Stickies Audit in Recycled Mills - CPPRI's Approach

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ABSTRACT

Recovered paper is an important fiber source for Indian Paper Industry. However often Recycling efficiencies are intimidated by the presence of contaminants particularly the adhesives which paper consumers such as printers and publishers introduce through their use of ink binders, labels, book bindings, hot melt coatings etc. These adhesive materials are liable to form stickies during recycling that can lead to several problems such as deposits on paper machine, fabrics, breaks on the paper machine as well as specks and holes on the paper sheet.

A major impediment to the control of stickies in the papermaking system is the inability to effectively quantifying the concentration of adhesive contaminants in the raw material. However, one way to understand the stickies concentration in a specific system is to measure the stickies level from pulper to machine using a stickies profiling procedure. Quantification of stickies during processing of RCF is therefore pre-requisite before a control/ removal strategy is adopted. Lot of work has been done in different laboratory across the world on quantification of stickies based on their size, shape and physical character employing combination of techniques but till date no standard method has been developed.

CPPRI being an R&D organization has also developed a protocol of methods integrating different techniques to quantify the Macro, Micro and Colloidal stickies concentration in RCF stock. Based on this methodology, CPPRI conducted stickies audit in different mills. The present paper highlights the findings of stickies audit conducted in these mills which has helped the mills in understanding the performance of control strategies adopted in their mills.

Introduction

Over the decades, the Indian Paper industry has witnessed a sea change in raw material consumption pattern with the increase in Recycled fiber consumption from 40% to 47% in 2012. As per an estimate it will increase further to a level of 53% share in P & B production by the year 2025. In a nut shell RCF has now become a mainstay raw material furnish for Indian Paper industry particularly for production of Newsprint and Packaging grade of paper.

The key to the utilization of Recycled fiber is contaminant removal which is one of the most important factor due to its direct influence on both the process efficiency and the product quality and therefore on the total cost.

During RCF processing a large number of contaminants are introduced to the system with the recovered paper and therefore one of the key factors in a recycling process is the efficient removal of these contaminants. However some contaminants always remain in the process creating deposit problem.

The Recycled fiber furnish often contains a wide variety of contaminants which are insoluble and tacky in nature such as pressure sensitive adhesives, hot melts, wax inks, seam bindings latexes, wet strength resins etc. These water insoluble type and tacky contaminants generally termed as Stickies are considered more trouble some to papermaking operation and therefore need close monitoring.

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'STICKIES' is therefore used as a collective term denoting all substances of different origins which owing to their permanent or temporary tackiness give rise to problems in paper manufacturing and results in product quality losses.

Problems Due To Stickies

Stickies are gelatinous, tacky contaminants, which originate from the PSA's while hot melts are broken fragments of the bindings in the magazines. The characteristics of stickies include hydrophobicity, low surface energy, tackiness and deformability due to which they frequently agglomerate and deposit on wire, felts or other parts of paper machine or appear on sheet as spots. The most common problems caused by stickies are:

- Increased machine downtime caused by breaks and required clean ups.
- Reduced product quality caused by picking pinholes and poor appearances.
- Increased replacement costs for wire and felts.
- Reduced efficiency of converting / printing operations.
- Limited levels of fiber substitution.

Stickies Classification

Stickies can be classified into two groups based on their size.

Macrostickies- Materials that are large enough to be retained on a 150 µm or 100 µm laboratory flat screen plate

Microstickies - Which pass through such screen plate with the filtrate

Quantification Of Stickies

The quantification of stickies is an essential tool to control them. Till date there is no standard method for quantification of stickies and various research organizations across the world has developed their own methodologies to meet their requirement. Looking into the needs of Indian Paper Industry CPPRI also made an effort to develop a methodology for quantification of Macro/Micro/Colloidal stickies. With the help of this methodology stickies profiling was conducted for few mills by CPPRI.

CPPRI'S Methodology

For quantification of macrostickies (>100 µm), CPPRI's methodology involves application of Slotted Pressurized Screen (Pulmac Master Screen) to separate and collect the macrostickies on filter paper followed by quantification by Image Analyzer having customized software for macrostickies measurement.

For quantification of Microstickies (<100 µm) conventional solvent extraction method has been applied.

The present paper highlights the findings of case studies on stickies profiling conducted for RCF based mills based on the methodology developed by CPPRI for quantification of Macrostickies and Microstickies in the pulp stock collected from different locations.

Material & Method

1. Pulp samples collected from different locations of the selected Newsprint mills.

Mill A - In Southern India
Mill B - In Eastern India

2. Pulmac Master Screen.
3. Image Analyser with software.
4. Soxhlet Apparatus for extraction.

Results & Discussion

Stickies Quantification Based on CPPRI's Methodology

The process steps of CPPRI's Methodology include:

- Separation of +100 µ and -100 µ fraction.
- Quantification Macrostickies counts in +100 µ fraction expressed as Counts (No./kg) by Pulmac Master Screen and Image Analyser.
- Quantification of Microstickies in -100 µ fraction expressed as gm/kg by extraction method.

The above method has further been extended to separate and quantify colloidal stickies in -100 µ filtrate down to the size of + 10 µ. However, this has not been covered in this article.

Stickies Audit conducted in Newsprint Mills

A description of two stock preparation plants follows where stickies audit was conducted and quantification was carried out employing CPPRI's Methodology. Both the two mills operate on large scale modern processing system, however, the characteristics of mill configuration differs significantly.

(i) Process Description of Newsprint Mill-Mill A

Mill-A is producing newsprint using Old Newsprint (ONP) & Old Magazine Grade (OMG) as a raw material. In mill-A, repulping is done in low consistency continuous pulper followed by two loop system having pre & post flotation stages with disperger system. The mill is following oxidative-reductive bleaching sequence for newsprint production. The mill is using stickies control agent as preventive measure. For stickies quantification eleven sampling points have been identified in the mill.

The details of sampling points are shown in figure-1.

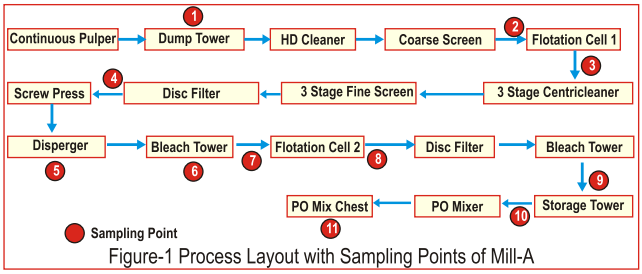

Figure-1 Process Layout with Sampling Points of Mill-A

(ii) Quantification of Macrostickies (> 100 µm) Counts in Mill A

100 gm of pulp samples collected from identified locations were subjected to pressure screen having slot size 100 µm (Pulmac Master Screen) to separate and collect macrostickies ≥ 100 µm size on a filter paper which was then heat set to fix the sticky particles to the filter paper which were counted using image analyzer having customized software for stickies counts. The stickies counts are expressed as No./kg of pulp. The graph shown in fig-2 depicts the classification of stickies counts in different size range between 100 µm to 2000 µm.

The graph clearly shows a downward trend in macrostickies size reduction across the processing line. However, it is also observed that the predominant macrostickies size ranges between 100 µm to 1500 µm which is remaining in the system. Table -1 shows the macrostickies counts in numbers which indicates that there is an overall reduction of 90% in the size range of 100 µm to 200 µm and 96% reduction achieved in the size range of 200 µm to 1500 µm size range. This may presumably due to the reason that the mill is using some stickies control agent.

(iii) Microstickies (< 100 µm) Concentration in Pulp (Mill A)

For estimation of microstickies (<100 µm) concentration in pulp, 100 gm O.D pulp was passed through 100µ sieve and filtrate is

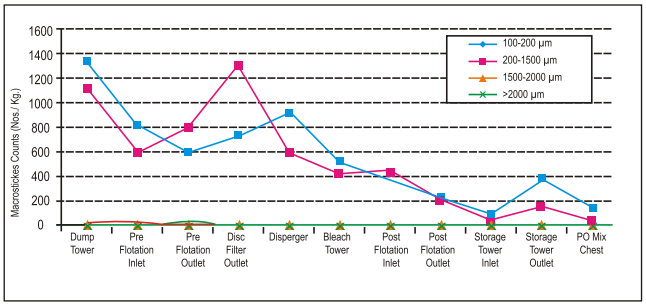

Fig-2 Graphical presentation of Macrostickies (>100µm) counts/kg in Mill A

(iv) Microstickies concentration in Process Back water in Mill A

To establish the above facts the process Back water samples from different sources viz DAF-I, DAF-2, Saveall clear water were analyzed for microstickies concentration expressed as gm/kg. The results are shown in Fig-4, which indicates high concentration of microstickies in DAF-1 inlet 148 gm/kg, DAF-I outlet 270 gm/kg, DAF-2 inlet 44 gm/kg, DAF-2 outlet 210 gm/kg and save all clear water 480gm/kg. The reason is attributed to the fact that the stickies control agent used may be of dispersant type which is preventing the agglomeration of stickies and thus the smaller size stickies particles are passed on to the water phase.

Table-1
Macrostickies (>100 µm) classification expressed as No./kg in the size range of 100 to >2000 µm

Unit Operation	100 - 200 µm	200 -1500 µm	1500-2000 µm	>2000 µm
	Counts (No./kg)			
Dump Tower	1340	1120	20	0
Pre-Flotation Inlet	820(↓)	600(↓)	20	0
Pre-Flotation Outlet	600(↓)	800(↓)	0	20
Disc Filter Outlet	733(↓)	1300(↑)	0	0
Disperger	920(↓)	600(↓)	0	0
Bleach Tower	520(↓)	420(↓)	0	0
Post Flotation Inlet	420(↓)	440(↓)	0	0
Post Flotation Outlet	220(↓)	200(↓)	0	0
Storage Tower Inlet	90(↓)	40(↓)	0	0
Storage Tower Outlet	380(↓)	160(↓)	0	0
PO Mix Chest	140(↓)	40(↓)	0	0
Overall Reduction, %	**90**	**96**	**100**	**100**

collected. The collected filtrate was treated to precipitate the microstickies which was again filtrated off through Buchner funnel. The dried residue was then subjected to solvent extraction using Soxhlet apparatus. The results are shown graphically in Fig-3.

The graph indicates that there is an increase in microstickies concentration expressed as gm/kg pulp when compared with Dump tower. It is clearly observed that the microstickies concentration has increased at the pre-floatation and post floatation stage which is presumably due to introduction of microstickies through process back water which was used for dilution. The values of microstickies concentration in gm/kg pulp are summarized in Table-2 which also shows that wherever the dilution was done there was an increase in microstickies concentration. An overall increase of 35 % was observed.

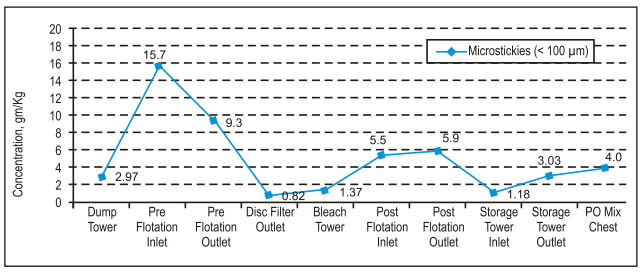

Fig-3 Microstickies (<100 µm) concentration in Mill A

(v) Efficiency of Unit Operation towards Macrostickies/ Microstickies Removal in Mill A

Table-3 summarizes the efficiency of various unit operations for removal of macrostickies and microstickies calculated on the basis of quantification of macrostickies expressed as No./kg pulp and microstickies concentration expressed as gm/kg pulp.

Table-2
Microstickies Concentration expressed as gm/kg in Mill A

Unit Operation	Microstickies Concentration (gm/kg)
Dump Tower	2.97
Pre-Flotation Inlet	15.7(↑)
Pre-Flotation Outlet	9.3(↑)
Disc Filter Outlet	0.82(↓)
Bleach Tower	1.37(↓)
Post Flotation Inlet	5.5(↑)
Post Flotation Outlet	5.9(↑)
Storage Tower Inlet	1.18(↓)
Storage Tower Outlet	3.02(↑)
PO Mix Chest	4(↑)
Overall increment, %	**35**

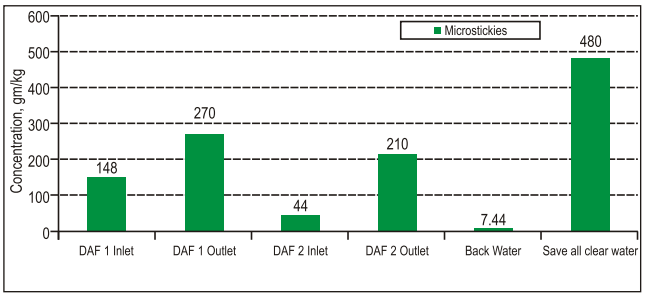

Fig-4 Microstickies (<100 µm) concentration in process back water samples (Mill A)

The results indicates that coarse screen, disperger, post-floatation, disc filter are able to remove around 40-50% of macrostickies which may either be in the form of rejects or size reduction as in case of disperger thus reducing the macrostickies count.

For reducing microstickies concentration the pre-floatation and disc filter have been found to be effective where in at pre-floatation stage it is removed as rejects while at disc filter it is passed on to the water phase.

Table-3
Efficiency of Various Unit Operations for Removal of Macrostickies and Microstickies

Unit Operation	Macrosctickies (> 100 µm) Counts, No./Kg			Microstickies Concentration (< 100 µm), gm/kg		
	Inlet	Outlet	Removal Efficiency, %	Inlet	Outlet	Removal Efficiency, %
Coarse Screen	2480	1440	42	2.97	15.7	Nil
Pre-Flotation	1440	1420	1	15.7	9.3	41
Disperger	2033	940	54	0.82	1.37	Nil
Post Flotation	860	420	51	5.5	5.9	Nil
Disc Filter	420	130	69	5.9	1.18	80

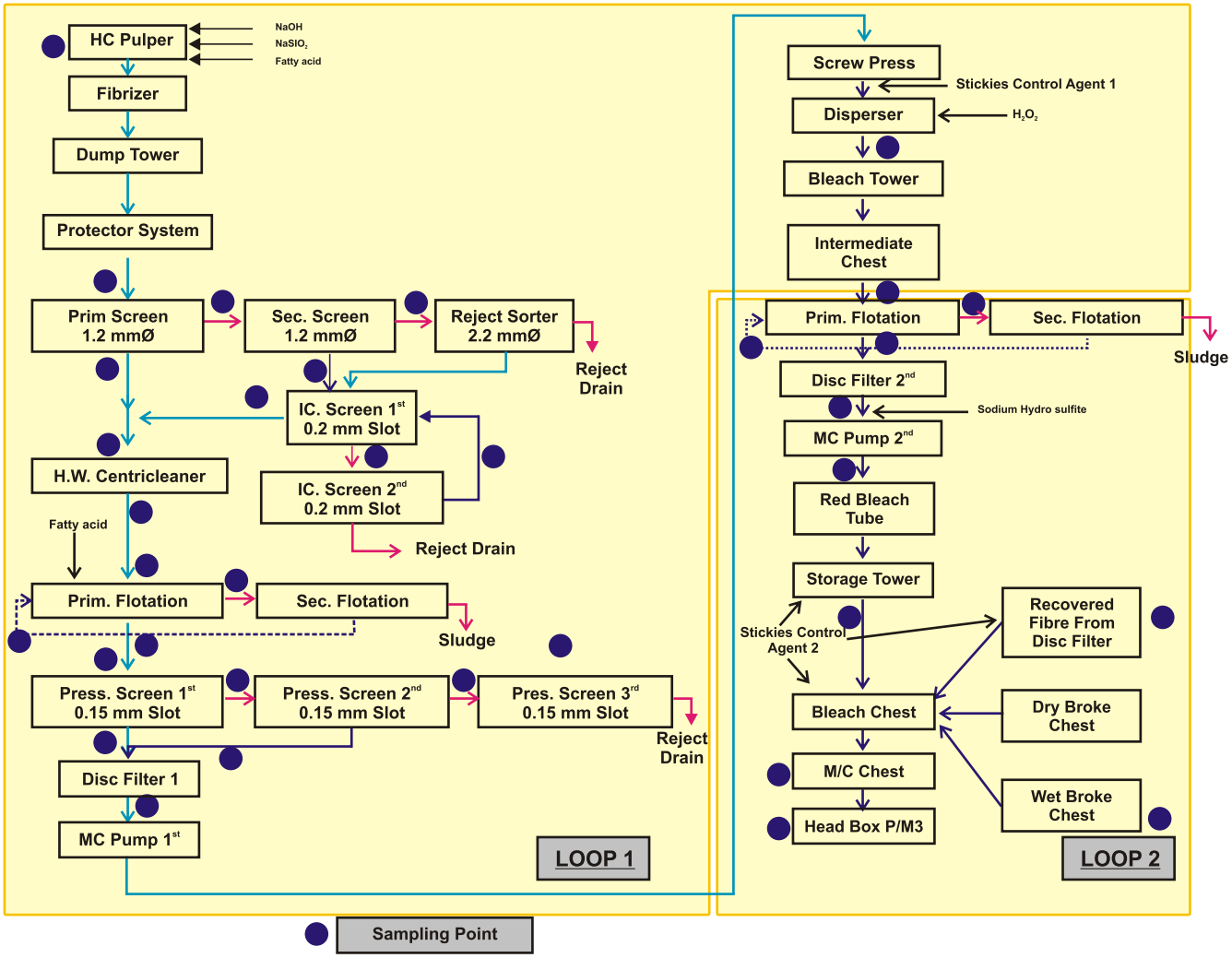

Figure-5 Process Layout with Sampling Points of Mill-

(vi) Process Description of Newsprint Mill-Mill B

Mill -B is producing newsprint using 75% Old Newsprint (ONP), 20% Old Magazine Grade (OMG) & 5% Office Record as a raw material furnish. Mill is having high consistency batch pulper followed by two loop deinking system with disperger system. The mill is following oxidative-reductive bleaching sequence for newsprint production. The mill is using dispersant type stickies control agent in combination with detackifier to control stickies accumulation. The process layout and details of sampling points are shown in Figure 5.

(vii) Quantification of Macrostickies (> 100µm) Counts in Mill B

100 gm O.D. pulp was subjected to Pulmac Master Screen using 100µ slot and macrostickies ≥ 100µ size were separated and collected on the filter paper which were quantified using customized image analyzer for stickies quantification. The macrostickies were quantified in different classes of size range ranging from 100µm to >2000µm size. The graphical representation is shown in fig-6.

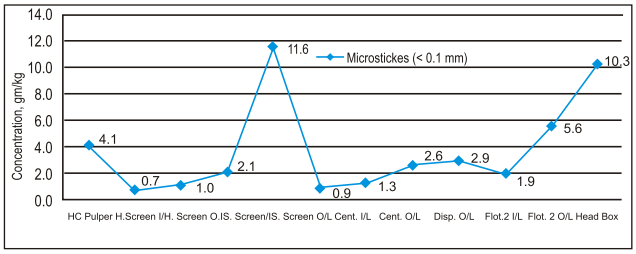

Fig.7 Microstickies (< 100 µm) concentration in Mill B

The graph shows initially a downward trend in macrostickies counts which increased marginally at centricleaner inlet due to mixing of two streams (Primary hole screen accept and IC screen 1st accept). However an overall reduction efficiency of 99-100% was achieved in macrostickies counts presumably due to the reason that the mill is

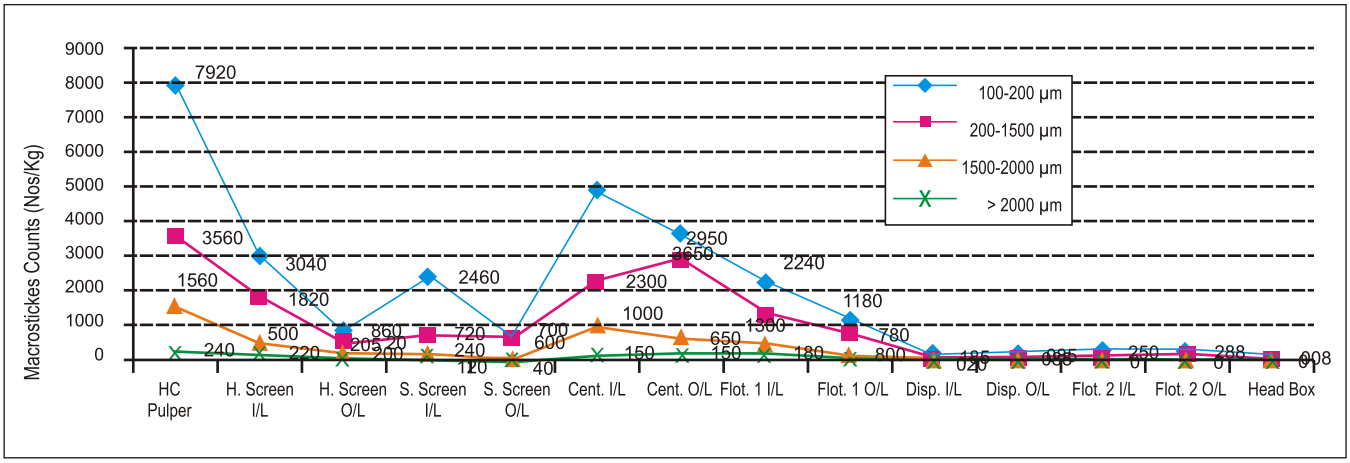

Fig-6 Graphical presentation of Macrostickies (> 100 µm) counts/kg in Mill B

Table-4

Macrostickies (>100 µm) classification expressed as No./kg in the size range of 100 to >2000 µm

Unit Operation	100- 200 µm	200 -1500 µm	1500-2000 µm	>2000 µm
	Counts (No./kg)			
HC Pulper	7920	3560	1560	240
Hole screen inlet	3040(↓)	1820(↓)	500(↓)	220(↓)
Hole screen outlet	860(↓)	520(↓)	200(↓)	20(↓)
Slot screen inlet	2460(↓)	720(↑)	240(↓)	120(↓)
Slot screen outlet	760(↓)	680(↓)	40(↓)	40(↓)
Centricleaner inlet	4900(↓)	2300(↓)	1000(↓)	150(↓)
Centricleaner outlet	3650(↓)	2950(↓)	650(↓)	150(↓)
Flotation 1 inlet	2240(↓)	1300(↓)	460(↓)	180(↓)
Flotation 1 outlet	1180(↓)	780(↓)	160(↓)	80(↓)
Disperger inlet	185(↓)	25(↓)	0	10(↓)
Disperger outlet	165(↓)	90(↓)	0	5(↓)
Flotation 2 inlet	256	81	0	6(↓)
Flotation 2 outlet	288	175	0	6(↓)
Headbox	108	26	0	0
Overall reduction,%	**99**	**99**	**100**	**100**

Table-5
Microstickies Concentration expressed as gm/kg in Mill B

Unit Operation	Microstickies Concentration (gm/kg)
HC Pulper	4.1
Hole screen inlet	0.7 (↓)
Hole screen outlet	1.0 (↓)
Slot screen inlet	2.1 (↓)
Slot screen outlet	11.6 (↑)
Centricleaner inlet	0.9 (↓)
Centricleaner outlet	1.3 (↓)
Disperger inlet	2.6 (↓)
Disperger outlet	2.9 (↓)
Flotation 2 inlet	1.9 (↓)
Flotation 2 outlet	5.6 (↑)
Headbox	10.3 (↑)
Overall increment,	**2.5 times**

using dispersant chemical at the disperger and detackifier at storage tower, blending chest and recovered fibre chest. The values of macrostickies counts expressed as No./kg pulp in different size range is depicted in Table-4.

(viii) Microstickies (< 100 µm) Concentration in Pulp in Mill B

For estimation of microstickies -100µ fraction of the pulp stock was subjected to solvent extraction and the microstickies concentration expressed as gm/kg pulp is depicted in fig-7. The graph shows an overall increase in microstickies concentration from HC pulper to Headbox nearly 2.5 times which may presumably due to carry over of microstickies with dilution water. The values of microstickies concentration expressed as gm/kg summarized in Table-5 clearly show an increment of microstickies concentration at slot screen outlet, flotation 2 outlet and headbox.

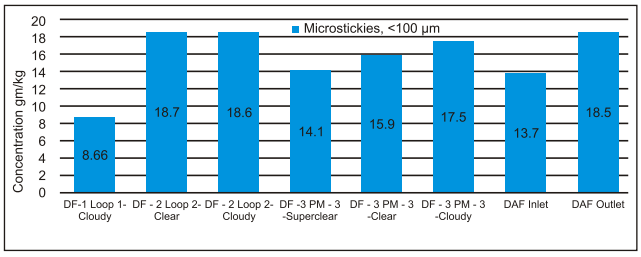

Fig.8 Microstickies (< 100 µm) concentration process back water samples in Mill B

(ix) Microstickies concentration in Process Back water in Mill B

The process backwater samples collected from different sources viz. Disc filters, DAF and Paper machine back water subjected to analysis for microstickies concentration expressed as gm/kg. The results show that there is a stable concentration of microstickies level in all the process back water stream which may be causing the accumulation of microstickies concentration in pulp stock after dilution.

(x) Efficiency of Unit Operation towards Macrostickies/ Microstickies Removal in Mill B

Table-6 shows the efficiency of various unit operation in reducing/ controlling the macrostickies/ microstickies levels during operation. This is calculated based on the quantification of macrostickies/ microstickies. The result indicates that Hole screen, slot screen and centricleaner are able to remove macrostickies counts in the pulp whereas no reduction was achieved in microstickies concentration by these unit operation.

Conclusion

Quantification of stickies levels is a pre-requisite and essential tool to study the overall impact of stickies on productivity loss due to web breakes and paper machine deposition. The mills are in practice to use stickies control agent like dispersant, detackifier etc. but due to lack of quantification method the performance of these chemicals cannot be judged.

CPPRI has made an effort to develop a method for quantification of macro/ micro/ colloidal stickies in pulp stock based on which several mill evaluation have been done. This methodology has helped to track down the stickies concentration at various stages of processing line and which ultimately helped the mill and the chemical suppliers in understanding the performance of stickies control agent used by the mill. Till date CPPRI has done five (05) case studies on stickies quantification.

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Table-6
Efficiency of Various Unit Operations for Removal of Macrostickies and Microstickies

Unit Operation	Macrosctickies (> 100 µm) Counts, No./Kg			Microstickies Concentration (< 100 µm), gm/kg		
	Inlet	Outlet	Removal Efficiency, %	Inlet	Outlet	Removal Efficiency, %
Hole screen	5580	1600	71	0.7	1.0	Nil
Slot screen	3540	1520	57	2.1	11.6	Nil
Centricleaner	8350	7400	11	0.9	1.3	Nil
Disperger	220	260	Nil	2.6	2.9	Nil
Flotation 2	344	469	Nil	1.9	5.6	Nil