Developments in Pressurized Flotation De-inking Technology

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ABSTRACT

This paper describes the raw material scenario in India and emphasizes the need for utilization of more and more waste paper to meet the demand growth in the next eight years.

Flotation de-inking has been carried out conventionally in flotation cells which operate in normal atmospheric conditions. The Pressurized de-inking modules (PDM) is the first flotation cell which operates under pressure.

Description of PDM cells (PDM I) and further developments done to PDM (PDM II) to improve ink speck removal, Brightness, Yield and production capacities are discussed in this paper. The technical challenge involved in better utilization and how the PDM I and PDM II are meeting the challenge are brought out in detail in this paper.

INTRODUCTION

Raw material availability at affordable cost is the prime concern and constraint for Indian Pulp and Paper Industry.

Deprived of the facility for growing captive plantations in wastelands, Paper Industry has to depend heavily on agro-residues like bagasse and waste paper.

Bagasse once thought of as a waste material in Sugar Mills is no more available easily for paper making-as Sugar Mills are encouraged to go in for cogeneration. In Maharashtra, a few bagasse based Mills are closed or have curtailed their production for want of bagasse. Cultivating area of sugar cane is said to be shrinking for want of water. Even in Tamilnadu, traditionally bagasse based mills like TNPL and S.P.B. are unable to procure bagasse at reasonable price.

PAPER-DEMAND GROWTH

Experts predict

a. The per capita consumption in India will rise from 3 Kgs to 6 Kgs before 2005 A.D.

b. Developments in the next 10 years will happen only in Asia Pacific area more than in other areas in the world.

WASTE PAPER USAGE IN INDIA

Indian Paper Mills have been traditionally using waste paper of all grades. In addition substantial quantities are being imported into India from Overseas.

To meet the demand in the coming years Indian Industry will be forced to use more and more waste paper by recycling as well as by imports.

The paper Mills who are not presently using waste paper will be forced to go in for this. Those who are using small amounts will be required to increase the use of Recycled fibers.

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TECHNICAL CHALLENGES

Technical challenges involved in greater and better utilisation of waste paper is in improving the quality of these fibers to the same level as that of Virgin fiber that is being replaced.

The difficulties for countries like India will be that they will be forced to deal with an ever decreasing quality of waste paper (both imported and indigenous) as time goes on.

To meet this challenge deinking systems must be more sophisticated. AT Beloit Corporation we have the ability to meet this challenge.

PARTICLE SIZE AND REMOVAL EFFICIENCY

Ink Particles can be removed based on particle size.

> **Washing** operations are efficient on very small particles (< 10 microns).
>
> **Flotation** is able to remove particles over a wide size range from 10-200 microns.
>
> **Centrifugal** cleaning removes particles of 100 microns or greater with very high efficiency.
>
> **Screening Operations** will remove larger particles depending on the basket characteristics (size of holes/slots).

Combining this with the knowledge of particle size distribution in pulp we can predict which unit operations will be most effective.

Image Analyser

Since 1981-efforts from Beloit were there to find a different method for measuring the amount of ink present in a pulp sample. The technique chosen was automatic image Processor. This unit is able to identify ink particles and determine their number and size.

FLOTATION-WHY PRESSURISED?

If we take an overview of the paper industry there is a very interesting trend. A review of all major developments show the step from atmospheric to Pressurized operation has resulted in major improvements in both process efficiency and runnability. Thus we have moved from atmospheric to pressurised operations in Head box Technology, Refining Technology. Screening Technology, and now in Flotation Technology.

PRESSURISED DEINKING MODULE

The Beloit Pressurised Deinking Module or PDM is one of the most innovative developments in deinking Technology in the last ten years. The first PDM system was sold in 1987 and since then more than 100 PDMs in thirty deinking systems are operating all over the world.

While all other flotation cells operate in atmospheric conditions, the PDM is a totally sealed cell and uses the internal pressure to produce a number of advantages.

1. Deinking efficiency is improved by using pressure to maximise the ink removal and minimise the fiber loss.
2. Runnability is improved by using a pressurised level control strategy as well as pressurized rejects removal system.
3. Maintenance is minimised because the air intake system does not require the use of ventury devices which are prone to Plugging.
4. The sealed design of any potential air pollution problems.

WORKING OF PDM I

Air is added to feed pulp just prior to a **mixing zone** where high turbulence serves to form the froth. It is primarily here that the work of forming bubbles and creating bubbles to particle collision occurs. This is where the hydrodynamic conditions promote bubble formation and attachment of ink particles to bubbles. Of course, surface chemistry must be right for this process to be efficient and for the stability of the ink bubble attachments.

After the mixing zone bubbles rise in a less turbulent flotation zone to form surface froth which is separated at the reject weir and removed through the reject valve.

The process operates under positive pressure typically 1-2 bar with higher pressures for those situations where there is a second series PDM cell without an inter stage booster pump.

Rejects froth is expelled through the reject valve and passed through a separator cyclone to separate excess air from the collapsed foam. Rejects are then transferred to a sludge collection chest for further processing and disposal.

Level control is accomplished by means of an automatic control valve at the vent position which responds to a differential pressure level sensor system. The vent control valve opens incrementally in response to sensing a level below the set point or closes incrementally in response to sensing a level above the set point.

PDM vs CONVENTIONAL CELLS

In conventional cells aeration zone, mixing zone, and separation zone are in the same location. However in the PDM these stages are deliberately separated and optimised.

In **acration stage** air is drawn into a conventional cell by a ventury cell, The limitation here is that air quantity is limed by the flow of pulp. With PDM air can be adjusted independently of pulp flow to suit the requirements of various furnishes that can be deinked.

In **mixing stage** PDMs are designed for a high turbulent flow which increases the number of collisions and hence attachments between ink particles and air bubbles.

In **Separation Zone** the performance of this stage is enhanced by pressure.

In conventional cells air is used to float the particles and then air escapes into the atmosphere.

PDM is designed so that air does not escape. Air is used to pump out the inky foam rejects from the cell. The air is then separated in cyclone separator from the rejects.

FIBER REJECT RATE

In most conventional flotation cells the inky foam is removed by a gravity overflow. A moving layer of pulp carries the inky foam over a weir and into a Rejects Chamber. The disadvantage of these cells is that the moving layer of pulp also contains good fiber which is lost from the cells.

In PDM design the high reject rate is reduced because pulp level in the cell is below the weir level. Foam is transported to the weir by the bulk movement of pulp within the cell. The foam builds up and is transported across the weir by the pressurised air within the cell.

PDM has lower fiber rejects than convent onal cells.

INK REMOVAL EFFICIENCY

Flotation is a three stage process-collision, attachment, and separation, Ink particles and air bubbles collide in the first stage. In the second stage the ink particles and air bubbles become attached. The air bubbles and ink are separated from the pulp.

DESIGN MODIFICATION IN PDM II

Four specific design changes comprise the PDM II configuration.

1. Flow baffles
2. New reject weir
3. Small recirculation stream
4. New type and position of level sensor

Refer to the **Fig.2.** Please note the new baffles near the beginning of flotation zone, the new reject weir in a mere forward position, the new recirculation port from the terminal end of the PDM, and the new level sensor directly in front of the new reject weir.

PROCESS EFFECTS

The flow baffles perform several hydrodynamic functions.

1. Avoid back currents by stabilisation and flattening of the cross sectional velocity profile.

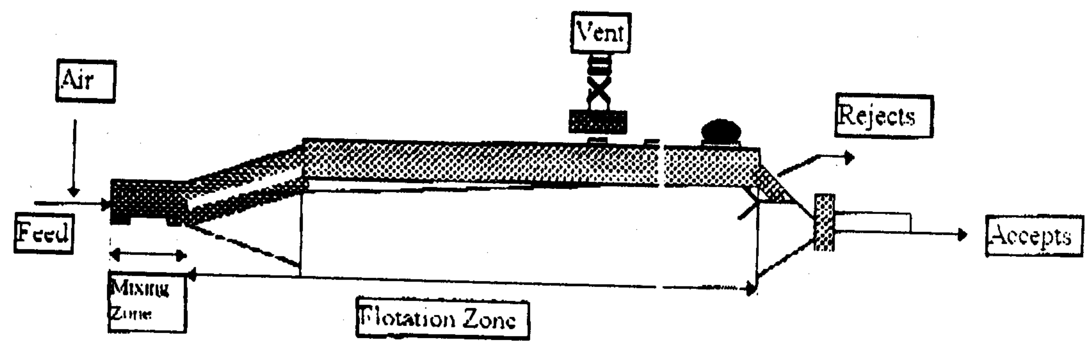

Figure-1. PRESSURISED DEINKING MODULE (PDM I)

2. Reduction of interfacial turbulence and hence transport of ink from the froth to the pulp phase underneath.

3. Damping of surface resulting from the rapid rise of the froth. This further reduces the ink transport to accepts. Further by reducing interfacial reentrainment it avoids transport of bulk phase accepts into the rejects stream.

THE REPOSITIONED REJECT WEIR PROVIDES

a. More rapid separation and removal of ink rich froth.

b. Reduced interfacial area and thus less opportunity for reentrainment of ink from the froth to the accepted pulp.

c. Less residence time for froth which will eliminate or reduce the formation and collapse of large bubbles into distinct air pad and consequently,

d. decreased requirement for compressed air due to more effective use of pressurized air for bubble formation and transport.

THE RECIRCULATION STREAM AT THE TERMINAL POSITION

a. Provides for a longer residence time if the second flotation zone for the slow rising time bubbles which have passed under the primary reject weir. The recirculation is hardly 1 to 5 percent of the cell inlet flow.

b. is enriched in air at 10 to 15 percent and as expected this contains fine ink particles.

c. contains the fine foam and ink which is not easily separated from the bulk liquid phase and consequently is rich in useful fiber. It is thus recirculated to the feed chest for a subsequent pass back through the process.

Note that there is absolutely no loss to added rejects and fiber as in a secondary treatment cell but this is recirculated with no loss of fiber. The selective recirculation of ink enriched stream improves the efficiency more than direct recirculation of accepts.

The new level sensor is used for single loop level control system with an automatic reject outlet valve. This has proven to be very effective in better facilitating and maintaining constant level which of course improves separation efficiencies.

CONCLUSIONS

In summary, the benefits from PDM II improvements include

Increase in brightness gain;

Increase in ink speck removal;

Decrease in rejects or yield increase;

Improvement in automatic level control;

Significant production capacity increase.

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