Removal of Contaminants In Waste Paper Systems-Strategies, Methods, Screening Means

Lascar Alain, Thomassin Dominique & Fejoz Roland

INTRODUCTION

Wast paper quality is decreasing every day, while the stock produced by waste paper system must always be improved. How is it possible to solve this question ? How do we have to design waste paper systems regarding screening equipment? To try to answer, we could analyse what we want to eliminate. We will separate these prohibitive particles in three main categories:

- Contaminants,
- Ink particles (for printed waste paper),
- Fines or ash (depending on the use of the stock produced).

In this paper, we will mainly analyse removal of contaminants. We will:

- First define what are the main contaminants we could find in our waste paper; and how to elininate them.
- Then we will focus on screening concept and sticky removal. We will also comment the limits of present-day sticky measurements. We will compare screening with fine slots and Gyroclean.
- Considering what was analysed before, we will also comment the limits of present-day sticky measurements. We will compare screening with fine slots and Gyroclean.
- Considering what was analysed before, we will analyse an example of waste paper system and look into the design of a deinking line regarding screening.

CONTAMINANT ANALYSIS

a) Contaminant Definition

We could define contaminants by their shape, specific gravity, thickness, "melting point", "softening point".

The main contaminants present in our waste paper are described in the following table.

For stickies and hot-melts, we will make a special analysis.

b) Stickies

We have two kinds of stickies:

- Primary stickies:

It is a sticky particle present in the stock.

- Secondary stickies:

It is a particle coming from re-agglomeration of dissolved particles due to certain physico-chemical conditions.

Characteristics of primary stickies are:

- Visco-elasticity,
- Specific gravity close to 1, but variable, higher or lower than 1,
- Grain-like shape mainly.

The main origin of stickies is adhesive papers.

They are mainly creating sticking points.

c) Hot-Melts

They are chiefly coming from "high speed binding".

The melt is fluidised by the temperature and the melting action is obtained by cooling the binding.

C/o C.P. Engg. (India) Pvt. Ltd.
85, G.N. Chetty Road, T. Nagar
CHENNAI-600 017 (T.N.)

CONTAMINANTS / DEBRIS	MAIN CHARACTERISTICS			
	SHAPE	MELTING	THICKNESS	SPEC.GRAVITY
- **Metals-staples** . Ferrous metals..... . Aluminium (laminated).....	(1) C P-G F-G- P	(2)	Length: 3-15 mm 7 to 15 µ	> 7 7 to 8 2,7
- **Minerals** . Sand, gravel . Glass, pigments.....	G-P		ϕ Gravel > 4u0 µ Sand > 200 µ fine sand < 200 µ other variable	2,5
- **Wood** . Shive fragments.....	P		variable	typically > 1
- **Heavy synthetic polymers** . Vinyl resin (PVC, etc...)..... . Polyamide resin (Nylon etc...). . Polystyrene (not expanded)..... . Rubber (+ or - reinforced).....	 P-F F P	 R = 90 F = 160 R = 80	 50 - 100 µ	 1,38 1,13 1,05
- **"Thermomeltable" polymers** . Tar, bitumen (coatings) . Wax, paraffin	 P-G G-P	{R = 85 {F = 160 R = 60-110	variable, thick at process start	typically > 1 0,9 - 0,98
- **Light synthetic polymers** . Polycoated sacks..... . (low specific gravity)..... . Polypropylene..... . Expanded polystyrene.....	 F F G-P G	 F = 110 R = 130 R = 80	 20 - 200 µ 10 - 20 µ 15 - 30 µ	 0,92 0,90 0,1
- **Stickies, hot-melts**	will be dealt separately			

(1) P = splinters/G = grain-like/F = films/C = cylindrical
R = softening point in °C/F = melting point in °C

Hot-melt properties are:

- Very flexible depending very much on temperature,
- Specific gravity 0.98 to 1.

They are mainly creating translucent specks and are hot-meltable.

The kind of problems created on the paper/board and/or on the paper/board machine is summarised in the following table.(given on next page)

REMOVAL OF CONTAMINANTS, STRATEGIES

a) Basic Principle

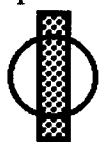
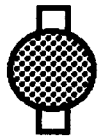
The basic principles of contaminant removal are:

b) What is the right unit for each kind of contaminants.

We will then focus in this paper on how to measure and remove stickies and hotmelts by Gyroclean and slot screening equipment.

CONTAMINANTS		TROUBLE
MINERAL: Sand, glass, pigments	➡	◆ Abrasion, wear
WOOD: shives	➡	◆ Breaks and web cleanlines
SYNTHETIC POLYMERS (except stickies)	➡	◆ Soiling in the dryer part ◆ Cleanliness
STICKIES	➡	◆ Soiling: dryer part, wire, felt ◆ Lower runnability ◆ Stickies, hot melts ◆ Breaks at calander and on ◆ Machine breaks
TAR (OCC)	➡	◆ Typical black specks
THERMOMELTABLE WAX PARAFFIN AND POLYMERS, HOT MELTS	➡	◆ Translucent dots ◆ Lower physical properties ◆ Soiled clothing

BASIC PRINCIPLES OF CONTAMINANT REMOVAL

PARAMETERS	SHAPE	SPEC. GRAVITY
HOLES	Splinters / Films  Contaminant Hole	NO influence
SLOTS	Grain - like  Slot Contaminant	NO influence
CLEANING		
HD cleaner	G and bigger	d > > > 1
Forward cleaner	G preferred	d > > 1
Reverse cleaner	G preferred	d < < 1
Gyroclean	P/F/G	d close to 1 and d < 1 (d = 0.98 to 1)

Splinters = P Films = F Grain-like = G

FOR EACH TYPE OF CONTAMINANT, THE RIGHT UNIT

CONTAMINANTS		CONTAMINANT REMOVAL STRATEGY
METALS, STAPLES	→	• HD cleaner
SAND, GLASS	→	• HD cleaner • Forward cleaner
SHIVES	→	• Forward cleaner, slot screen
HEAVY SYNTHETIC POLYMERS	→	• Forward cleaner • Hole/slot screen
THERMOMELTABLE POLYMERS (tar, bitumen)	→	• Forward cleaner • Slot screen • Kneader
WAX	→	• Gyroclean • Dispersion unit • Slot screen
LIGHT SYNTHETIC POLYMERS	→	• Gyroclean • Hole/slot screen
STICKIES, HOT MELTS	→	• Slot screen • Gyroclean • Flotation • Kneader • Forward cleaner • Process water looping design and Dissolved Air Flotation

STICKIES AND HOT-MELT MEASUREMENTS

Current measurements can evaluate stickies and hot-melts retained on a Sommerville screen plate of 0.15 mm. At the same time, screens with ever decreasing slot size (see following chart 1) and equipment like Gyroclean capable of removing very small particles (see following chart 2) are state-of-the-art technology.

Why is a Gyroclean capable of removing such small light stickies and hot-melt compared to a classical reverse cleaner ?

Following these statements, can we assume that the current measurement method is appropriate? Has this method followed the very quick equipment technology evolution ?

SLOT WIDTH IN DIP PROCESS FOR FINE SCREENING		
Period		**Available slot widths**
up to 1994	→	0.20 to 0.25 mm
1995 - 1996	→	0.15 to 0.20 mm
1996 up to now	→	0.10 to 0.15 mm

COMPARISON: CLASSICAL REVERSE CLEANER and GYROCLEAN		
Technical features	Classical reverse cleaner	GYROCLEAN
G forces	210 g to 240 g	700 g
D well time	0.5 to 1.4 sec	5 to 10 sec.
Reject by weight per stage	6 to 17%	0.1 to 0.5%
Number of stages to be installed	2 to 4	1

For these questions, we answer = NO.

We think that:

- Screen plate with slots of 0.15 mm is not appropriate,
- Due to different physical characteristics of hot-melts and stickies, it is interesting to develop a new method to separately measure stickies and hot-melts.

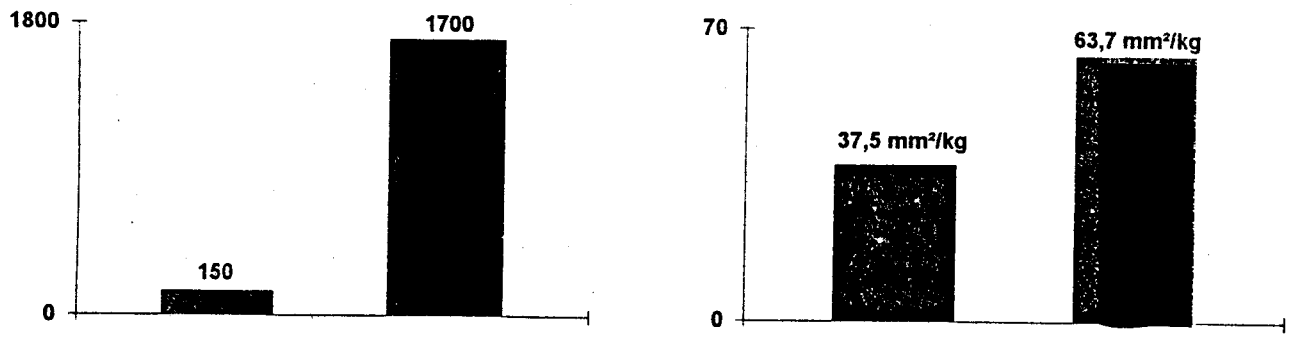
In this respect, we have first analysed the difference between screen plate with slots of 0.15 mm and slots of 0.08 mm.

The comparative test is done:

- On the same sampling of stock,
- Evaluated with the classical method (the only change is the screen plate).

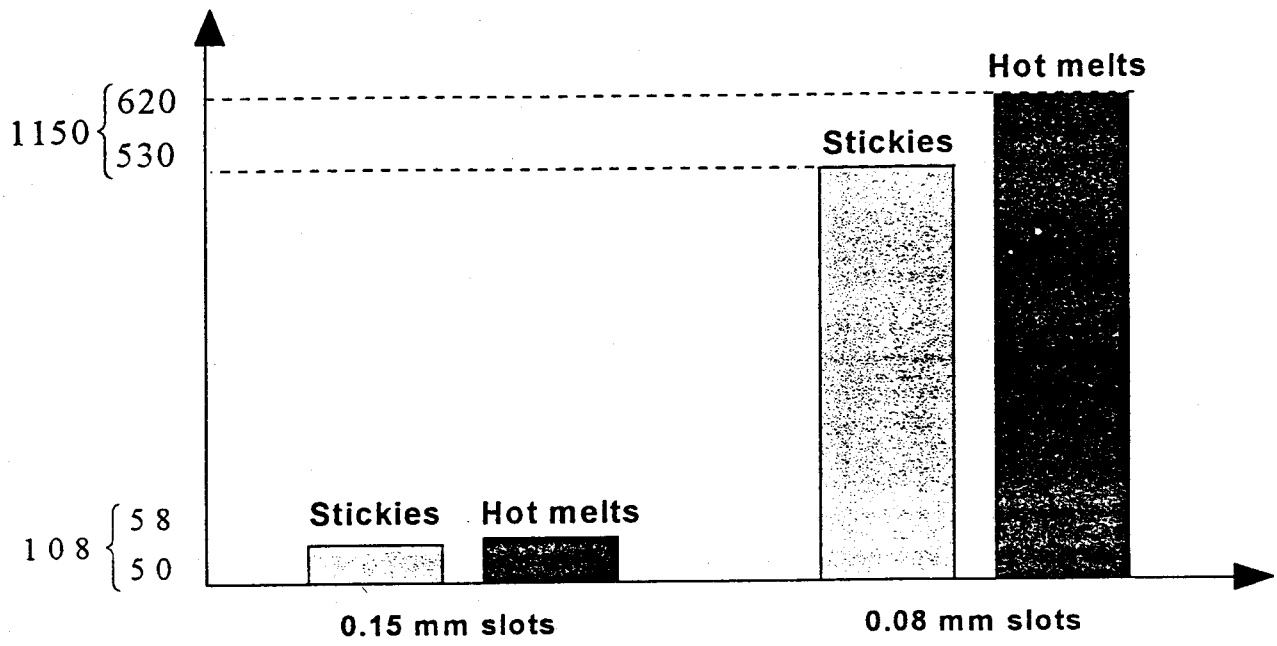
The results are:

COMPARATIVE STICKY MEASUREMENTS WITH 0.15 and 0.08 mm SLOTS



PRESENT-DAY METHOD

COMPARATIVE STICKY MEASUREMENTS WITH 0.15 and 0.08 mm SLOTS



LAMORT METHOD

We have then compared the method LAMORT is developing with slots of 0.15 mm and slots of 0.08 mm. Our method gives a possibility of separately measuring hot-melts and stickies. Measurement is made on a stock sample different from the one used for the comparative trials with the current method.

Of course, measurements could vary depending on stock sampling and contamination. Anyway, obvious conclusions appear:

- Sticky measurement with slots of 0.15 mm is not appropriate,
- There is a large number of stickies and/or hot-melts which are identified with the method with slots of 0.08 mm. We need to measure them to be able to evaluate what equipment will remove them.

SCREENING CONCEPT

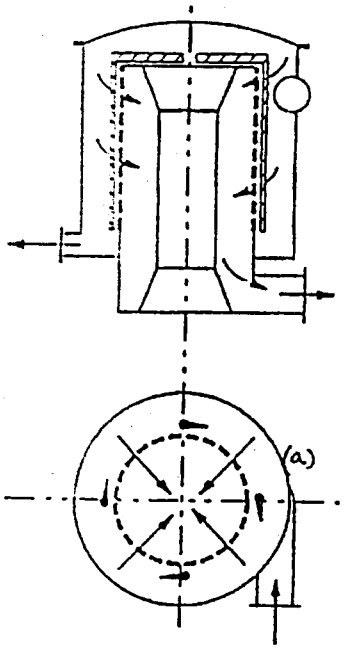
a) Screen Design

We could separate screen designs in 3 different concepts:

- Centripetal design inlet side foil = LAMORT SP Screen and vertical screen.
- Centrifugal design, inlet side foil = OTHER Screens and vertical screen.
- Centrifugal design, inlet side foil = LAMORT CH Screen and horizontal screen.

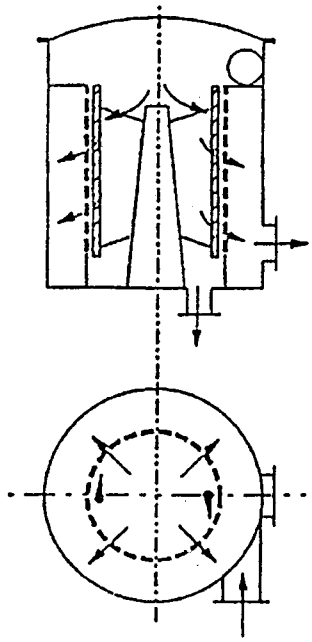
SCREEN DESIGNS

LAMORT SP SCREEN



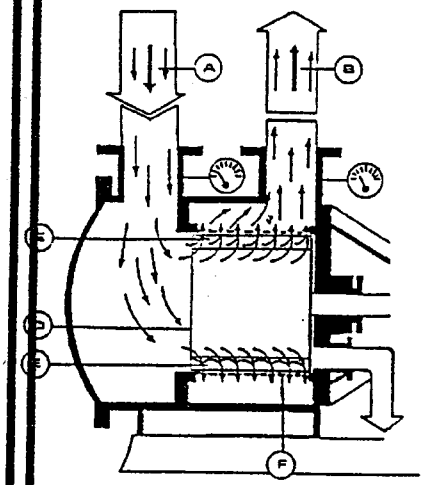
CENTRIPETAL DESIGN
INLET SIDE FOIL
VERTICAL SCREEN

OTHER SCREENS



CENTRIFUGAL DESIGN
INLET SIDE FOIL
VERTICAL SCREEN

LAMORT CH SCREENS



CENTRIFUGAL DESIGN
INLET SIDE FOIL
HORIZONTAL SCREEN

SCREEN APPLICATIONS

Screen type	Application	Working cons.
LAMORT SP SCREEN	➡ Holes or slots down to 0.10 mm ➡ Fine screening for Waste paper systems ➡ Headbox screens	below 1.5%
LAMORT CH SCREEN	➡ Holes or slots down to 0.10 mm ➡ Mid-consistency screening for waste paper systems	up to 4%-4.5% with 0.15 mm slots for waste paper stock

b) Lamort Basket Design

Basket design could influence efficiency rates. To meet these objectives, we have developed our COBRA design.

figures, we have worked on rotor and screen design to:

- Optimise what we call tangential

COBRA

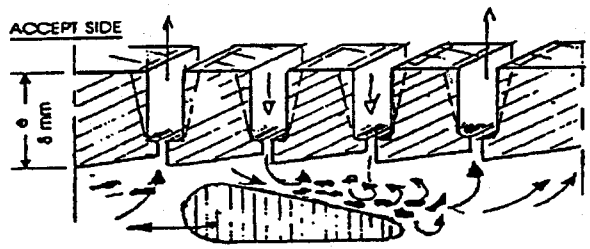


Fig. 1 : Standard wedgewire or plate

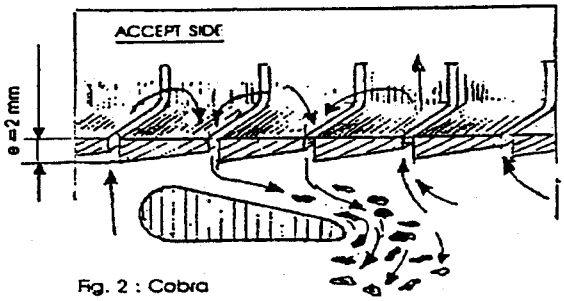


Fig. 2 : Cobra

ΔP standard >> Δp Cobra

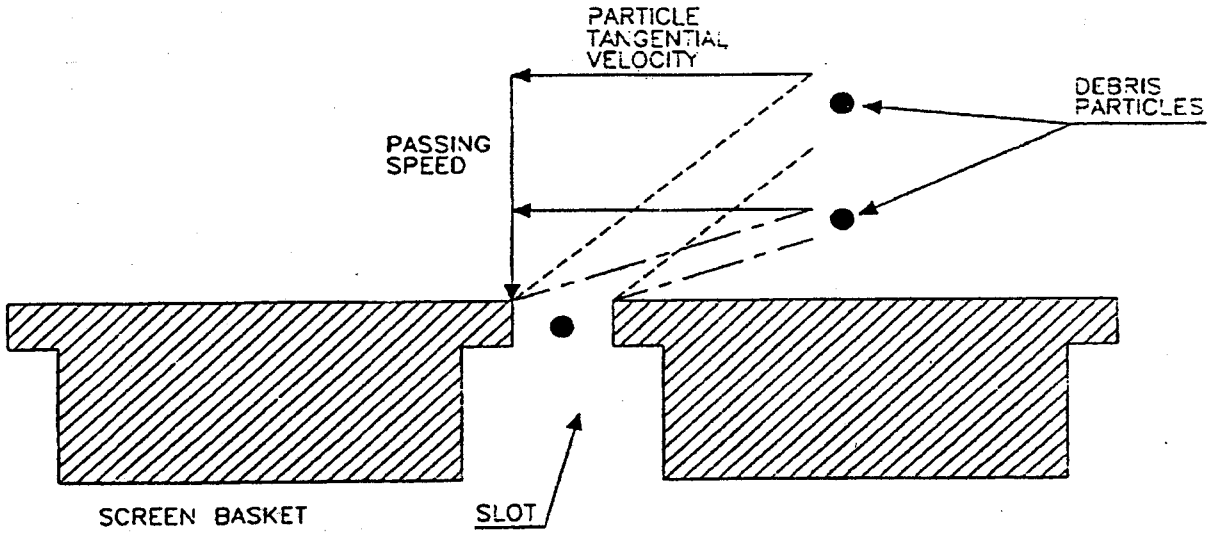
- maximum open area up to 65% and +, compared to standard basket
- fine slots in industrial conditions down to 0.10 mm
- less ΔP thanks to the thickeness of the basket
- no extrusion of flexible contaminants
- high efficiency for sticky removal

c) Lamort Rotor And Screen Design

In order to also improve screening efficiency

presentation of contaminants (see following chart).

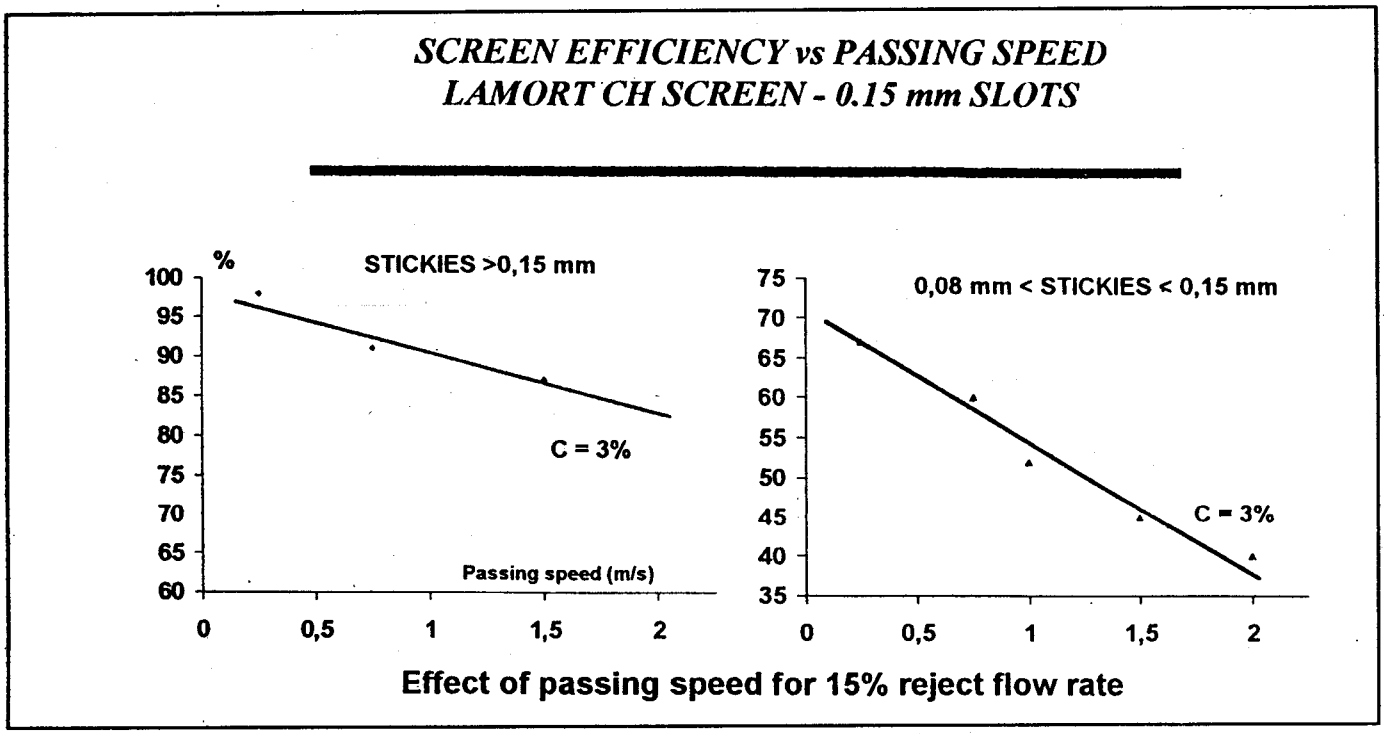
EFFECT OF PASSING SPEED ON PROBABILITY EFFICIENCY

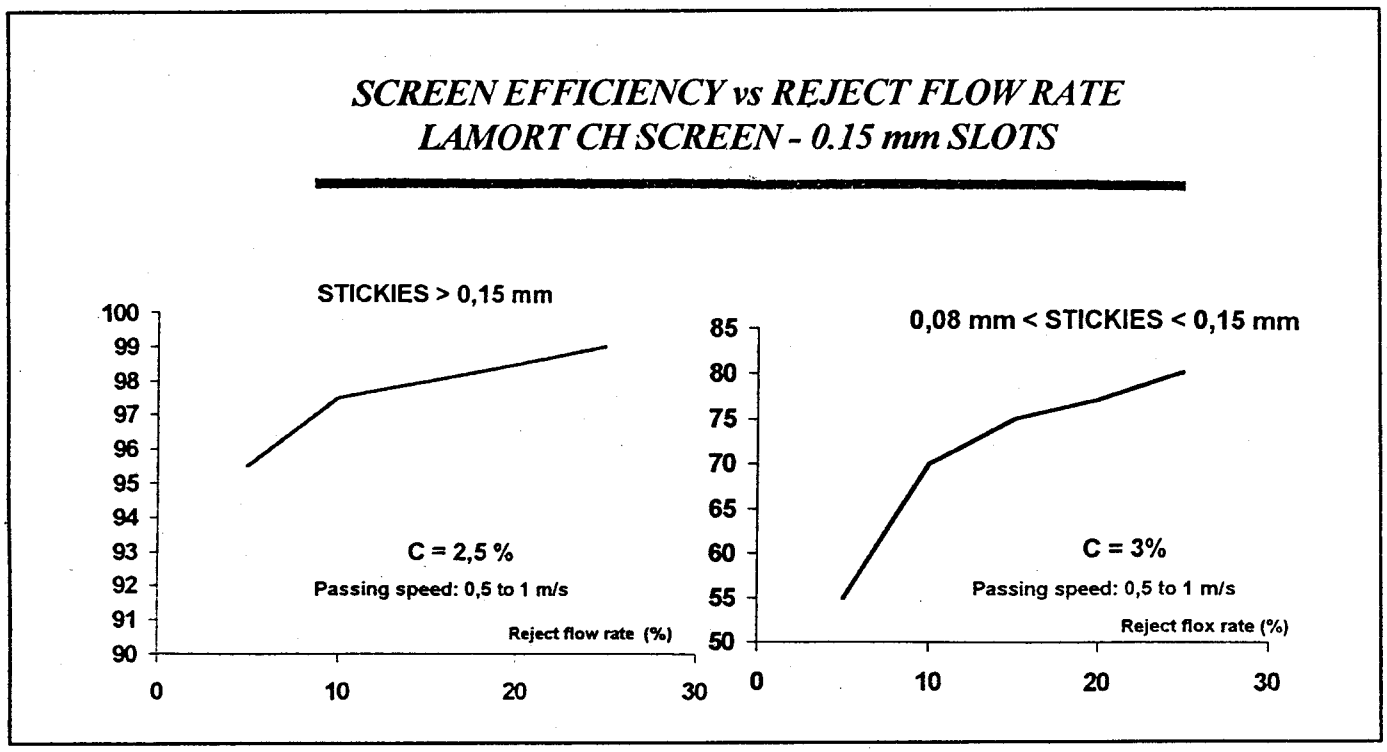


- Limit to the maximum the effect of extrusion of flexible contaminants, when the rotor is cleaning the basket.
- Increase life of basket, by decreasing wearing problems, mainly for slot screens.
- Minimise energy consumption and fiber losses of screening systems.

d) Effect of passing speed and reject rate on screening efficiency.

Considering our comments regarding the sticky





method, we have defined two kinds of stickies:

- Large stickies = over 0.15 mm size.
- Small stickies = below 0.15 mm size and bigger.

We have then analysed the effect of passing speed and reject rate on screening efficiency. This study is done:

- with LAMORT CH screens,
- analysing large and small stickies removal.

e) Comparison of Micro-Slot SP Screens

System and Gyroclean, regarding large and small sticky removal efficiency.

We have examined and compared 3 different systems:

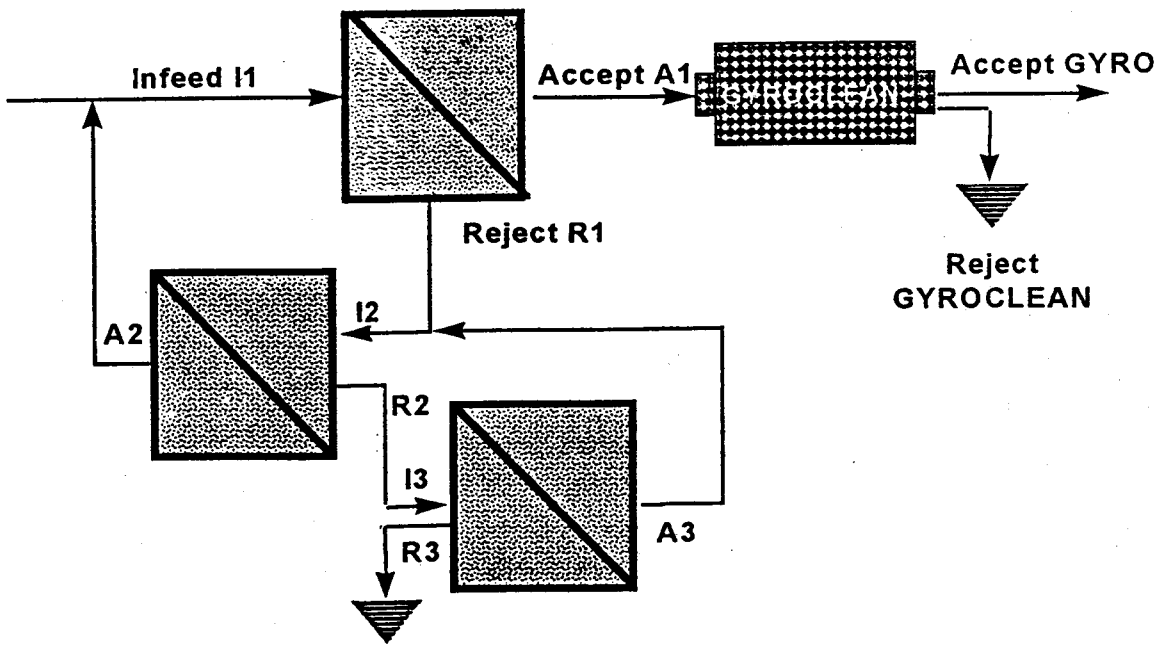
We have then evaluated efficiency of these three systems for large and small stickies. For our study, We have estimated that sticky distribution will be:

- 70 % light-30% heavy,
- 50 % light-50% heavy

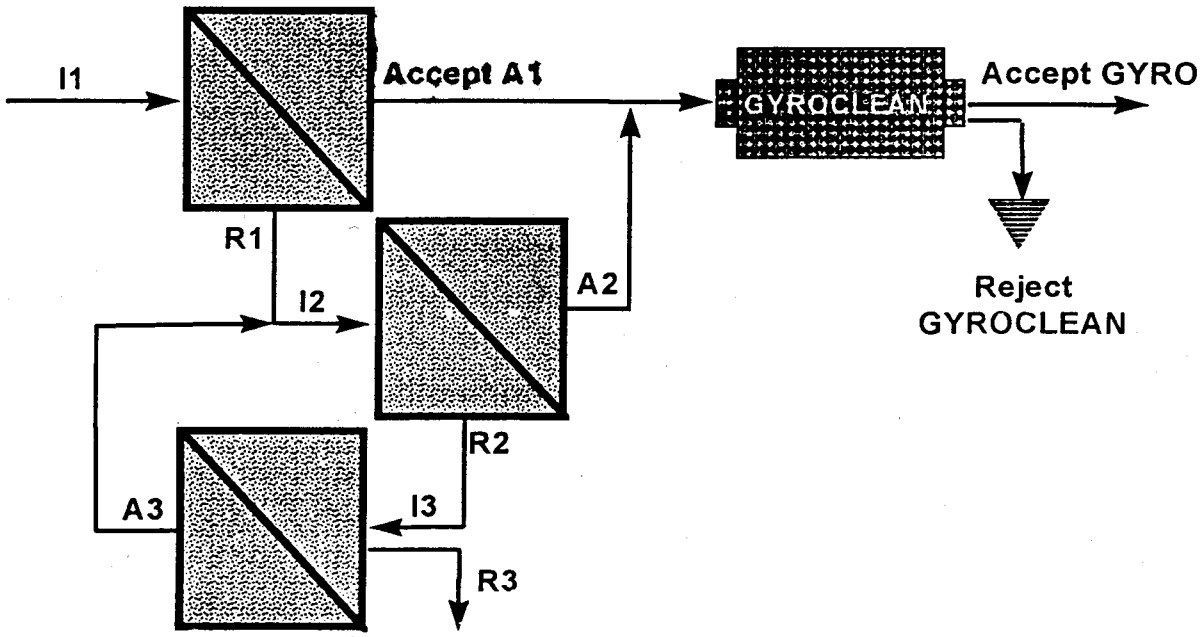
Analysing these curves, we can conclude that:

- When the Gyroclean is installed on the full flow the system efficiency is better above all for small stickies.
- System 3, with Gyroclean on the reject of the first screen stage, is certainly a very good compromise.

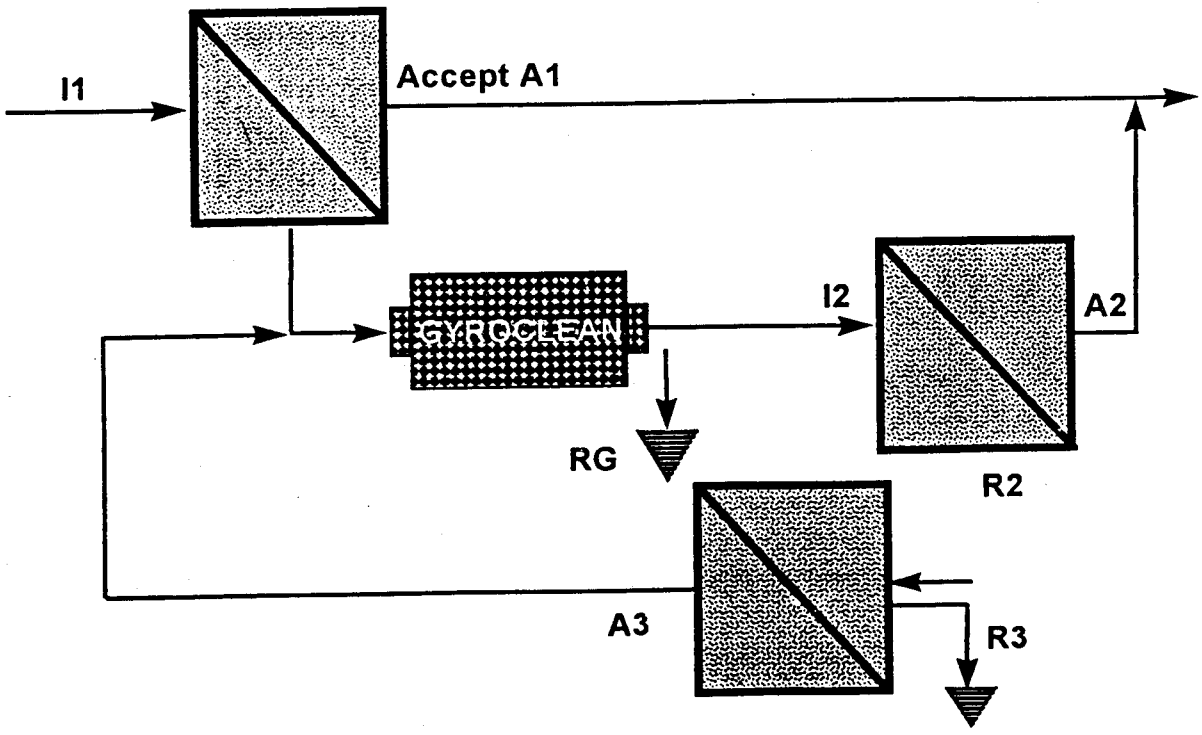
SP SCREEN WITH 0.12 mm SLOTS, 3 STAGES, IN BACKWARD GYROCLEAN IN FULL FLOW



SP SCREEN WITH 0.12 mm SLOTS, 3 STAGES, 2nd STAGE IN FORWARD - GYROCLEAN IN FULL FLOW

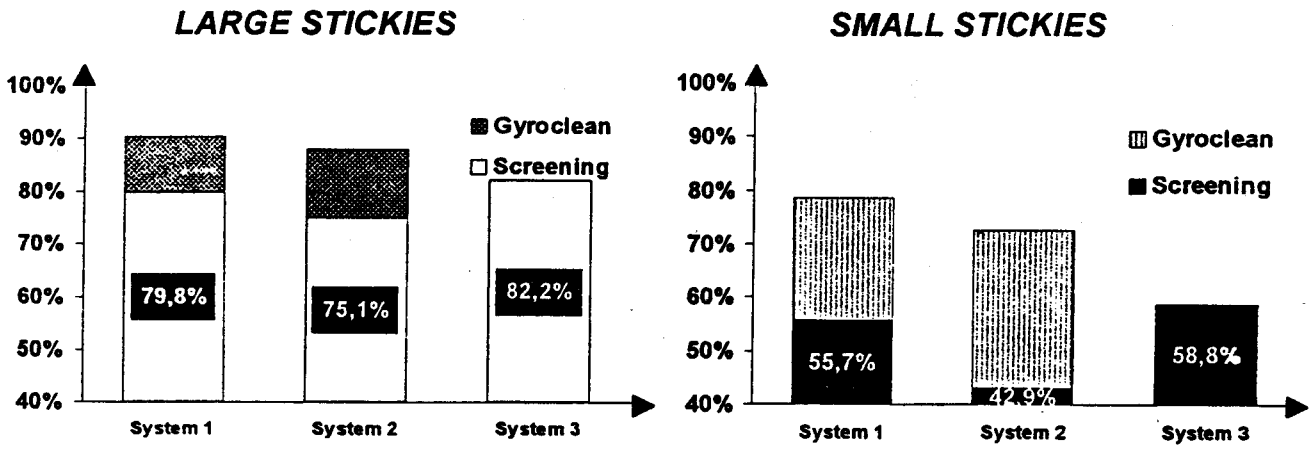


SP SCREEN WITH 0.12 mm SLOTS, 3 STAGES, 2nd STAGE IN FORWARD GYROCLEAN ON THE REJECT OF THE 1st SCREEN



COMPARISON OF STICKY REMOVAL EFFICIENCY SP SCREEN 0.12 mm SLOTS AND GYROCLEAN

(70% light stickies, 30% heavy stickies)



SYSTEM 1: SP screen in 3 stages, backward and Gyroclean full flow

SYSTEM 2: SP screen in 3 stages, 2nd stage forward and Gyroclean full flow

SYSTEM 3: SP screen in 3 stages, 2nd stage forward and Gyroclean on reject of 1st stage

WASTE PAPER SYSTEM DESIGN AND SCREENING FOCUSING ON STICKY REMOVAL

We have analysed as an example how to design a deinking line regarding screening and sticky removal.

Screening as demonstrated before is important for sticky removal, but other systems must be considered:

- Pulping condition and coarse screening.
- Flotation cells. As an example, our new MAC cells have a 55-60 % sticky removal efficiency.
- Heavy cleaners with small infeed diameter.
- Kneader and/or dispersion unit.
- Process water circuit and dissolved air flotation.
- Chemicals used and physico-chemical operating conditions.

Our basic rules are:

- No degradation of contaminants and especially of stickies and hot-melts in the pulping area.
- To remove contaminants as quickly as possible before they are cut to small pieces by pumps, rotors, etc.

As an example, we remove in our coarse screen 85 to 95 % of the total contamination by weight if it is installed just after our Helico pulper.

It is also a big advantage for us to do a lot of the screening job with micro-slot screens at medium consistencies:

- To maximise each machine so as to design DIP lines as compact as possible.

To optimise and develop the right strategies regarding looping of process water.

We have not the time to present in detail the above topics, but it was important to note them.

CONCLUSION

Screening is and will be an important matter in designing waste paper systems. State-of-the-art technology allows us to screen with micro-slots of 0.10 mm or 0.15 mm. Nevertheless, slot size is not the only parameter to consider. Passing speed, reject rate, screen and rotor design, basket design, tangential presentation, wear and tear must be thoroughly analysed.

Questions must also be asked on how contaminant measurements are made and how to improve waste paper system designs for each special application.