Deinking Studies with Flotation Cell of ONP

Dr. M.C. Bansal, Mr. Puneet Kr. Agnihotri

Dept of Paper Technology, (IIT, Roorkee), Saharanpur-247 001

ABSTRACT

The use of secondary fibre is growing over the years and thus the interest for more work in the area of deinking is evident world wide. Deinking operation was studied in two stages-first difiberization at high temperature and with suitable chemicals in hydropulper and then removal of separated ink as foam in a flotation cell. The final brightness of 59 has been achieved after flotation for ONP, under suitable operating conditions. The ERIC values were also observed and indicate the removal and dispersion of ink by repulping and flotation operations. More studies are in progress to obtain suitable economic and better properties in paper.

INTRODUCTION

The use of secondary fibres in paper industry has been growing over the past few years because of the current environmental awareness. The most important factor which will decide the growth rate of paper industry in the coming years, is the availability of suitable raw materials economically on sustained basis. The use of waste paper (recycled fibres) has now been established as an important source of furnish for the paper industry world wide. Forest based pulp is continuously loosing its share, out of the total pulp and paper furnish in the global paper industry for the last few years. As per an estimate (5), the share of the wood pulp out of the total world furnish mix will be 44% by 2014 as against 52% in 1998 and 70% in the year 1980. For effective utilization of waste papers as sources of secondary fibre, it is necesary to sort and classify the materials into suitable quality grades. Relative utilization, based on major classification, is given in the Table 1.

Much of the sorting is done by the collector because this allows him to obtain best price for the waste product. The waste paper dealer pays less for unclassified materials and thus the supplier must sort out the waste paper to extract the better quality waste. About 80% of all waste paper comes from three sources: corrugated boxes, newspapers, and office papers, Less than 20% of the waste paper is deinked to be used in newsprint, tissue, or other brighter grades (4).

Table 1 Waste paper use by grade (1)

Corrugating	43 %
Old news print	16 %
Mixed waste	19 %
Pulp substitues	15 %
High grade Deinked	7%

This also requires a drive at national level to increase the rate of recovery of waste paper in the form of a well knit industry. In India this is around 20%, it is around 62% in Denmark and 45% in Japan. It is increasing over the years in almost all the countries. Collection of waste paper, obviously, thus is a large enterprise and suppliers/exporters.importers are now well established in this field too.

It is further observed that deinked pulp suitable for use in printing papers usually imparts special properties to the finished papers compared with papers made from wood pulp. These properties are increased opacity, less curling tendency, less fuzziness, better formation, better retention of size and fillers.

Effect of different chemicals on the waste paper (3)

Sodium Hydroxide

Sodium hydroxide is used not only to adjust the pH to the alkaline region, but to saponify and/or hydrolyze the ink resins. The alkaline environment is often reported to "swell" the fibres. This term is more descriptive than reality. At the pH conventionally used for pulping; 9.5-11.0, the fibres would take up some water and become more flexible, rather than puff up lime-cellulose balloons (Fig. 1).

NaOH

Functions

Raise pH
- Aids in Ink Release
- Activates Hydrogen Peroxide
- Modifies-Additives & Contaminants

Cause Yellowing in Mechanical Fibre
- Lingin release
- Peroxide prevents yellowing

Alternative
- Soda Ash
- Sodium Silicate
- Ammonia

Fig. 1

The addition of caustic soda to Mechanical pulp, furnish will cause the pulp to yellow and darken. This is the phenomena that is often referred to as "alkali darkening". The problem with alkali darkening is only of concern with wood containing furnishes. Higher pH = (11) can be used with wood free furnishes with no Alkali darkening.

Hydrogen Peroxide

Hydrogen peroxide is usually added to prevent Yellowness, to strip the colour and to increase the brightness. The decomposition of peroxide can be reduced by the addition of "stabilizing" agents such as chelants and Sodium silicate. Hydrogen peroxide is also used as post bleaching agent. The balance between how much peroxide should be added in the pulper versus how much in the bleaching stage must be optimized for each furnish. It should be rembered that the peroxide is added to the pulper simply to affect the formation of chromophores created by the alkaline pH (Fig. 2).

H_2O_2

Function
- Prevents Mechanical Fibre Yellowing at high pH
- Bleaching at med-high consistency
- Alternatives (Reductive)
  - Sodium Hydrosulphite
  - Formamidine Sulphinic
  - Acid (FAS)

Fig. 2

Chelating Agents

DTPA (diethylene triamine penta aceticacid) is the most commonly used chelant but EDTA (ethylene diamine diamine tetra acetic acid) is also used. The role of chelant is to form soluble complexes with heavy metal ions. The complexates prevent these ions decomposing the hydrogen peroxide (Fig. 3).

Sodium Silicate (Na_2SiO_3)

The sodium silicate most commonly used in deinking mills as at 41-6^0 Baume solution of sodium metasilicate which contains roughly equal amounts of SiO_2 and Na_2O. (Fig. 4) Silicate aids in deinking through an ink dispersant action or by preventing the ink from redeposting on the fibre surface. The anti-redeposition effect is what made silicate popular in laundary soaps. The dirt or soil was emulsified and prevented from sticking back on the clean wash. The fact that silicate is a source of alkalinity and will affect the pulper chemistry, increasing the silicate will increase the pH and this may call for a reduction in the sodium hydroxide addition rate.

Surfactants/Active Chemicals

The terms surfactant is derived from their function as surface active agents. "Surfactant" is a catch all term that covers, uses like dispersants, collector, wetting agents, displectors, anti-redeposition aids and the like (Fig. 5).

Chelants

Function
- Metal ion Chelation
- Peroxide Stabilization
- Assists in Preventing Brightness reversion

Fig. 3

Na_2SiO_3

Function
- Buffers pH
- Stablizes Hydrogen Peroxide
- Complex with Metals
- Aids in ink Dispersion
- Alternatives
  - Phosphates
  - Chelants

Fig. 4

Surfactants

Function
- Detergency
- Dispersion and Emulisification
- Collection
- Frothing (Foam Stabilization)

Fig. 5

Surfactants that are used for deinking will have two principal components, a hydorphilic and a hydrophobic component. During flotation, the hydrophobic end will associate with the ink oil and dirt while the hydrophilic end will remain in the water. Some of the most common surfactants used in deinking are the Eo/Po (ethylene oxide/ propylene oxide) copolymers. The hydrophilic (water liking) is the ethylene oxide and the hydrophobic (water hating) end is the prophylene oxide end. Active chemicals (proprietory deinking chemicals combining functions of dispersant and collector) help the ink and dirt particles removal in suspension, which have been freed during the pulping operation. It helps their removal during washing and flotation.

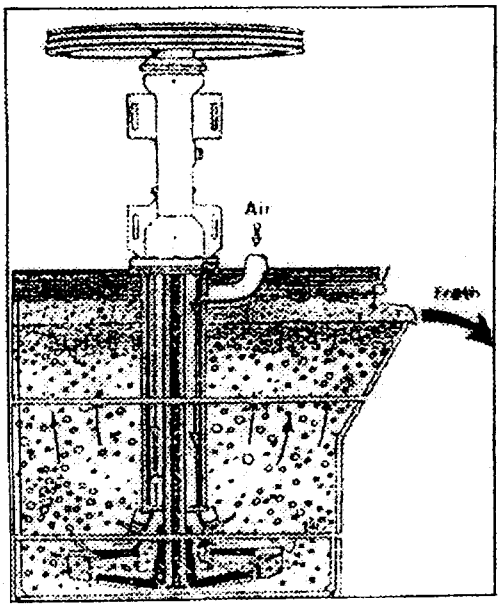

FIG 6 Flotation cell

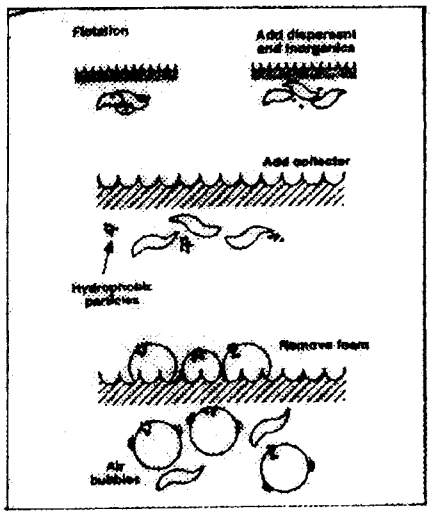

FIG 7 Flotation Deinking Mechanism (2)

EXPERIMENTAL

The newsprint which was used in this study is from- The Indian Express newspaper, New Delhi edition. The studies have been carried out for pulping in a hydropulper and its subsequent flotation in a flotation cell to remove the separated ink in the form of foam.

The function of the pulper in a deinking operation is to defibre the paper and to detach the ink particles from the fibres, while retaining the contraries (undesirable materials) large enough to be removed by centri-cleaners and screens is subsequent stages. The flotation unit has often been referred to as the "heart" of the deinking system. It is reasonable then to think of the pulper as the "brain" of the system (1). If the pulper does not work properly, or if the chemistry of the chemicals added is unbalanced, the batch has little chance of success. The slushing of ONP is carried out in the laboratory 35 litre capacity Hydropulper, having provision for controlling rpm and temperature, at varying conditions. The deinking chemicals were added in the hydropulper at the operating conditions, as shown in Table 2.

Deinking by flotation Cell

Flotation deinking is a selective separation process that

Table 2 Pulping conditions

Exp. No.	Consistency %	Temperature °C	Time (min)	NaOH	Na_2SiO_3	DTPA	H_2O_2	Active Chemicals
E - 1	4	50	30	2.0	6.05	1.05	2.0	2.0
E - 2	4	55	35	2.5	6.25	1.25	2.5	2.5
E - 3	4	60	30	2.2	6.15	1.25	2.5	2.5
E - 4	4	62	20	2.5	6.22	1.20	2.5	2.5
E - 5	4	65	15	2.5	6.25	1.25	2.5	2.5
E - 6	5	60	25	1.8	5.0	1.0	2.0	2.0
E - 7	5	60	25	2.0	5.0	1.0	2.0	2.0

Table 3 ISO Brightness and ERIC values; before and after flotation

Exp. No.	After pulping (before flotation)			After Flotation		
	pH	Brightness %	ERIC (ppm)	pH	Brightness %	ERIC (ppm)
E - 1	9.5	50.54	590	8.5	54.95	536
E - 2	10.0	52.0	545	9.0	56.82	484
E - 3	9.5	52.0	560	9.0	57.0	390
E - 4	10.0	51.32	590	9.0	58.11	252
E - 5	10.0	52.62	586	9.0	59.02	247
E - 6	9.5	51.30	517	8.5	57.0	206
E - 7	10.0	50.26	572	8.0	56.0	199

utilizes air to separate ink particles from a pulp suspension. As the air bubbles rise through the flotation cell, ink particles become attached to the bubbles and are carried to the surface of the cell. Flotation chemicals are added to the pulp to make the ink particles hydrophobic and increase the probability of flotation. Inky foam forms on the surface the cell and is removed, while the fibre remains in the pulp and is accepted. The flotation cell operation (Fig. 6) was conducted 1% and 0.8% consistency, while the process of flotation deinking are shown in the (Fig. 7).

ERIC 950 values have been determined for repulper pulp and deinked pulp obtained after inked foam removal from flotation cell. The basic purpose of ERIC 950 option is to determine how much residual ink remains in the sample of deinked paper. This is accomplished by measuring the reflectance in the infrared region of spectrum (950 nm) and manipulating these reflectances via Kubelka Munk analysis until the Effective Residual Ink Concentration (ERIC) is computed (6).

The infra-red region of the spectrum has been used for the analysis as research has shown that ink and ink alone (not dyes, lignin or other colorants) absorb light at 950 nm. There are certain inherent defects in this mode of measurement. If the ink particles are agglomerated and not uniformly dispersed in the sheet then the ERIC value achieved is lower than what it should be.

RESULTS AND DISCUSSION

The results have been shown in the Table 3 for the slushed pulp before flotation and after flotation in the flotation cell. The pH obtained in repulper for all the runs, with varying amount of chemicals is around 10 only, while in the flotation cell it is between 8 and 9. It appears that a higher pH in flotation shall help in better ink removal, and thus relatively higher quantity of chemicals for run. The results at 65°C gave better brightness and lower ERIC values thus preferred. The flotation cell operation was at ambient conditions only. The lower ERIC value of 199 for the run E-7 shows that the residual ink concentration has come down at lower pH in flotation cell, though brightness has also decreased. This could be that residual ink has dispersed better at these operating conditions, than at other run at E-6 conditions, where the brightness is higher.

The desired minimum brightness as per BIS No. 11688:1999 for newsprint is 52% while after flotation the brightness achieved is between 55 to 59% for all the experimental runs. Further work is in progress to look into the economic aspect of the deinking operation and addition of other additives to improve the paper properties.

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REFERENCES

1. Ferguson L.D. Deinking chemistry-I **TAPPI J.**, 75 (7), 75 (1992)
2. Ferguson L.D. Deinking chemistry-II **TAPPI J.**, 75 (8), 49 (1992)
3. Rangan S.G. Santasarkka Matti, Rangamannar G., **IPPTA J.**, Convention Issue, 129 (Dec. 1998).
4. STC-Tata Honeywell Ltd., **IPT (IITR)** Secondary fibre processing and deinking (Nov. 2001).
5. Jain R.K., Mathur R.M., and Kulkarni A.G., **IPPTA J.** 13 (3), 21 (2001).
6. Technidyne Corporation, New Albany, Indiana, USA.