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New Opportunities with Paper Mill Pulpers

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Abstract: ***This presentation will highlight new innovations aimed at simplifying process solutions and eliminating the need for many traditional unit processes such as secondary pulper, coarse screening, HC cleaners and reject drums in recycled fiber lines. This leads to lower total investments, less energy consumption, less operating costs and reduced climate emissions together with higher fiber yield.***

Recycled paper contains various impurities which have to be removed from pulp. Hard and heavy particles cause wearing of the process equipment and the most economical way is to remove these impurities as soon as possible. Light rejects tend to rotate above the vortex made by rotor and they have to be continuously removed. Traditionally there are several equipment needed to remove all these different rejects, but it can also be done in a simpler way.

Usually there are easily degradable material and material which is difficult to disintegrate in the recycled paper. It is known many cases where the disintegration time is too short for the material with higher wet-strength and this material ends up in reject. New process innovation makes it possible to extend the disintegration time for the most difficult fibers meanwhile the energy consumption can be kept lower than traditionally.

These new innovations presented at this paper are result of long-term research and engineering work. They make possible to improve efficiency of old pulpers and also building whole new pulping lines where coarse screening of pulp happens inside the pulper are possible.

Key Words: ***Recycled paper, Pulping, Screening, Cleaning, Reject handling***

Introduction: In paper and pulp making processes the fibers are usually mixed with water. Typical feeding consistency from paper machine head box is from 0,2 to 1,5 %. This means that the rest of the slurry – more than 98 % is water. Pulper is the first tool to prepare homogeneous wetted pulp and with a pulper the dry material can be changed to pumping form. In addition, a pulper can separate also coarse impurities. Typically the pulper has a screen plate with Ø 10 – 20 mm perforation. The screen prevents the unslushed material and impurities from escaping forward, but of course the screen plate separation is limited to hole diameter. Smaller particles and impurities can escape. In case of bale and broke pulping, the residual flakes will be further wetted in dumb chest mostly disintegrated in pumping. Impurities do not disappear but they have to be screened.

The middle consistency pulpers are normally operating in consistency range 3 – 6 %. There are also high consistency pulpers which operate in range 12 – 16 % but they are not discussed in this paper. One limiting fact is that centrifugal pumps can reliably operate up to 6 % consistency and this is the good reason why the MC pulpers operate below that limit.

Pulpers in paper mills are in three main positions:

1 Bale pulps for incoming virgin fiber pulp slushing

2 Broke pulpers to collect broke paper from paper machine and disintegrate the paper back to pumping form. Pulp is returned back to paper making process. Although broke paper is not saleable the fibers are flawless.

3 Pulpers as a part of recycled paper stock preparation line. Pulper is the first piece of equipment in line and takes care of pulping the raw material.

Some mills have all of them but all mills have at least one of them.

RESULTS AND DISCUSSION

Pulping process types

There are two basic operations used pulpers:

1 Discontinuous process – called also batch process

2 Continuous process

In batch process the pulper vat is first filled with water up to 1/3. When the wished filling level has been reached rotor will be started and conveyor feeds the wished amount of bales in. Rotor slushes the bales and water is added up to final amount. This means that in the vat there is a decided amount of water and bales. After slushing there will be a full vat of homogeneous pulp in wished consistency. Then it will be pumped out to a dump chest or to a storage tower. Batch pulper gives a possibility to produce flexibly different pulp furnaces. This is the case when e.g. producing tissue paper of hard wood (short fiber) and soft wood (long fiber) pulp.

In continuous pulping there will be an even dry material feed and corresponding water flow to meet the wished consistency. Material is flowing continuously in and also there is a continuous outflow through the screen plate. Continuous flow is especially needed e.g. in under paper machine broke handling. If the web breaks, pulper gets a signal of that paper web will come to pulper. Level in pulper vat is already convenient. Break signal

starts the rotor and shower pipes. In this way pulper can start in few seconds it will be ready to take broke paper in. Slushed broke pulp can be sent continuously to broke storage chest.

Also for recycled material, like used corrugated boxes from super market, the continuous process is convenient especially because the high rejected impurity portion. It can be up to 20 % or even more. If not removed continuously, it will fill the vat and slushing of material will be prevented. Therefore you have to remove both ready pulp and rejects continuously. In continuous process the screen plate has an important task being a barrier and guards the accepted pulp quality from pulper.

Mechanical solutions of pulpers

There are vertical pulpers where the vat cylinder is in vertical position and the rotor is located in the vat bottom. Screen plate and rotor are thus in horizontal position.

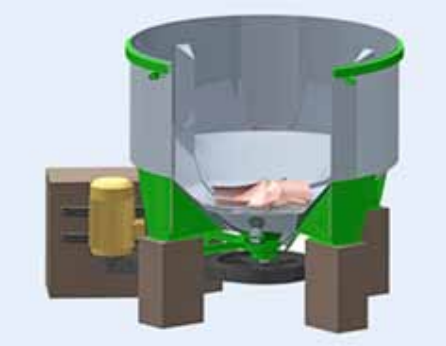

Fig. 1 – Vertical pulper for bale pulping

In horizontal pulper the vat is horizontal and rotor with screen plate is located to the side. The screen plate is then vertical. In some new designs rotor unit is located in inclined position. This is possible providing that the vat is fully cylindrical.

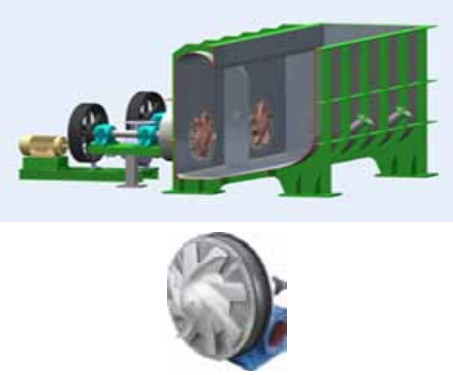

Fig. 2 – Horizontal pulper for broke pulping

Both designs can be operated continuously or discontinuously. Horizontal pulper is almost exclusively used for clean pulps; broke and virgin fiber bales.

However, the newest innovation for recycled material pulping, SimplyOne process, is based on continuous process in horizontal vat. The best feature of the horizontal vat is that it is 2 – 3 meters lower than a vertical pulper for same production capacity. It saves lot of building height.

Fig. 3 – Newest development for recycled fibre pulping – SimplyOne

How to remove continuously rejects from the pulper vat

There are several unwished impurities in waste paper material:

3 Metal wires from bales

4 Other metal pieces

5 Plastic in big pieces like bags

6 Stones, gravel, sand

7 Pieces of wood

8 Glass as broken pieces

9 Styrofoam

Some of the materials are heavier than water. They will fall down to the bottom of the vat. Stones and metal meet then very often the foils of the rotor and get between rotor and screen plate. Wearing of those parts is strong. Light particles will float on pulper upper part because their specific gravity is very close to water. When the rotor rotates there is a continuous vortex in the center of pulper. If the plastics are not continuously removed they start form concentration by spinning. Mill people call them dragons. Around a classic pulper there are several auxiliary machines in order to remove different rejects. In the following picture they are described:

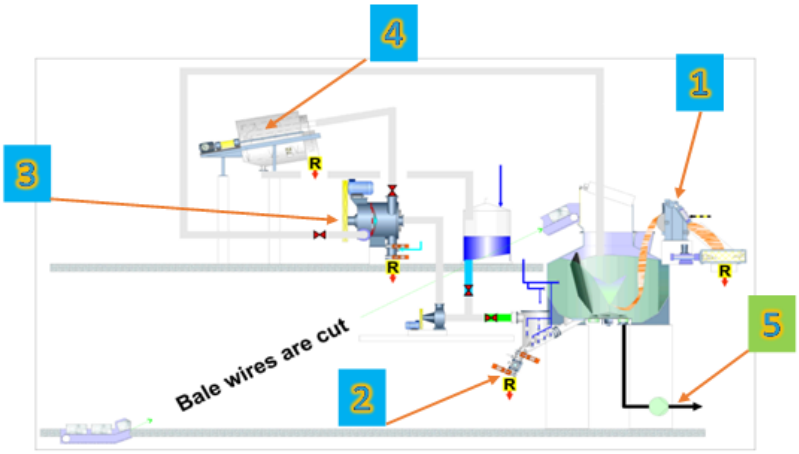

Fig 4 – Reject removal from a conventional OCC pulper

In above picture there are:

1 Ragger to remove bale wires. The vortex creates a rope of metal wires and plastics. The rope is slowly pulled out and cut to pieces.

2 Junk trap with two slide valves. The higher valve is normally open and heavy material is collected to pipe (diameter typically 400 – 500 mm). Then upper valve will be closed and lower opened. Heavy particles fall out without interrupting the process.

3 Secondary pulper takes a side flow from the pulper. This flow includes plastics. It is separated by a screen plate. Accepted pulp will be sent to main pulper and reject will go into a reject drum.

4 Reject drum is like a washing machine and it separates fiber containing water from plastics. This is done by rotating a perforated drum and spraying washing water by a shower pipe. The washing filtrate will be used for dilution.

5 Accepted pulp will be pumped out to a dump chest. It still needs additional cleaning. Before dump chest, heavy particles which have passed screen perforation (typically Ø 10 mm) perforation, will be removed by HD-cyclone type cleaner. Later, after dump chest, coarse pressure screening will remove bigger particles and break remaining flakes.

Looks and sounds complicated and it also is!

This is the new concept for reject removal from recycled fiber pulper:

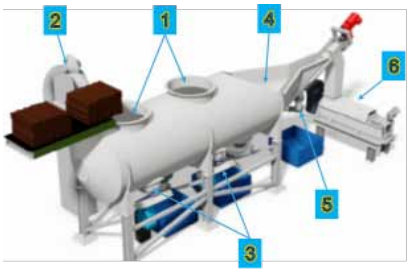

Fig. 5 – SimplyOne Compact – New solution for OCC pulping and coarse screening

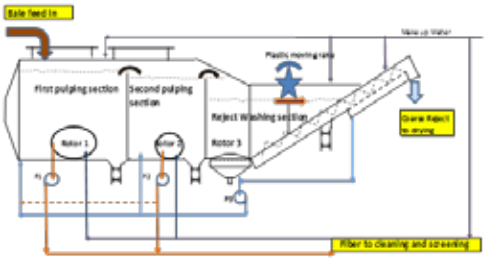

Fig. 6 – SimplyOne Compact – Operating principle

In SimplyOne Compact everything happens in one horizontal vat. Bales will move into the pulper by the help of conveyor and corresponding dilution water (blue line in Fig. 6) will continuously fow in same time. There are two pulping sections (1) separated from each other by an overflow wall. Bale wire ragger (2) collects the wires out from the first section. Both sections have an own rotor unit with 2,5 mm slotted screen plate (3). Each section has also an own heavy reject junk trap. That material which cannot be accepted through the first section screen perforation will overflow to second pulping section. This gives extended pulping time for the difficult part of material. Second accepted pulp flow will come out through rotor 2.

The last section is reject washing. It is also separated by an overflow wall and equipped with a rotor unit (rotor 3). In reject washer the rotor unit gives a good washing effect and fibrous filtrate will be removed through screen plate. An inclined screw conveyor removes heavy and plastic rejects. Heavy rejects are separated first (5) and coarse plastic reject will be taken to compacting (6).

What a pulper rotor can do?

As discussed earlier there the accepting perforation from pulper system is Ø 10 mm. This means that any smaller particle can pass this barrier. It is also known that state of art screen room have typically fine screens with # 0,18 mm slotted basket. By experience it is known that narrow slotted basket cannot handle the impurities, flakes and sand with particle size up to 10 mm. Therefore HD cleaning is needed to remove heavy particles like sand, glass, metal stables etc. and a coarse pressure screen to remove bigger debris. If the pulping has not been successful there are also paper flakes in the pulp coming from pulper. Normal pressure screens do not deflake them and pressure screen with 3 mm perforated basket will send them to screen reject. However, any rejected amount of flakes means lower yield in form of fiber losses. What are the possibilities with new pulper solutions? In below picture Fig 7. there is the newest rotor described.

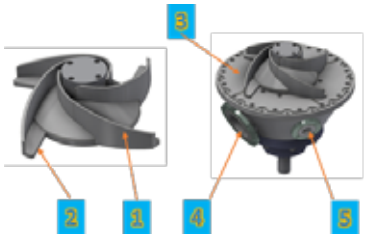

Fig 7 – SimplyOne - Pulper rotor

If we make a short list of rotor unit tasks it could be as follows:

1 Make a good mixing of pulper vat content – done by vanes (1)

2 Effectively transfer the power from drive motor to pulp – done by vanes (1)

3 Keep the unshlushed materials inside of the vat – done by screen plate (3)

4 Help the accepted material to pass through the screen plate – done by outlet (4) and foils (2)

5 Keep the screen plate clean – done by foils (2) and dilution water (5)

An important new development is to feed dilution water through rotor to screen plate. This dilutes and helps to flush fibers out but keeps the rest of the pulper in higher consistency which is good for fiber disintegration. This patented dilution rotor is a crucial change in whole pulper technology. By diluting the screen plate surface it enables to use small perforation or slotted screen plates down to # 2 – 2,5 mm. It is possible to get quality of pulp acceptable to narrow slotted fine screening. Heavy rejects earlier removed by HD cleaner can now been removed directly from reject washer. Any flake material will also kept in pulper. It will get extended retention time and good fibers are recovered.

What are the good news for existing pulpers?

There are many ways how to improve pulpers when experience and new innovations are available. In most of the cases rebuilding a pulper does not cost much and the benefit of that pays soon back.

Mechanically pulpers have a long lifetime –30 years and even longer. During the mechanical life time the pulping process can change several times from the start-up. Very often, the needed capacity can increase. Pulp quality can change. If the paper machine will change, it can have an influence to under machine broke pulpers.

New rotor for capacity increase or for energy saving

As a first step it is advisable to collect existing information of the pulper. In can easily done by filling an questionaire form where the production, process and mechanical data are asked. Also the wished capacity and other expected features are listed. In addition old documentation like assembly drawings, manuals and recent photos are useful.

It is also good to check that pulper pump works properly and it is capable to meet the expected capacity.

Fig 8 – Rotor shaft end with key

In order to check the potential of the vat and drive, a new rotor for the pulper will be dimensioned. It is possible easily to change the belt drive speed by changing the smaller pulley at motor end. Big rotor pulley remains unchanged. In case of gear box, the rotor speed will remain same. Rotor will be dimensioned based on rotor change is simple

and only what have to be measured are the dimensions of the shaft end. This means that no part in existing rotor unit will be changed and the old rotor can be used e.g. a spare.

A new rotor can also save energy by a shorter retention time. This means that pulping time with a new effective rotor can be shorter and savings can be achieved.

Changes to vat

When a rotor change is considered, the operation of the pulper can be in one way or another unsatisfying. E.g. the rotating vortex is missing or a broke pulper cannot sink the incoming paper web. In horizontal pulpers many times unshlushed material stays in some corner and does not move. In effective pulper unslushed particles hit the rotor as often as possible. In pulper you need not only pheripherical vortex but also pulp mixing between top and bottom. This can be helped by flow guiding plates which guide pulp and change the vortex partly to up and down movement. In horizontal vat this means that the both ends of the vat are effectively agitated. The mechanical construction of guiding plates is simple. They are stationary and normally welded on site to the walls of the vat.

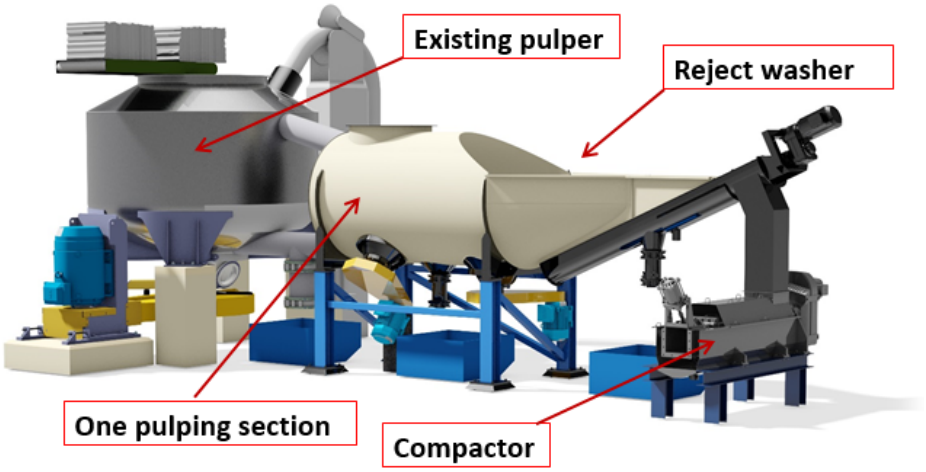

Fig 9 – SimplyOne Add-On – Capacity expansion for OCC pulping

Pulping capacity increase with SimplyOne AddOn

It is possible to combine an existing vertical pulper with a SimplyOne system. So it is possible to use the existing vertical pulper with its bale conveyor and ragger. Capacity will be extended by one separate pulping section. Reject handling will be based on SimplyOne concept.

SimplyOne concept is based on small perforation pulper screen plates. It is possible also to modify a classic type of pulper rotor unit to new narrow slotted technology. This can be done by installing a new screen plate with # 2,5 mm slotted perforation and a dilution water rotor. Dilution water feed may need some additional pipes and drillings. By modifying also the rotor unit of the existing pulper, the system will be closed and coarse screening and HD- cleaners can be eliminated. Considerable energy saving will be reached.

Conclusion

Several technical innovations and product improvements have been done. Target has been to simplify the systems and boost the component efficiency. Pulper improvement can be started by small steps or take the full advantage of the newest technical developments in the market. High efficiency means competitive edge in paper mill production. The starting point is to offer improvements that pay the investment back.