Review of Worldwide Packaging Stock Preparation Markets and Processes

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ABSTRACT

Packaging market has to face several challenges

- Decrease of Raw material quality,
- Lower weight in test liner and fluting papers,
- Higher speed on paper machines,
- Stock preparation line with capacity up to 2000 TPD.

Improvement in pulping technologies, coarse screening, fractionation, cleaning give today possibility to design more compact and more economic systems.
This paper is reviewing the raw material as well as all technologies per module, pulping, coarse screening, fractionation, cleaning, fine screening, and is giving development paths for new compact stock preparation designs.

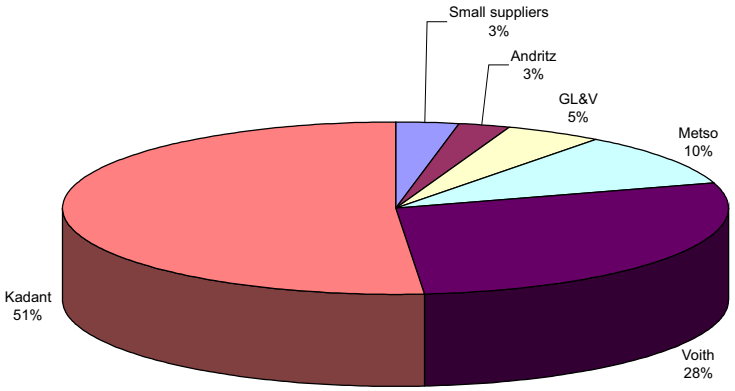
Introduction

Through his brand names Black Clawson and Lamort, Kadant has been deeply involved in the stock preparation using OCC recycling boards, and has then developed a global market knowledge and understanding.

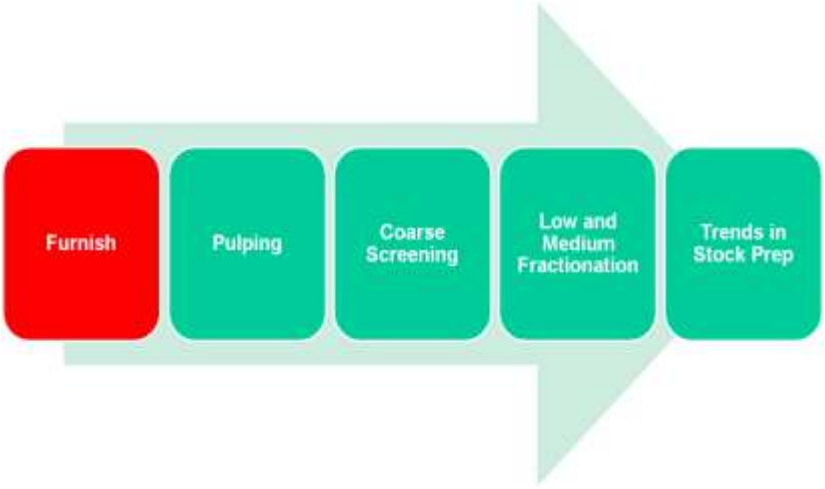
The Market shares reported by Fisher data base, for stock preparation using recycling papers for test liner and fluting are shown on the following chart.
Based on this field and market experience, this paper is proposing a world wide review of packaging stock preparation markets and processes through.

- Market and raw material quality trends
- Review of the Stock Preparation Line based on a Module System
  - o PULPING MODULE
  - o COARSE SCREENING MODULE
  - o FRACTIONATION / CLEANING / FINE SCREENING MODULE
- Trends in stock preparation line designs

MTPY INSTALLED CAPACITY FOR RCF OCC LINER BOARD/CORRUGATED MEDIUM SYSTEMS - MAIN 5 SUPPLIERS



Modular Design and Considerations



Market and Raw material quality trends

Test liner and Fluting papers are manufactured with 100% of recycle papers, using OCC grades.
As only Kraft liner papers are using virgin pulp, new pulp introduction in this recycling loop is extremely low.

At the same time in Europe, European directive 94/62/EC has been amended and reinforced though the directive 2004/12/EC.

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Essential requirements are :

- Waste reduction by minimising the weight and the volume of packaging. "…*Packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and customer.*"
- Minimised quantities of the presence of substances considered to be dangerous.
- Nature and conditions of packaging to be reused (if claimed)
- Recovery of packaging by one route at least
    - o Material recycling
    - o Organic recovery
    - o Energy recovery

In order to establish a common basis for assessing conformity with the essential requirements above, European commission has prepared five principal standards EN13428 to EN13432.

General considerations

Type of Furnish	ml CSF	Fibre Strength	Contaminant level
America OCC	500-600	Strong and difficult to defiber	2 – 5%
European OCC	350-450	Moderate Strength and reasonably easy to defiber	4 – 8%
Korean OCC	300– 400	Very short fibre and relative easy to deflake	10 – 13%
Thailand OCC	300-350	Highly recycled and lacking in inherent strength typically supplemented with AOCC and JOCC	3 – 6%

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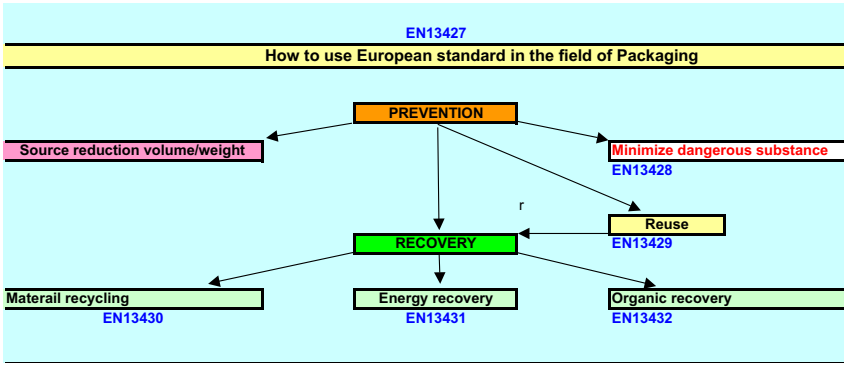
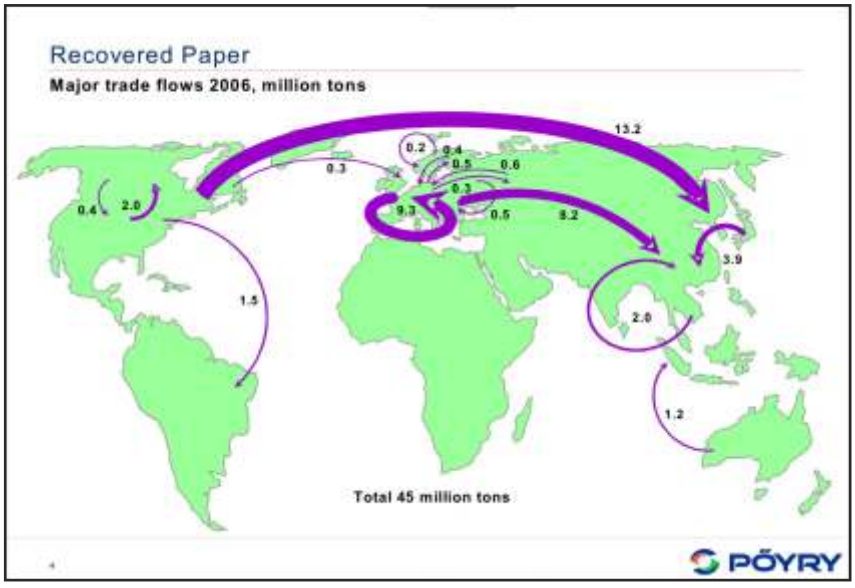
To create a frame work within which these standards should be unified, EC have done an "Umbrella" standard EN13427, called requirement for the use of European standards in the field of packaging and packaging waste.



Recovered paper major trade flows
An impact on recycling paper quality and costs



All this legal pressure is driving the market towards lower grammage test liner and fluting, but with always a need of good strength.

Quality of raw material is also relying on collection possibilities and organisation per countries as well as big trading flows. The following picture is showing some of the recovered paper major trade flows.

As a matter of fact, the types of raw materials you will find in various countries are different. The above table is showing some of the differences noticed. Fibre strength and contaminant levels are shown.

Contaminant level Trends

It is noticeable that the contaminant level has risen to values as high as 5 15%, with sorting of the furnish being reduced to a minimum. We know it is critical to ensure that the removal of contaminant is carried out as early as possible to allow steady and efficient fine cleaning and screening to be carried out at a later stage farther down the System. But due to these high levels of contaminants systems need to be adjusted to suit the more serious problems with the incoming furnish.

Contaminant Levels can include undefibred wet strength material, plastic, wood, etc as part of the incoming furnish. Measurement of such contaminants is possible with use

of a Sommerville fractionator's and a disintegrator for separating the easy 'to defibre' flakes.

The contaminant itself has been seen to rise at an alarming rate.

Ash level and fines

We know that the furnish quality is also reduced as the level of recycling is increased. Ash contents as high as 15 20% can be seen in some recycled, so called EOCC raw material.

This has an adverse effect on the strength of the final product and especially results in serious effects on the formation of low grammage products at the Board Machine. The ash/fillers need to be removed or controlled as we know that the situation on this furnish is likely to deteriorate further and without any control on the System we will end up with serious problems with the Machine runnability.

If we look at recent values taken at the Pulper feeds, as spot measurements, we find contradicting qualities of furnish and type of fibre/contaminant.

For example 1, we see extremely high ash values and short fibre length, while in example 2 we notice far higher contaminant rates, with a lower (but still reasonably high) ash content for EOCC.

Long Fibre is equated to 14 and 28 mesh on the Bauer Mc Nett

European Mills	[C] In pulper	Ash 575°C	Somerville 0,15 mm	Bauer Mc Nett 14M	28M	48M	200M	Residual
Mill 1	4.65%	19.20%	6.02%	16.59%	8.22%	16.15%	20.30%	32.71%
Mill 2	4.50%	25.96%	4.18%	13.17%	17.48%	16.23%	8.27%	40.73%
Mill 3	5.04%	7.31%	14.5%	28.75%	9.15%	12.4%	15.25%	12.64%

Short Fibre is equated to 48 and 200 mesh on the Bauer Mc Nett

Residual is made up of the fines and fillers for the furnish \

We see levels as high as 14.5% of contaminant in furnishes (Mill 3) loosely calls EOCC, being placed onto the conveyor and fed to the Pulper at the beginning of the process. This gives an extremely concentrated and contaminated operation for the Pulper with levels of contaminant concentration seen to affect both throughput and consistency of operation for the Pulper.

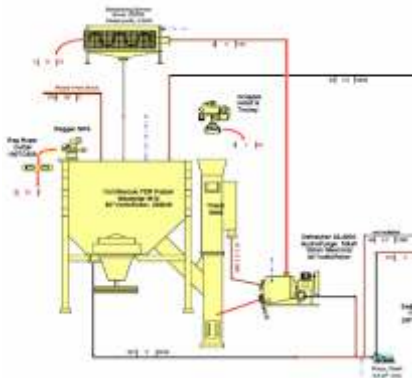
In the case of fines and fillers, we see very high values, which represent remarkable figures as high as 40% ash and filler, however this does not prevent the Pulper operating and in fact allows for higher consistencies to be used but can have an adverse affect on the final Board Production.

The fillers, in particular help the stock circulate in the Pulper with improved slippage or sliding inside the Pulper itself, which allows the fibres and contaminant to turn at higher consistencies. The problem with this type of material is the effect on the water system and on the strength of the final product as excessive levels can reduce the final Board strength.

Review per stock preparation main module

Pulping module

The Pulper Loop relies on contaminant removal by the Ragger, Trashwell,



Pulper Cleaning unit and Reject Drum. The high contaminant level has to be taken into consideration when designing the Pulping Loop for the Pulper. The size of take-off from the Pulper to the Pulper Cleaning unit needs to be large in area otherwise with higher consistencies and more contaminant in the furnish blockages will occur and that can make the Pulper become totally contaminated in a very short period of time.

The advantage of a large take off in the Pulper to the Junk Trap or Trashwell area can ensure that blockages in the feed to the Pulper Cleaning Unit are prevented and the efficiency of the cleaning unit is maintained at its maximum.

The use of smaller holes in the Pulper and Pulper Cleaning unit, has brought definite advantage to the treatment of European recycled fibre by improving contaminant removal and reducing the level of undefibred material passing forward to the screening stages. Lack of fibre length in the incoming furnish has made it essential that all possible good fibre (especially in the form of fibre flakes) are recovered and passed forward in the System.

The better the level of defibering, the lower the fibre and flake losses will be as well as a resultant higher paper strength due to recovery of longer fibres.

High ash contents have meant that the Pulping Consistency can be raised in the order of between 1 - 2%, resulting in operating values of up to 6 or even 7% in the Pulper, without increasing the required Pulping Power.

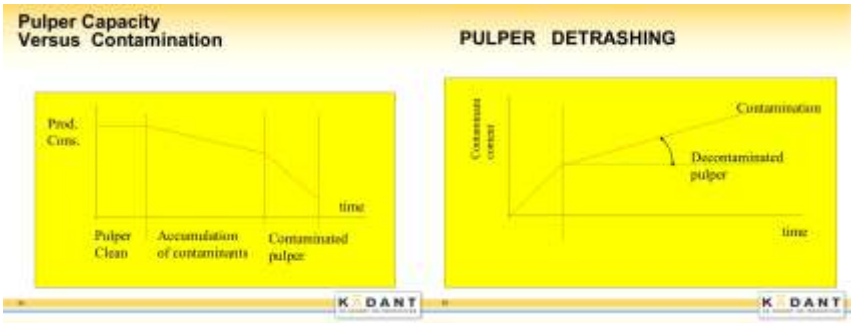
The ash helps considerably the action in the Pulper by means of slippage, so that we have the same level of submergence but at higher consistency. This allows

PULPER RETENTION TIME	Cons	TUB SIZE	Capacity	Consumed Specific Energy	Installed Power	Hole Velocity	Pulper
4 MINUTES	4%	57 m3	700 MT/Day	15 kWhrs/T	600 KW	0.5 m/sec	Low Cons Pulper
4 MINUTES	6% - 7%	40 m3	700 MT/Day	13 kWhrs/T	450 KW	0.4 m/sec	Higher Pulping Cons

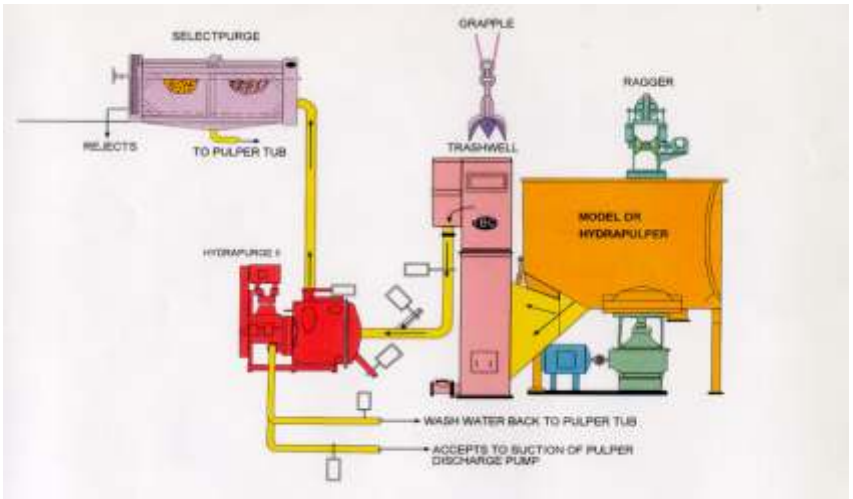
the same Pulper Capacity to be used for higher throughputs provided sufficient open area is available in the Perforated Bedplate.

The Pulper cleaning loop is crucial. All cleaning units installed around the pulper should be properly designed to handle the raw material contamination trends. A pulper that is not well cleaned is not capable of doing the capacity or it will operate with a very low consistency accept

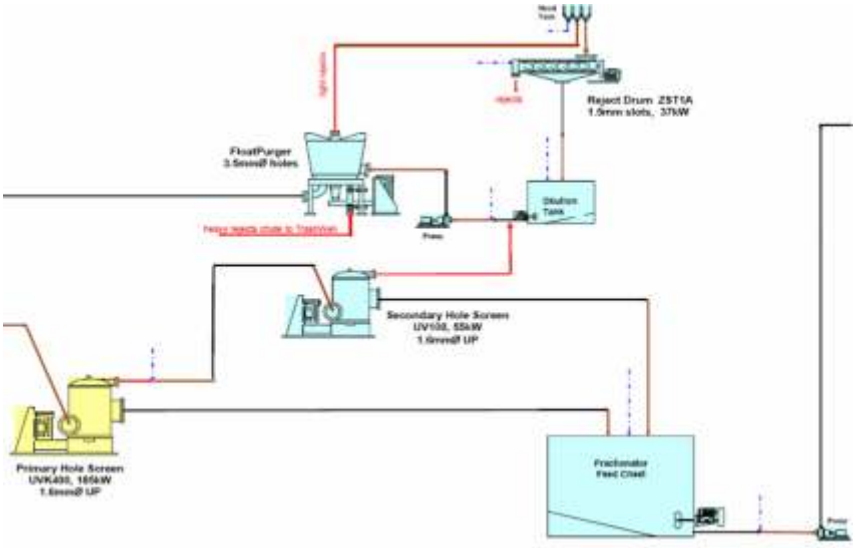
The Pulper Cleaning units, for example, need to be capable of handling both high consistency (to maintain the flow from the Pulper, low consistency means far higher passing velocities in order to maintain the same quantity from the Pulper) and also having a large capacity tank size in the range of 3 - 5 cu meters in order to accept large rates of contaminant without blocking the Bedplate.



COARSE SCREENING MODULE



In line with the raw material contaminant level increase, the Coarse Screening system should be designed to handle more contaminant than previously envisaged.



Objective of this module is

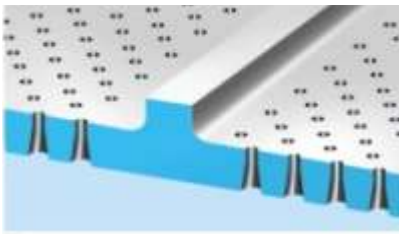
- to clean the stock of all coarse contaminants such as plastics, polystyrene ….
- to deflake the remaining flake going through the pulper bedplate.

Some years ago and even today in a lot of paper mills having OCC stock preparation, you will find in the coarse screening system, aggressive deflaking machine or so called disc screens with large holes of between 2.4mm up to 4mm. These machines are installed even in the first stage, and sometimes you find also deflakers on the reject. Despite the fact, this kind of process is very expensive in maintenance and in energy costs; all contaminants are broken down into small pieces and are then more difficult to remove at the subsequent stages of screening.

Trends have been to reduce hole size of the screens down to 1.6mm, and to have very soft actions with only the last stage of coarse screen reject machine seriously deflaking the stock without cutting the contaminants.

As a matter of fact, power consumption can be also minimised by selective, screen design with baskets and rotors allowing a significant reduction in power usage, and small holes or large slots. Micro-vortex baskets have lower power consumption than the disc screen design.

A typical example of basket design is



	T/D	% Flake	T/D Flake
Feed	573	21.64	124.0
Accept	489	4.61	22.1
Reject	93	18.8	17.5

shown in the picture above; there is a light or small deflaking action that can be seen from the specially designed rotor and basket to achieve some separation of the fibres without breaking of the contaminant.

Critical final separation of the Fiber is then made by the defibring of both wet strength and undefibred flakes by the reject unit. At this point the fibre, fibre flakes and contaminant are extremely concentrated and this allows the specific power to work on the flakes and contaminants without wasting power on fibres that have already been separated by the Pulper and deflaking effect in the Primary and Secondary Screens.

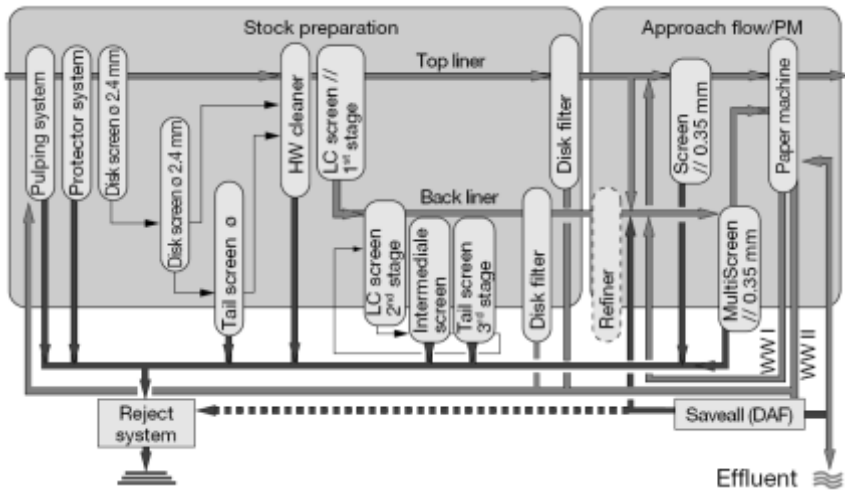
Extent of defibring and good contaminant separation is dependent on the design of the reject unit. By the use of a Floatpurger with its internal vortex design, lightweight contaminants such as polystyrene or small piece of plastics, even smaller than the hole size, are efficiently removed in the centre of the unit, without having been adversely damaged.

Concentration of the contaminant and undefibred flakes in the reject stream ensures that the power used is applied to the recovering of the necessary fibres and this results in rejection of the contaminant with no fibre loss.

Applying all above feature, energy consumption can be highly reduced in pulping and coarse screening systems, while quality is improved. The following table is summarizing this trend;

The deflaking can be carried out between the rotor and bedplate to ensure recovery of not only undefaked fibres but even mildly wet strengthened fibres.

TECHNOLOGIES COMPARISON PULPING COARSE SCREENING PACKAGING BOARDS EOCC LINE	Conventional technology Competition	Conventional technology KL	Advanced technology Vorto Maximizer	Advanced technology Vorto Maximizer
Hole size in the bed plate in mm	16	12	10	8
Hole size in coarse screening in mm	2.4	1.8	1.6/1.8	1.6
Specific capacity/pulper volume in T/Day produced/m3 pulper volume	10	10 to 11	12 to 14	10 to 11
Absorbed power of the pulper in KW.h/BDT	14 to 18	11 to 14	11 to 14	13 to 15
Absorbed power of the pulper cleaning in kw.h/BDT	4.5 to 5	4.5 to 5	4.5 to 5	4.5 to 5
Absorbed power of the coarse screening in KW.h/BDT	19 to 22	12 to 13	10 to 12	9 to 12
Total energy saving compare to conventional in Kw.h/BDT	0	8 to 10	10 to 12	10 to 12
Undefibered flakes after the pulper in %	12 to 13	6 to 9	5 to 7	3 to 5
Fibre and flakes losses savings compare to conventional	0	15 to 25% less	25 to 35% less	35 to 50% less



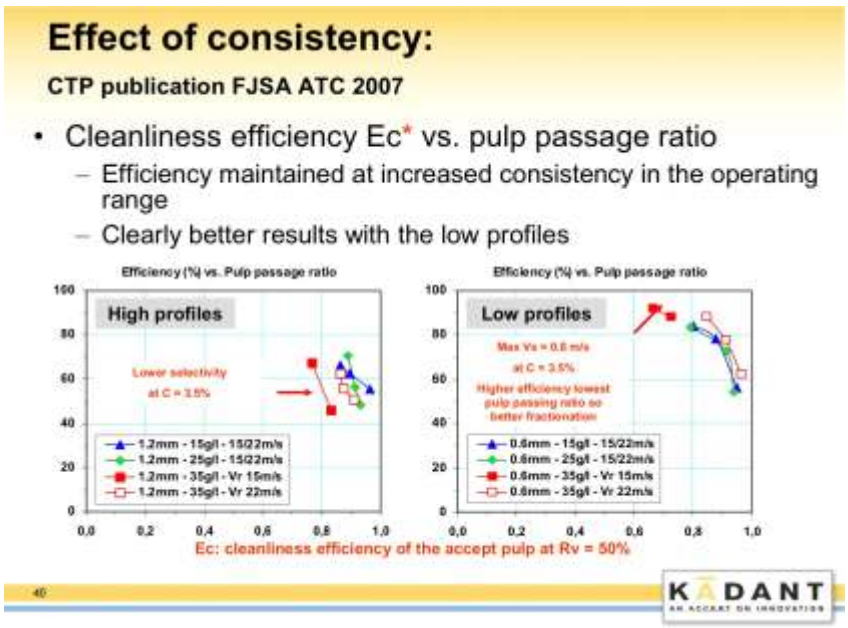
FINE SCREENING FRACTIONATION CLEANING MODULE

Some years ago, cleaning and fine screening were only done in paper machine approach flow and very often all of the Stock was refined. Stock preparation lines were only designed with the pulping and coarse screening module.

As the fine elements and short fibre content in the furnish increased, it became ideal to fractionate the stock and to only refine the long fibre fraction. At this stage the fractionators were mainly fractionators with small holes, very often 1.2mm, and only the long fraction was refined.

As raw material contamination increased, with a lot more stickies, hot melts, and also as the paper machine speeds were increasing, there was need of a better method of fine screening and cleaning.

Trends were to develop fractionation with very fine slots 0.2 or 0.15mm. The



Principle was not only to separate long and short fibres but also separate clean and contaminated stock. Fractionation, at that time, was mainly done at medium consistency.

Due to the fact that there was some medium consistency fractionator operational issues, some suppliers have adapted the way of operating some fractionation systems, that has resulted in a more dilute phase at the fractionator, and has been accompanied by the installation of cleaners before fractionation as shown in the block diagram.(on last page)

At the same time, there are needs to simplify stock preparation designs and to have more compact system.

Fractionation at medium consistency: A technical challenge resulting in more compact line designs

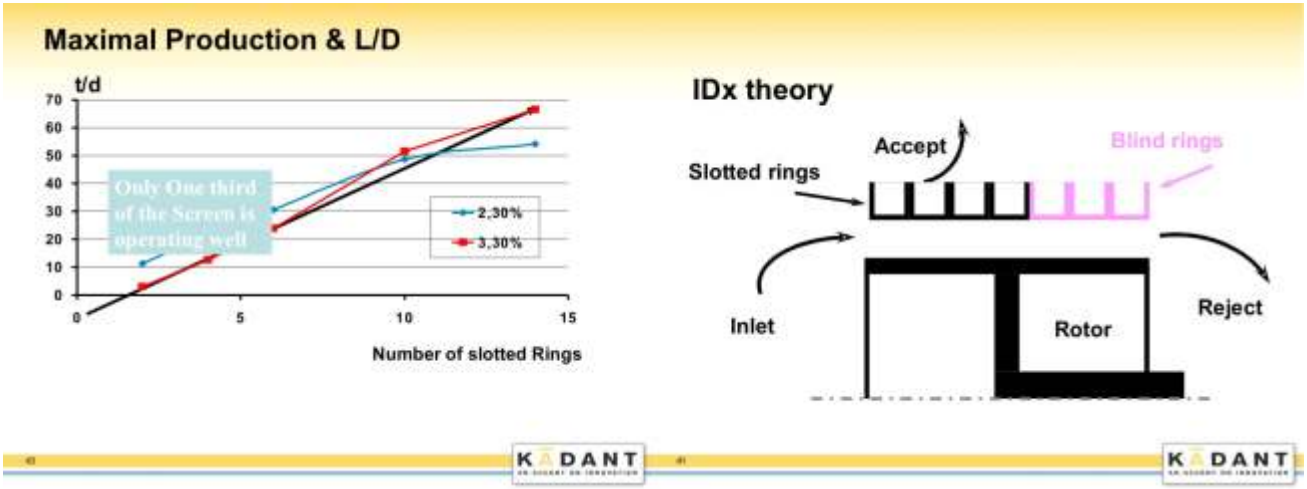
The first challenge is to be able to fractionate at a consistency high enough to simplify the thickening stages after the fractionators.

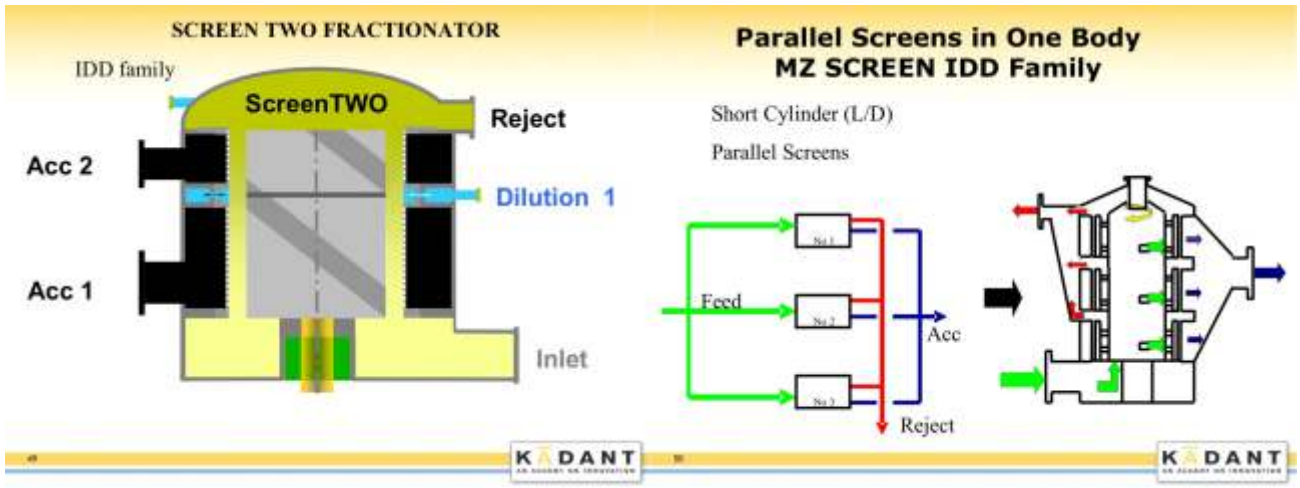
The second challenge is to do it, with safe runnability and with no plugging issues.

The third challenge is to have low wearing effect.

The fourth challenge is to have very high efficiency and good selectivity.

When looking at the research jobs done





on fractionation, it seems better to operate screens at higher consistency to have the best fractionation efficiency and selectivity. Ctp studied this issue and reported the following results in the ATC symposium in 2007.
All the above challenges show needs of Innovations.

Kadant through all his ID family screen development has studied this issue. First issues noticed were the fact that along a basket, consistency was increasing, thickening factor of the rejects was higher and capacity was lower. Trials have been performed in Kadant research center to demonstrate this effect.
Based on the above notice, innovations brought to the market were

- To split the infeed flow in part, through the ID concept, putting the screen basket element in series. They are the ScreenTwo, ScreenOne and FiberNet products

- To split the infeed flow in parallel, they are the Multi Zone Screen MZ Screens.

As an example, MZ screens have been able to match all above challenges

- High accept consistency 3 to 3.5%
- High efficiency with good fractionation effects
- Low wearing impact due to very low passing speeds and split of the infeed flow.

Toward compact stock preparation designs

Based on the above possibilities of fractionation at medium consistency and thanks to the development in pulping and coarse screening, Kadant installed in Asia and Europe the following compact lines to produce stock for test liner and fluting

Conclusion

Packaging market has to face several challenges

- Decrease of Raw material quality,
- Lower weight in test liner and fluting grades,
- Higher speed on paper machines,
- Stock preparation line with capacity of up to 2000TPD.

Improvement in pulping technologies, coarse screening, fractionation, and cleaning give us today the possibility to design more compact and more economic systems.

One of the next challenges will be to better work on water circuits and paper machine runnabilty improvements, implementing flotation technology in stock preparation for packaging grade, and specific filtration devices allowing us to go to zero effluent. Kadant R&D is working on it and will be pleased to communicate on this issue in the following years.