.5).

This might be due to difference in the nature of fines. Newsprint from mechanical pulp is expected to have large quantity of hydrated fines produced during mechanical pulping whereas mixed-waste must have larger quantity of filler fines which do not contribute to strength of the sheet.

(1) Good breaking length values were obtained for sequences AMW03, AMW04, and AMW15, which do not offer good brightness level and lower residual ink content.

(2) Considering the composite requirements of good brightness, cleanness and breaking length, MW05 appears to be the acceptable sequence.

(3) The values of burst factor are also higher for sequences AMW01, AMW04, and AMW15, suggesting that alkaline conditions during treatment offer better strength although the brightness and cleanness is not the best.

(4) Considering total requirement, MW05 at neutral pH is the best for achieving required level of breaking length and burst factor with the brightness and cleanness being considered more important in the analysis.

(5) As in case of other strength properties, alkaline conditions gave sheets of much better tear factor.. The sequence which can be recommended for best net product properties including tear will be MW03.