Cost Reduction Through High Efficiency Centrifugal Cleaning

STOLLEN LINDQVIET

INTRODUCTION

Cost reductions in the Pulp and Paper Industry are of course a big task for everyone involved in the pıoduction. It can, however, be made in many ways. Tnebig challenge is to manage without having to sacrifice other goals such as good quality, a clean environment and a reasonable profit level.

Some examples of fields that can be tackled are :

- Investment
- Energy
- Efficiency
- Runability
- Fibre losses
- Quality of end product
- Reclamations
- Process control
- Design

In the following we will show that with a well designed modern *centricleaner* plant it is possible to achieve :

- Energy savings
- Higher efficiency
- Good runability
- Less fibre losses
- Higher quality of the end product
- Lower reclamation costs
- Better process control

at reasonable investment costs.

The flow sheet (figure 1) shows the modern solution of removing trash as well as heavy and light weight contaminants in a waste paper stock preparation plant. The cleaning is done in three steps :

Step 1 *Trash extraction*, for removing oversized impurities from the stock before centricleaning

Step 2 *Heavy weight cleaning*, for removing heavy particles followed by a *fibre recovery* unit.

Step 3 *Light weight cleaning*, with parallel flow centricleaners, for removing low density contaminants.

The high cleaning efficiency is achieved through treatment of tne different impurities in stages one by one. A reverse or combined cleaner for removing both light and heavy weight contaminants may reach good values but will always be a compromise.

LIGHT WEIGHT CLEANING with CLEANPAC 250 LWR HUNTER, Centricleaner

One of the big problems within the Pulp and Paper Industry today is the increasing presence of light weight contaminants in the pulp, such as plastics, stickies, waxes and hot melts.

In the term "stickies and hot melts" we also include pressure sensitives and hot melt pressure sensitives, sometimes also called "floaters and swimmers".

All these contaminants occur mainly in waste paper and deinked stock systems. They have different characteristics compared to traditional heavy-weight impurities likes sand, bark etc, and are thus impossible to remove from the process by traditional cleaning equipment.

If not removed from the pulp, these light weight contaminants will cause a decrease in product quality followed, maybe, by claims as well as costly damage to equipment like fabric, felts, drying cylinders etc.

Modified traditional cleaners have been trioed in order to find a solution to the problem. None, however, have proved sufficiently effective.

Conference in MADRAS, April 7 - 8, 1988.

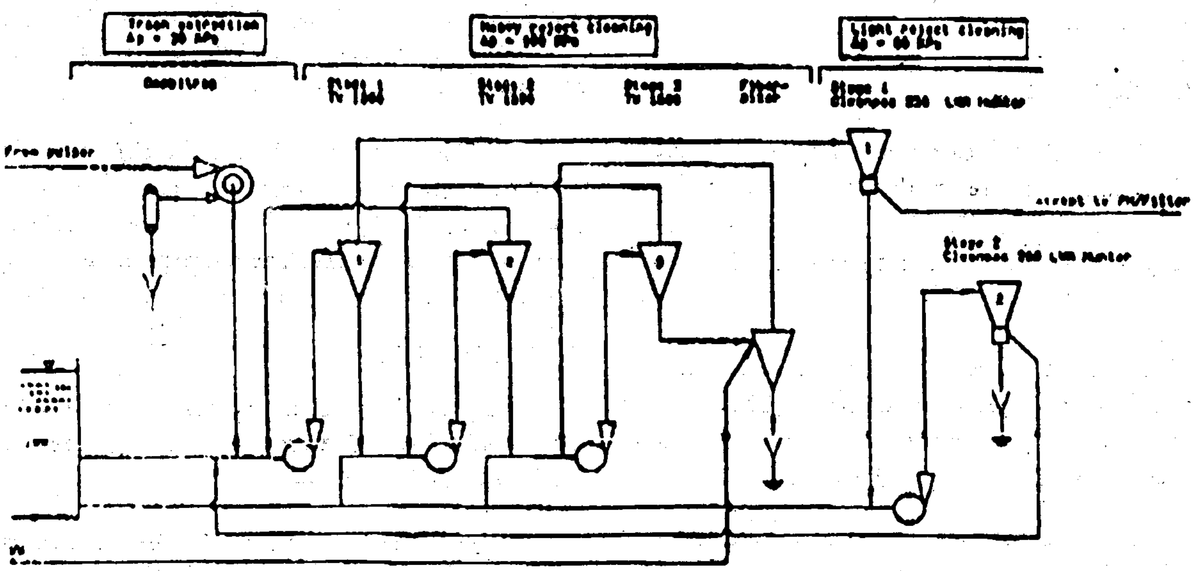
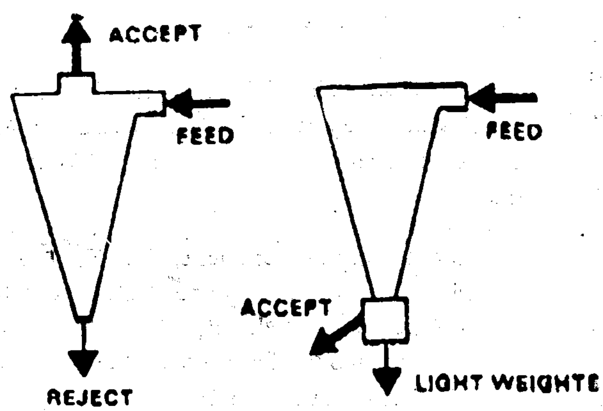
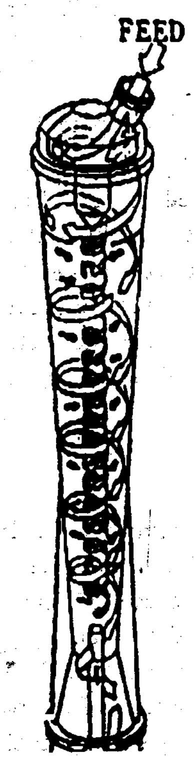


Fig. 1—Combination centrifugal cleaner system for removal of trash, heavy and light weight rejects.



Principle of conventional and parallel-flow hydrocyclone



CLP 250 LWR I· ·ER

Fig. 2.

A new approach based on the parallel flow centrifugal cleaner concept, has been developed from a patent by Bruce Hunter (see fig. 2)

WORKING PRINCIPLE

The accept and reject streams are transported in the same direction, and they are both discharged in the apex of the conical bottom This is opposite to conventional hydrocyclone where the accept stream is discharged in the upper part.

The feed stock enters the hydrocyclone through a distributor and forms a downward spiral. The accepted stock, forced to the periphery of the cone, is removed in the periphery of the accepts chamber.

The light-weight contaminants, forced to the core, are extracted axially from the center. The area of separation is formed like a diffusor and the extraction pipe is positioned in the center. This configuration secures efficient separation between accepts and rejects.

The unit body is made of polyeurethane and moulded in one piece. The heads for feed and outlets are made of stainless steel AISI 316.

Early in our development work we found that the new parallel flow principle was superior to the reverse flow principle used earlier. In order to achieve good separation of light weight contaminants we found that the establishment of stable flow patterns inside the hydrocyclone was most critical. Certain arrangements were therefore made in the cyclone inlet head to guarantee a stable inlet flow and as a consequence an extremely stable flow stable flow pattern inside the whole hydrocyclone was obtained.

The new commercial hydrocyclone unit named Cleanpac 250 DWR Hunter has been given an inlet head diameter of 5 inches (125 mm in order to enable us to use inlet and outlet openings with sufficiently large surface areas. The length of the unit was chosen to give sufficient residence time of the particles inside the unit and also to give a perfectly stable air core throughout the unit. The design of the accept chamber is made in such a way that the flow through the accept outlet does not interfere with the point of the reject flow seperation. Thus the stable flow pattern is maintained in the accept chamber. The inner diameter of the light weight reject tube is chosen so that the air core is completely captured by the tube.

The flow capacity of the commercial unit is between 225–260 l/min at an operating pressure drop range of 80–120 kPa. Under these conditiona the reject is between 8–10% by volume The corresponding fiber reject rate is dependent on the freeness level of the pulp.

TEST RESULTS

Our promising laboratory tests have been followed up by mill trials. The results from these are shown in the following figures 3—8.

Figure 3. laboratory test) To the bleached sulphate pulp was added polyprolylene plastics, cut into pieces from 1—3 mm in length and 0 5—1 mm in width. The density of the plastics are 0.88—0.93 g/cm². This efficiency was determined as the difference between feed and accept in counts of pieces of plastics per 100 g of pulp.

The test pointed to an optimum operating range within 80—120 kPa pressure drop where over 95% of the plastics are removed.

Figure 4. (mill trial) Here the plastic was prepaied in the same way as if it had passed through a continuous digester in a pulp mill. Three types were tested.

low density polyethylene, LDPE, (0.91—093g/cm²)
high density polyethylene, HDPE, (0 94–0.97g/cm³)
and polypropylene, PP, (0 88—0.93g/cm³)
The average surface area was 0 5 mm² and the thickness about 0 2 mm.

It can be seen that the removal efficiency for both LPDE and PP averaged about 90% but for HDPE around 80%. This lower value is due to the higher apecific weight of the HDPE The reject rate by weight was 0.5%

Figure 5. (laboratory test) The polypropylene plastics were added to a groundwood pulp in cut sizes of 1—3 mm in length and a width of 0.5 – 1 mm.

The removal efficiency is around 90% for all pressure drops tested. The fiber reject rate by weight is here about 5%. This higher value is due to a bigger amount of fine fiber materials in mechanical pulp.

Figure 6 (mill trial) This corrugated box board waste (OCC) contains a lot of stickies and hot malts.

The removal efficiency reaches around 90% with the reject rate by volume of about 9%.

These tests confirmed that the very good light-weight separation earlier achieved on chemical pulp fiber could also be obtained on other types of pulp and that the action of separation on light weight

Bleached sulphate/Polypropylene plastics

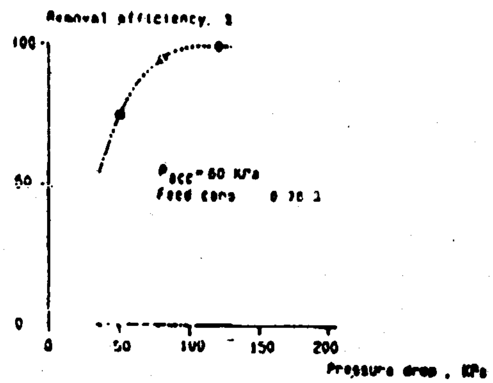


Fig 3

Bleached sulphate/LDPE, HOPE, PP

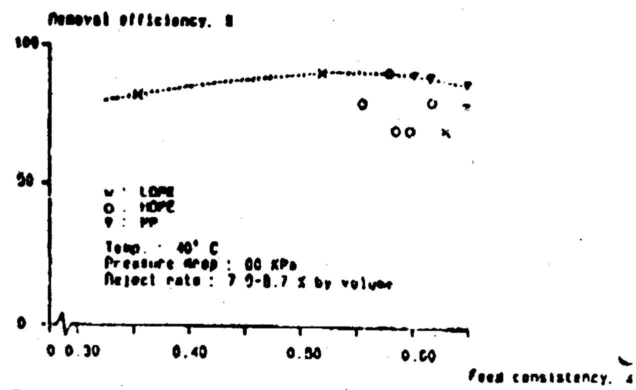


Fig 4

Ground wood, 70 ml CSF/Polypropylene plastics

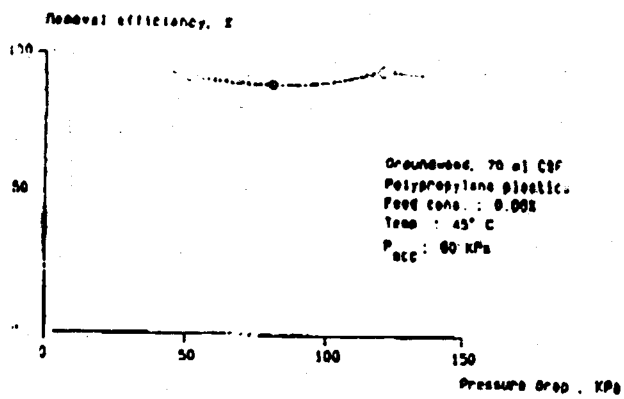


Fig 5

Corrugated box board waste (OCC)

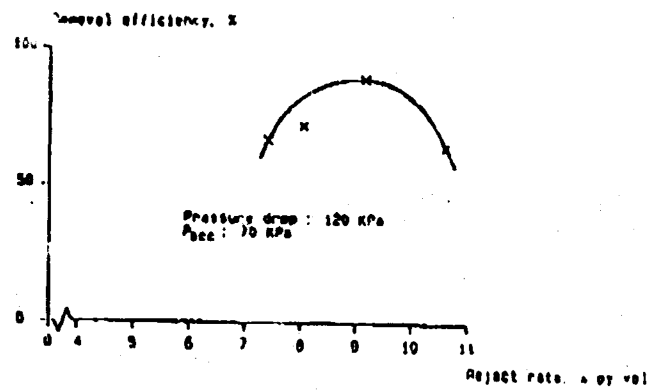


Fig 6

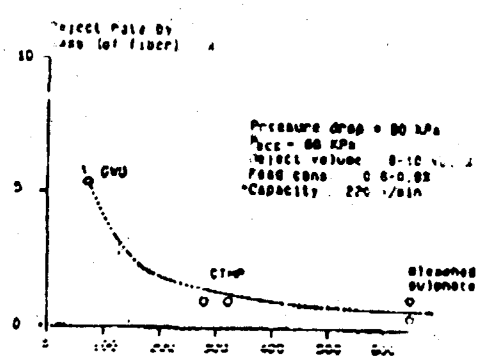


Fig. 7

Pulp mixture: CTMP 75% / Unbl. sulphite 25%

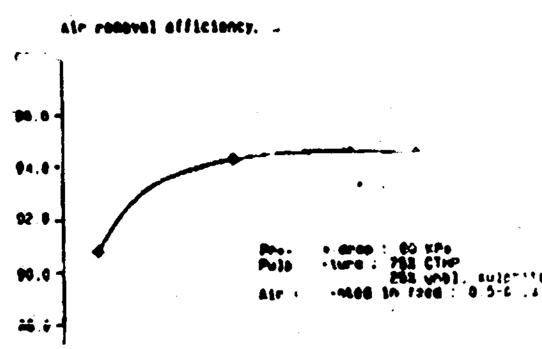


Fig. 8

contaminants is not much dependent on the freeness level or the pulp quality as such.

Figure 7. (mill trial) This curve demonstrates clearly the dependence of the fiber reject rate by weight on the pulp freeness level. So, for a pulp in the freeness range of 250 – 3:0 ml CSF, such as recycled bleached sorted.

Also the low reject rate by volume, 8—10%, means that the second and third stage in a cascade-coupled system can be sized very small, making the installation very economical.

Figure 8. The inherent design features of the Cleanpac 250 LWR Hunter also points out the possibility of using this unit for the removal of air in the pulp. Laboratory tests show 94–95% air removal at reject rates between 9.5 – 12% by volume.

These promising laboratory results on air removal were later repeated on a full scale paper machine installation at Zanders Feinpapier AC in Germany. This installation consists of a 3-Stage Cleanpac 250 LWR Hunter cleaner plant running in series with a normal heavy phase cleaner system. In this case the air content in the pulp feed was between 1.6–1 8%. The air content in the white water was 1.2–1.4%. At a reject rate by volume of about 10% and a pressure drop of 80 kPa, the air content in the accept was reduced to only 0.07% This gives a removal efficiency of 96% on free and loosely bonded air in the pulp.

SUMMARY.

- With the development of the new CLEANPAC 250 LWR HUNTER design of parallel flow centrifugal cleaners, we have found an efficient tool for removing light-weight contaminants from pulp.
- Critical design characteristics are stable flow patterns, residence time and stable air core.
- The optimum pressure drop is 80 kPa.
- The removal efficiency ranges between 80 and 95% at a pressure drop of 80 kPa depending on the specific weight of plastic tested.
- Type of pulp does not affect the high removal efficiency.
- CLEANPAC 250 LWR HUNTER is also a very good piece of equipment for the removal of free and loosely bonded air in pulp stock systems.

HEAVY WEIGHT CLEANING WITH TW 1500 CENTRICLEANER.

As mentioned earlier the best total cleaning result is achieved by removing the different kinds of impurities step by step. Heavy contaminants are best taken care of before the light weight ones The latest development of centricleaners for this purpose is the TW 1500 cleaner. It is suitable for applications like

- Ahead of paper machines.
- Waste paper lines.
- Annual fibers like bagasse, straw pulp etc.
- Unbleached kraft and mechanical pulps.

The most significant advantages are :

- Low pressure drop.
- High cleaning efficiency.
- Safe runability.
- Low sensitivity to flow variations.
- High feed consistencies possible.

DESIGN.

The design and flow patterns are shown in fig 9.

The cleaner head and lower cone are equipped with spiral grooves designed to optimize the hydraulic flow patterns for maximum efficiency. The lower cone is also equipped with callence patented wanes which cantrol the reject rate and thickening factor.

The head is integrated with pressed–on stainless steel stocking covered hoses, protecting the construction from vibration or stress. The covered hoses on the connection side have pressed–on aluminium flanges integrated with the stockings. This makes local manufacture of headers and structures much easier.

The outer shell protects the ceramic lower cone from damage.

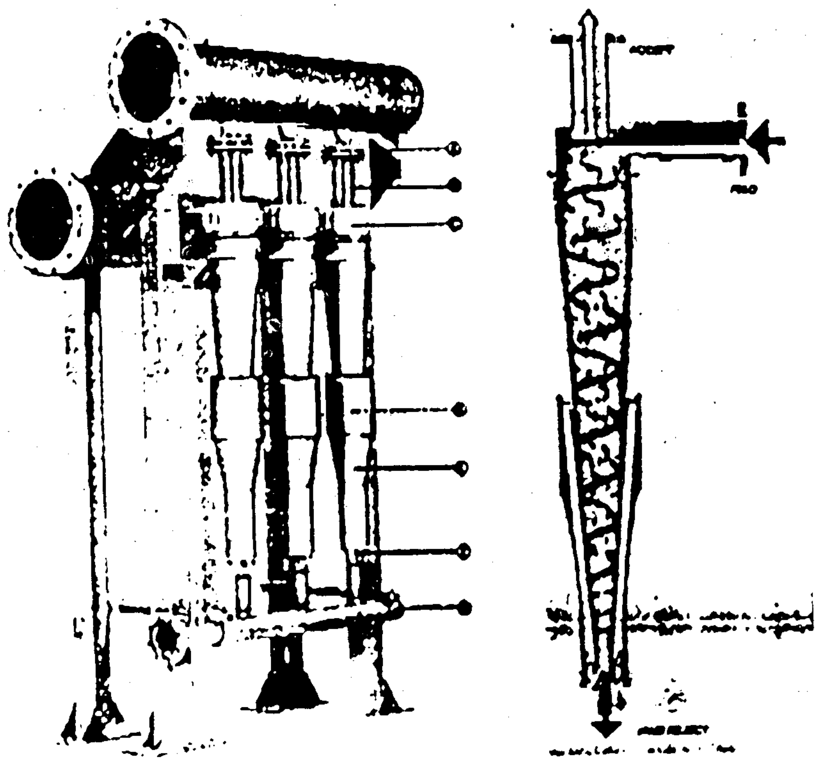


Fig 9 TW 1500 Centricleaner

The cleaner body and outer shell are made of stainless steel with a ceramic lower cone, offering a long wear life in highly contaminated systems.

The specially designed C-chamber for the reject features large opening at low rejecting rates. Replacement is also very easily made.

TEST RESULTS.

The TW 1500 cleaner has been tested against the two other Celleco cleaners, the Clp 350 and the TW 2000 Some results are summarized in the following figures 10–13.

The sizes are :

Clp 350 = 125 mm dia.
TW 1500 = 200 mm dia.
TW 2000 = 250 mm dia.

Figure 10 and 11—The curves show a higher removal efficiency for the TW 1500 cleaner at the pressure drop of 150 kPa than for the bigger TW 2000 at 200 kPa. At the pressure drop of 120 kPa for the TW 1500 the efficiencies are more equal.

Figure 12—The cleaning efficiencies for TW 1500 is, compared to the smaller Clp 350, slightly lower for all pressure drops tested which was expected.

Figure 13—The thickening factor for the TW 1500 is here lower than for the Clp 350. This minimizes the risk of plugging. Furthermore the TW 1500 can run at a much lower volumetric reject rate than the 350 cleaner, 4—8%, instead of 6—10%. This will reduce the number of units in the fiber recovery stages.

Further tests with feed consistencies up to 1 2% and volumetric reject rates as low as 0.8% could not plug the TW 1500 cleaner unit. Ash contents in the reject of about 34% were then measured.

SUMMARY

In stock preparation plants where raw materials of varying qualities are used, such as waste paper or hard

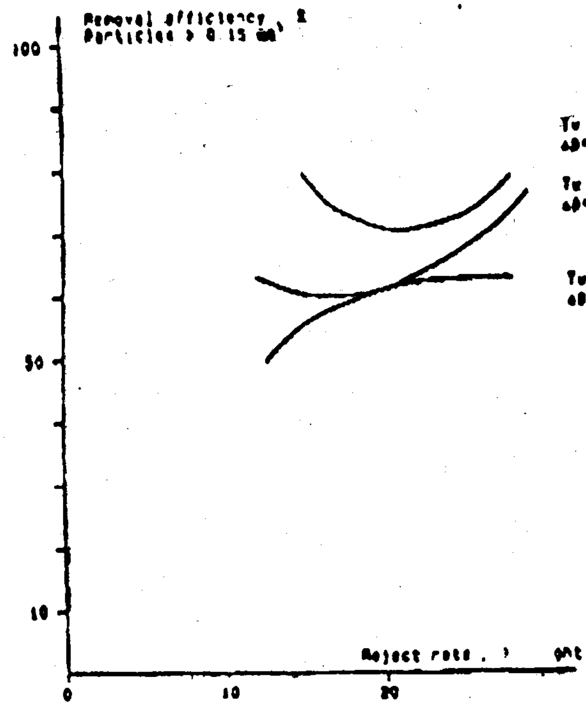


Fig 10 Removal efficiency versus

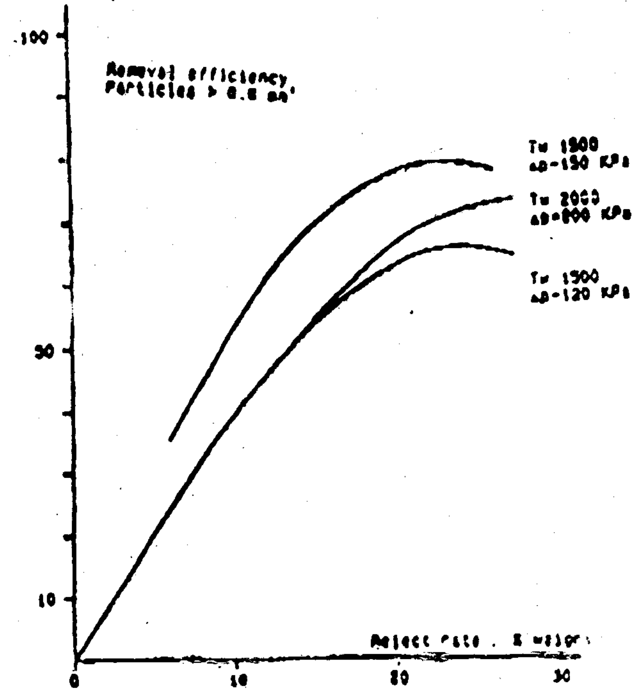


Fig 11 Removal efficiency versus

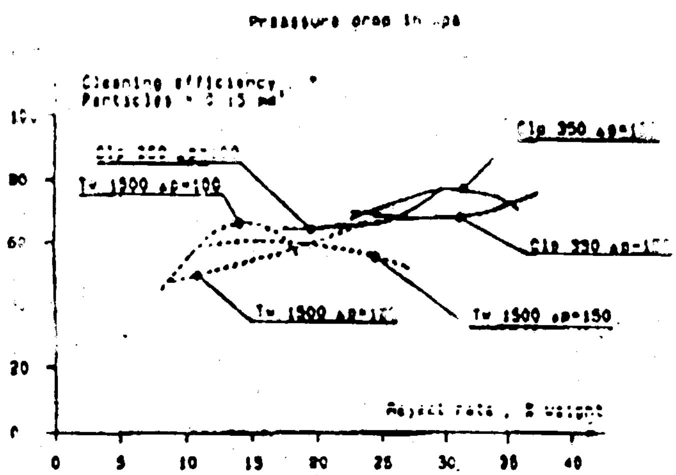


Fig. 12—Cleaning efficiency versus reject particles > 0.15 m²

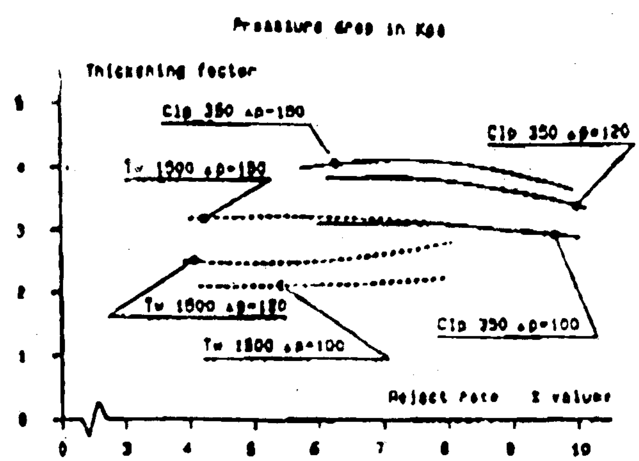


Fig. 13—Thickening factor versus reject rate

treated virgin fibers like annual fibers, the usage of insensitive equipment is of the utmost importance. The new TW 1500 centricleaner combines :

— low pressure drop, 100—150 kPa
— with maintained high removal efficiencies, 80-90%
— and a reliable opration
— for a wide range of tough applications

FIBER RECOVERY WITH FIBERMIZER

In a conventional cyclone plant for fiber suspensions the last stage is normally equipped with elutriation chambers, which results in a fiber loss of 0.2-0.5%. Lower fiber losses have been difficult to achieve, because of the sensitivity and lack of reliability of this type of equipment.

A new kind of eqiupment has been developed which makes it possible to decrease the final reject loss considerably.

WORKING PRINCIPLE :

The rejects rtream from the final stage of the centricleaners for heavy weight removal is fed to the Fibermizer. White water is used for dilution and acceleration of there reject feed.

The inlet zone of the Fibermizer cyclones is so designed that an ejector effect is created, wich helps to suck in the reject from the preceding stage. This eliminates the need of a pump.

The accept flows are returned to the process flow.

The principle with dilution in the feed zone contrary to dilution in the reject zone results in insensitivity and high reliability. Furthermore large cross areas can be used.

In spite of large areas a small final reject flow of about 25 l/min is achieved.

If, for example a 4-stage plant is supplied with a Fibermizer, it is normally posaible to come down to a fiber loss of 0 05—0.15%, based on the accept from the first stage.

If an existing cleaner plant is completed with a Fibermizer, the loss of good fibers can normally be reduced by 85% which has meant that the pay-off time for thr equipment has often not been more than a few months. A filler loss reduction of around 70% may also be achieved depending on the type and size of fillers used.

The Fibermizer is built up in one or two stages owing to the reject feed conditions. See figure 15.

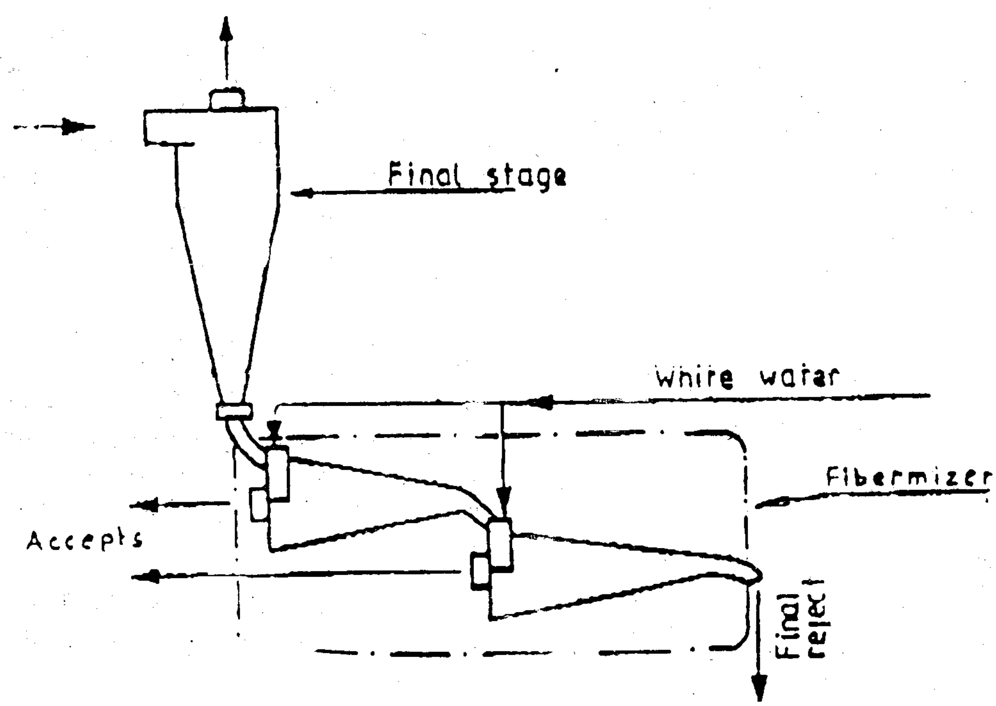
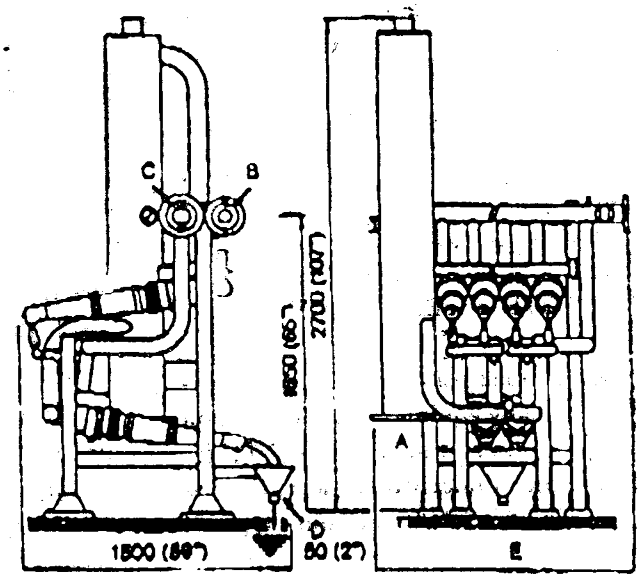


Fig. 14 Working principle of the Fibermizer

Fig 15
2-stage Fibermizer
type 4/2



§ Dimensions in mm (inches) Accept connection A Feed connection B Acceleration water connection C Reject connection D

SUMMARY

The Fibermizer is a very reliable way reducing costs through fiber recovery. It supercedes dilution chambers It also works with a minimum of maintenance without the requirement of extra pump capacity.

TRASH EXTRACTION WITH COMBITRAP.

Impurities too big and heavy to be handled by a centricleaner plant have to be removed earlier, by means of other equipment. In fact, whenever there is a requirement to remove coversized material from pulp stock or water the Combitrap may be the answer.

Suitable applications are :

- Aftar broke chests.
- Ahead of centricleaners.
- Ahead of deflakers of refiners.
- Equipment protection in waste paper lines.
- As a high – consistency cleaner in stock preparation.
- Trap after blow tanks.

CONSTRUCTION.

The Combitrap consists of a casing (A) with a tangential inlet (B), rejects and trash outlet (C) and a rotor (D) with multi–grid screen elements with an outlet at the end (E). The fiberglass reinforced grid elements from a rotor basket. The inside of the basket is smooth to avoid deposits and spinning from textiles.

The grid elements have eyelid–shaped slots and can withstand chemicals and boiling temperature.

Each one of the grid elements can easily be exchanged separately, if damaged. The entire rotor can be pulled out for service of scal and grid basket. There is no need to disconnect the supply and discharge pipes. The seal is an advanced and balanced mechanical type that can withstand 400 kPa over pressure. It has a carbon ring against Si–carbide ring seal surface with low–pressure seal water.

WORKING PRINCIPLE.

The Combitrap works as a combination of a large hydrocyclone and a multi–grid sieve. It has a very large open screen area compared to the drum dimensions, enabling high capacity at low differential pressure.

The feed stock is brought into rotation by the tangential inlet. All heavy contaminants are immedi-

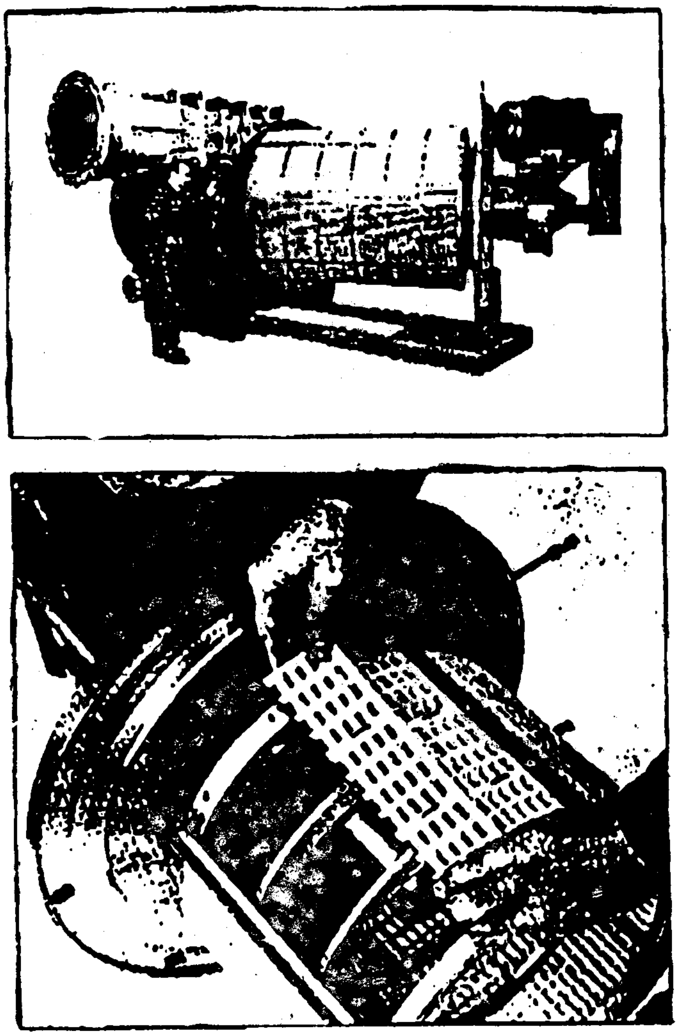
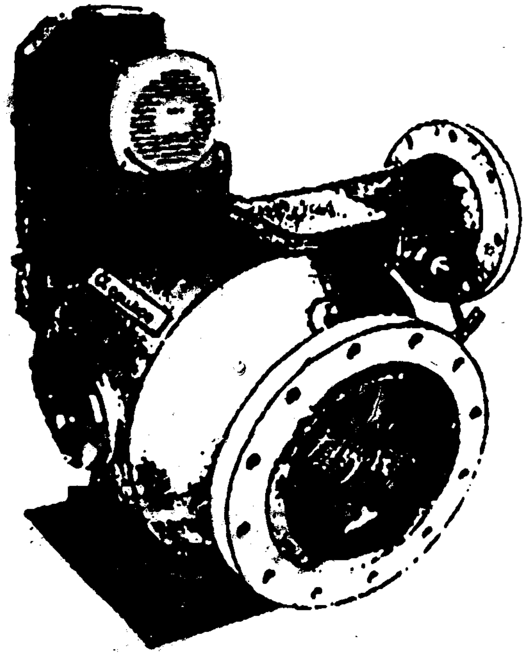
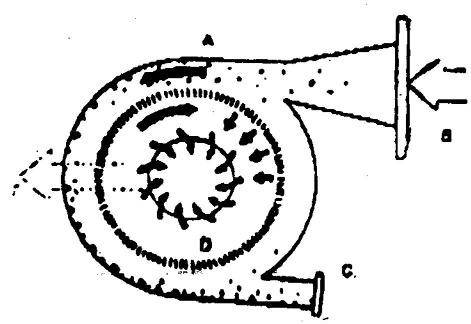


Fig 16 Combitrap construction





ately pushed to-wards the outer periphery of the casing by the centrifugal force and are discharged at the bottom outlet. The scrap-free stock is pressed inwards against the multigrid basket.

A new cleaning step occurs when the stock passes through the slots of the grid elements. Oversized contaminants of low specific weight, which cannot pass through the rotor gril elements, will be discharged with the heavy contaminants in the bottom.

The basket rotates counterflowwise, which gives a high relative velocity between the stock and the eyelid-shaped slots.

The high relative velocity and the stream pattern adised the slots ensure open slots up to 5% consistency.

The power requirement is low since the periphery speed can be maintained at a modest level due to the counter-flowwise stream pattern.

TYPICAL INSTALLATIONS.

Above figures show two typical installations for waste paper line.

In figure 18 a damping cyclone is used to minimize the reject rate. The discontinuous reject discharge

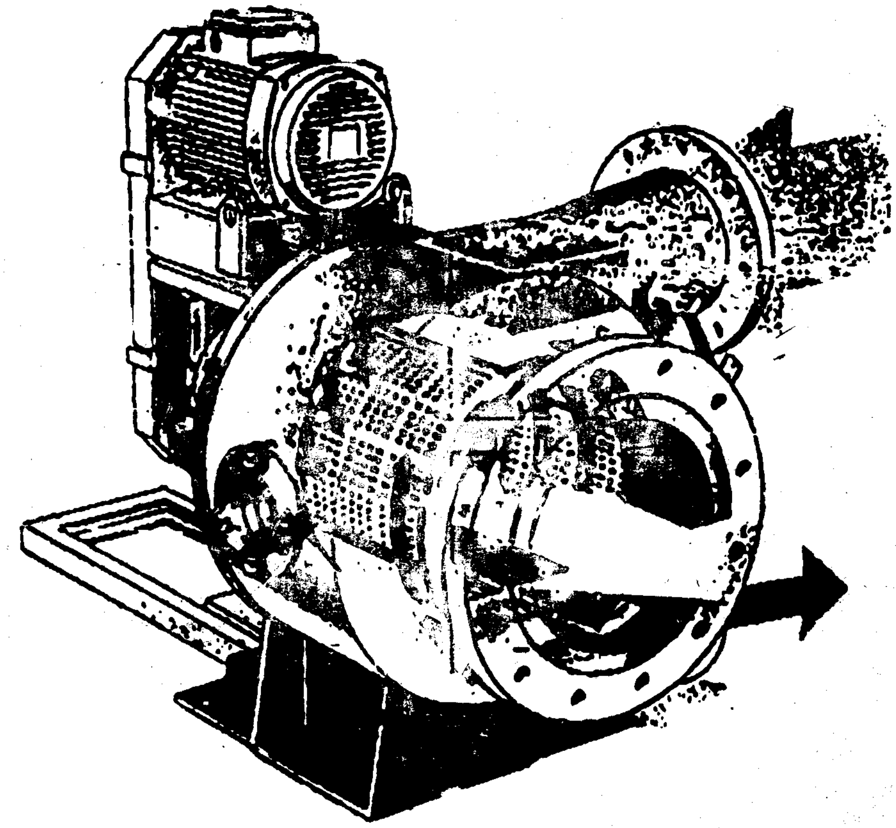


Fig 17 Combitrap, working sirciple

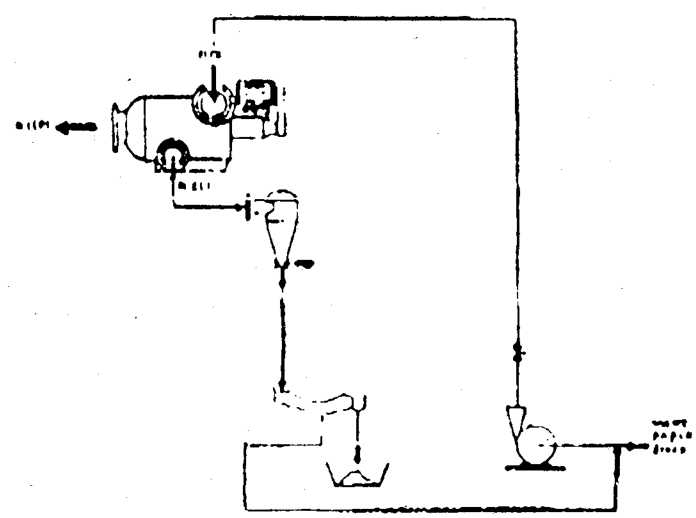


Fig. 18 Combierap with a data eyclone and vibra screen

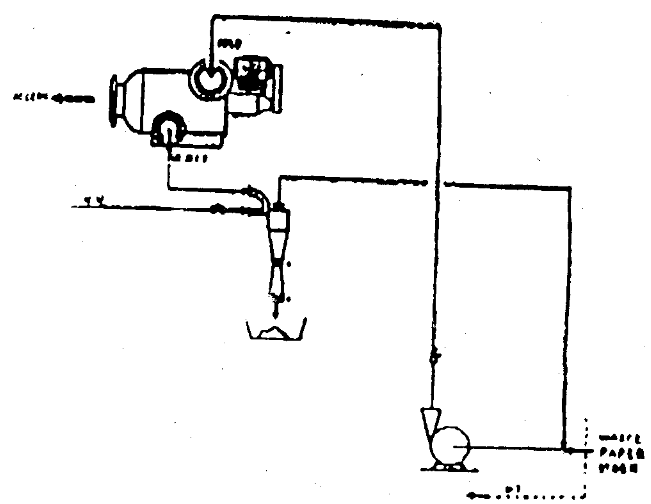


Fig. 19 Combicrap with reject eyclone.

passes over a vibrating screen. Screened back water is led back to the feed while the solid scrap is dumped.

In figure 19 the damping cyclone and vibrating screen are replaced by a reject cyclone if the recovery of fibers is of importance. Dilution water is required to make the separation more effective.

TEST RESULTS.

A lot of tests and measurements, both in a laboratory and on mill installations, have been made to find out capacity and power consumption. Some results are seen in the following diagram. (Figure 20)

The curves show fairly low energy consumptions in the wohle capacity range. Reject flows by volume are 1–15% and pressure drops 20–60 kPa.

SUMMARY

The removal efficiency and energy savings are the most significant characteristics of the Combitrap in comparison with other equipment for the same kind of work. It is also an easy and less expensive way of protecting subsequent equipment like refiner segments, centricleaners etc. It also removes undissolved long, slender impurities like plastic or metallic tapes that are very hard to get rid of and cause problems later in the process.

CONCLUSION

By utilising efficient centrifugal cleaning equipment, this paper has tried to describe a method to cost savings in the Pulp and Paper Industry. It is important to think both in short and long terms. An action that saves money tomorrow may later on turn out to be very costly.

So, for each move, many aspects have to be considered in order to achieve a profitable pulp and paper production, also when it comes to cost reductions.

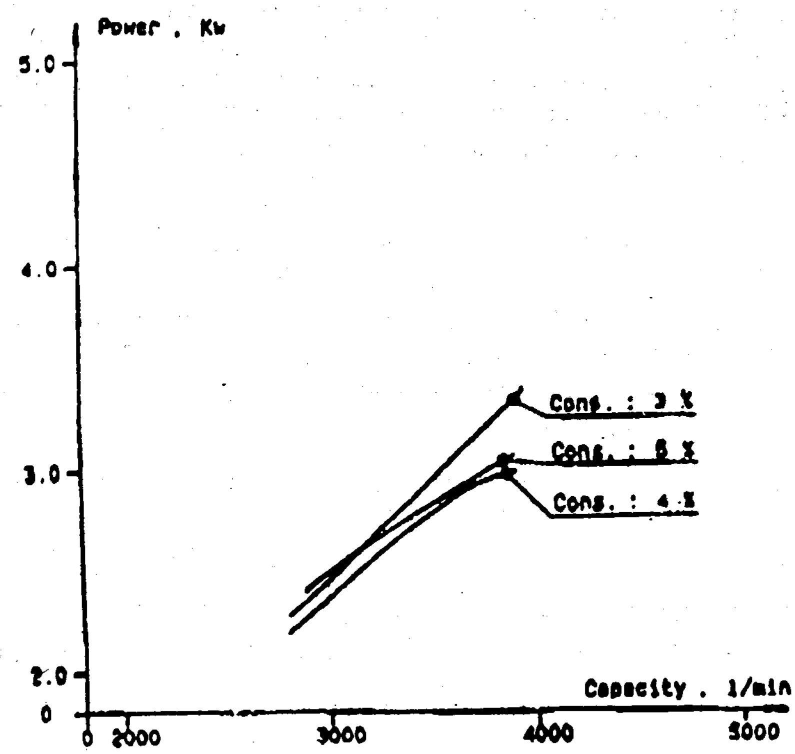


Fig. 20 Power consumption versus capacity for combiter 351 at different pulp conbistencies.