Flotation Deinking Studies of ONP for Deinking Chemicals and Process Conditions

Varshney Rupesh, Agnihotri Puneet. Kr., Sharma Chhaya and Bansal Mukesh. C.

ABSTRACT

Optimization of flotation deinking time has been attempted using Old Newsprint (ONP). It appears that beyond 10 minutes flotation time, removal of ink is not significant. 1% consistency during flotation has shown better performance.

Effects of deinking chemicals in flotation deinking operation of ONP have been studied using fatty acids and surfactants namely Oleic acid, Palmitic acid, Stearic acid and Jinex. It is observed that Oleic acid, Palmitic acid, Stearic acid have optimum dosage, after which the deinkability factor decreases with increasing dosage. In the case of Jinex, with the increase in its dosage, the deinkability factor goes on increasing resulting in better quality pulp probably due to the loss of fines.It appears that Jinex also accumulates dust or fines along with ink to form the medium size agglomerate, which can be carried away with the air bubble as foam with the increase in dosage. The ink agglomerate size increases with the increase in dosage of Oleic acid, Palmitic acid and Stearic acid resulting in its reversal back to the pulp beyond optimum dosage.

KEYWORD: Deinking Chemicals, Deinkability Factor, Flotation Time, Ink agglomerates, ONP

INTRODUCTION

The current environment awareness & legislation is leading us to maximum recycling of waste paper. The use of secondary fiber paper has been increasing over the past few years because of current environmental awareness. The paper industry is the exclusive user of waste paper as a secondary raw material. The source of fiber supply is becoming an increasing concern due to deforestation. Forest preservation and sustainability of the environment, are important burning issues in today's world. An exponential growth in the demand for paper-based products coupled with increased efforts for forest conservation has popularized the use of recycled fiber. Without recycling, the fiber supply in the world will not be sufficient to cope up with the demand. Deinking has taken lead in today's scenario of increased use of secondary fiber. Only after deinking, one can effectively use the recycled fiber for writing and printing.

The Indian paper industry uses a diverse mix of raw materials, primarily forest based, agro-residues such as bagasse or straws and waste paper. Though agro-residues are available, associated problems such as complexity during processing of these fibers, the quality of the end product and environmental issues are the major concerns in encouraging use of these potentially available renewable raw materials.

Department of Paper Technology,
Indian Institute of Technology Roorkee
SAHARANPUR-247001, INDIA

The reuse of the recycled paper fibers is essentially dependent on their deinking. Deinking is a sophisticated process for recycling of the paper and for the proper future growth of the paper industry. There is need for the application of effective equipments that will give the best results for recycling of the waste paper. Application of flotation cell is found to be one of the best choices for waste paper recycling.

In the flotation deinking, air bubbles rise through agitated liquid in the tank containing suspended cellulose pulp and contaminant particles. The rising bubbles collect hydrophobic contaminants and ink agglomerates. The attached particles are then transported to a froth layer, from where they are easily removed.

The deinking efficiency of the process has been evaluated by means of brightness measurements, as indicated in TAPPI Standard T452 using an Elrepho 2000 from Data color International, Lawrenceville, N.J, USA. To quantify this deinking efficiency, the brightness of the hand sheets must be compared with a reference. The brightness of the unprinted paper subjected to the same disintegration and flotation condition is considered as a reference value. Therefore, the following Deinkability Factor would define global efficiency of the deinking process (1):

$$E_F = \frac{B_F - B_D}{B_{BF} - B_D} \times 100 \quad [1]$$

Where

E_F = deinkability Factor (%)

B_D = Brightness of pulp after pulping (%ISO)

B_F = Brightness of pulp after flotation (%ISO)

B_{BF} = Brightness of unprinted paper subjected to the pulping and flotation stages carried out under the same conditions (%ISO).

EXPERIMENTAL METHODOLOGY

The wastepaper used was offset printed newspapers. Old newsprint (ONP) came from batches of recently printed offset newspapers (e.g. *The Times of India)*. The fiber distribution of the ONP as raw materials was determined by quantitative fiber analysis by Indian Standard IS: 5285 1969 (Methods of Tests for Fiber Analysis of Paper and Board). The fiber analysis of ONP contained a blend of softwood chemical

Table 1 PULPING CONDITIONS

SPECIFICATIONS		CHEMICAL ADDITION (On the basis of o.d. sample)	
Hydropulper Consistency	6%	Sodium Hydroxide	2.0%
Pulping time of Hydropulper	15 min.	Sodium Silicate	2.5%
Temperature	65 ^{0}C	Hydrogen Peroxide	1.0%
Flotation Cell Consistency	1.0%	DTPA	0.5%
Blank Run		**(ISO Brightness,%)**	
Cuttings of unprinted portion of the waste paper taken for the study were pulped with same chemical composition used for deinking of printed paper, and after flotation the results are as shown.		58	

Fig. 1 - Oleic Acid Dosages Vs.Deinkability Factor, %

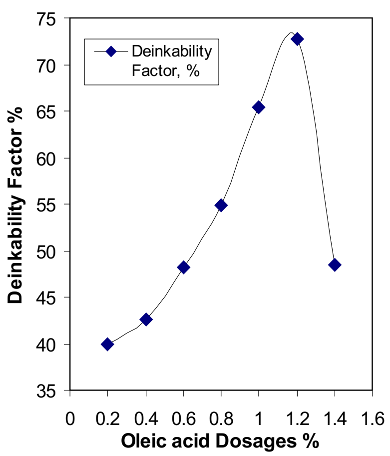
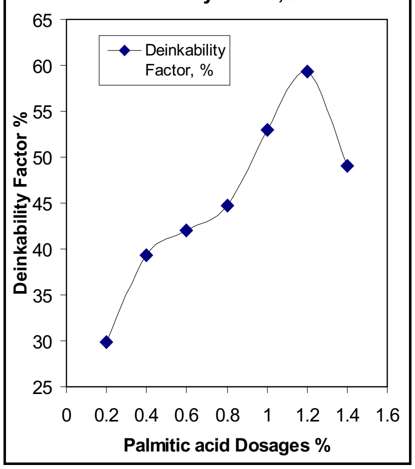


Fig. 2 - Palmitic Acid Dosages Vs. Deinkability Factor, %



and mechanical fiber with some hardwood chemical fiber, approximately 30% chemical pulp and 70% mechanical pulp.

The quantities of the chemicals charged in the deinking formulations were calculated as a percentage of the oven dry weight of paper fed to the pulper. Sodium hydroxide and Hydrogen peroxide were from Qualigens Fine Chemicals. Sodium silicate, DTPA and Oleic acid were from Thomas Baker (Chemicals) Ltd. Palmitic acid and Stearic acid were from Central Drug House (P) Limited. The deinking surfactant (Jinex) employed was from Jain Chemicals Ltd.

ONP was slushed in a hydropulper and its subsequent flotation was carried out in a flotation cell, to remove the separated ink in the form of foam. All repulping experiments were carried out in a laboratory helico pulper, which has provisions for controlling temperature and rotor speed. The principle and equipments have been discussed in our earlier paper (2). ONP was individually cut into 6-8 cm squares. Pulping was carried out using 500gram air-dry mass with 9% moisture content. Pulping conditions for all the experiments are given in the Table 1. Wastepaper was torn and added to the pulping solution when the required temperature was maintained. After all the paper had been added to the pulper, the rotor speed was increased. Chemicals (Fatty acid /Surfactant, DTPA, Sodium Hydroxide, Sodium Silicate, Hydrogen Peroxide) were added prior to the addition of the waste paper. The retention time for pulping operations is 15 minutes and was kept constant for all the experiments (3). The pH value for all these experiments during pulping is between 9.0 to 10.5.

In the flotation stage, about 100 gm oven dry repulped stock from the hydrapulper was diluted to 1 % consistency and about 10 lit diluted stock was sent to the batch flotation cell. The flotation time variation of the flotation cell was studied. The flotation operation was performed in the Lamort type flotation cell. The rotor speed was fixed at 1400 rpm. The reason for taking a reasonably high agitation speed was that the air was sucked in through the tube and air bubbles went out through the annular holes from the nozzle plate in the bottom of this tube (2,4). The flow of the air is proportional to the speed and thus adequate flow rate was maintained for good flotation. Proper ink particle size and air bubble ratio is important for good flotation (5). Szatkowki and Freybergar (6) have proposed that the optimum bubble size is approximately five times the size of ink particle agglomerates to be removed. Similarly flotation time of 10 minutes is adopted because further increase in flotation time produces minimal variation in efficiency. Proper flotation time ensures that all the particles had sufficient time to float, and further time shall only use power with no additional advantage in flotation efficiency (7,8). In both pulping and flotation stages, tap water were used as it contains some salts of Calcium and Magnesium, which help in the flotation process. The pH value in the flotation cell was between 8.0 -9.5.

The optical property was measured on sheets with a basis weight of 60 g/m^2, prepared before and after flotation on British standard hand sheet machine. ISO Brightness is measured on both sides of the sheet, is reported as an average of the two. ISO Brightness measurement has been done by Technibrite ERIC 950, Technidyne Corporation (New Albany, IN) USA.

RESULTS AND DISCUSSION

The results have been shown in figures for slushed pulp before flotation i.e. after pulping and after flotation in the flotation cell, which include deinkability factor.

Figure 1 shows the effect of chemical dosage of Oleic acid in terms of deinkability factor. In this figure, as the chemical dosage of Oleic acid increases, the deinkability factor increases to optimum value, and after optimum conditions the deinkability factor decreases. This shows that high chemical dosage beyond 1.2% has started affecting the deinkability and

Fig. 3 - Stearic Acid Dosages Vs. Deinkability Factor, %

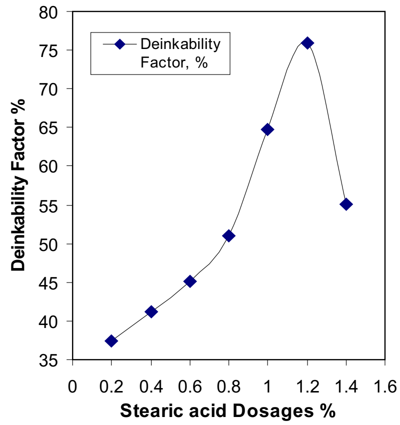


Fig. 4 - Jinex Surfactant Dosages Vs. Deinkability Factor, %

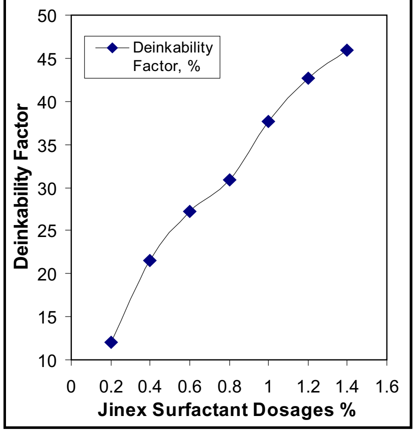


Fig. 5 - Flotation time Vs. Deinkability Factor for Oleic Acid

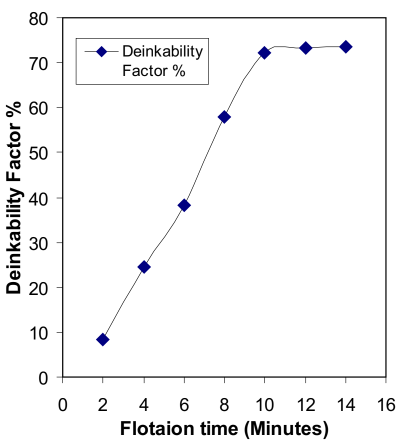


Fig. 6 - Flotation time Vs. Deinkability Factor for Palmitic Acid

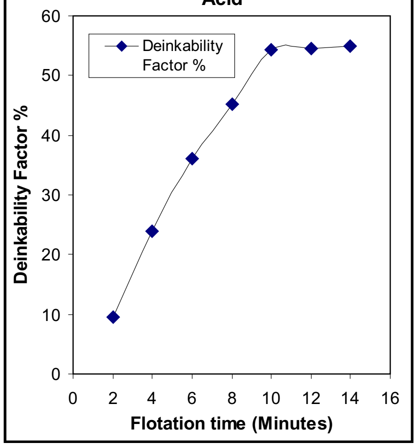


Fig. 7 - Flotation time Vs.Deinkability Factor for Stearic Acid

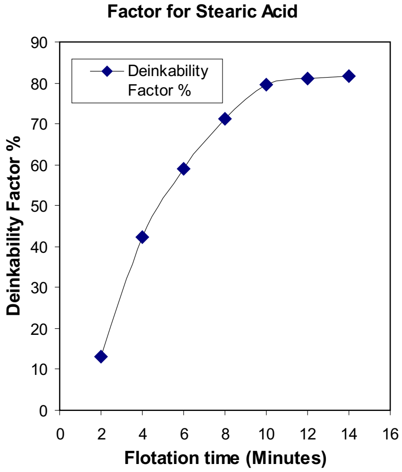
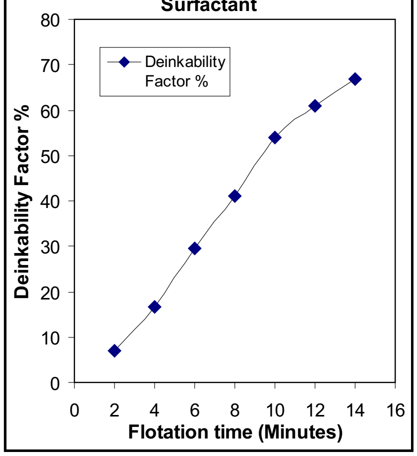


Fig. 8 - Flotation time Vs. Deinkability Factor for Jinex Surfactant



the ink has started reversing back in the system, after dissociation from the pulp earlier (4).

Figures 2 and 3 show the effect of chemical dosage of Palmitic and Stearic acid in terms of deinkability factor. In these cases too, the deinkability factor increases with the increased dosage of chemicals and after optimum condition, the deinkability factor decreases.

Figure 4 shows the effect of chemical dosage of Jinex surfactant from Jain Chemicals Ltd. in terms of deinkability factor. In this case also, the deinkability factor increases with the increased dosage of chemical, but no reversal is obtained as in the case of Oleic, Palmitic and Stearic acid.

Figures 5, 6 and 7 show the effect of flotation time on deinkability factor using Oleic acid, Palmitic acid and Stearic acid respectively. In these figures, the deinkability factor increases with the increase in flotation time up to 10 minutes significantly but after 10 minutes brightness increase is very less.

Figure 8 shows the effect of Flotation time on deinkability factor using Jinex surfactant. In this case, the deinkability factor increases with the increasing flotation time up to 10 minutes but after that, the improvement in deinkability factor is very less but fiber loss appears to be more.

CONCLUSIONS

From the experimental work, it is concluded that the amount of ink removal is more as we increase the chemical dosage up to the optimum condition and then it decreases as we exceed the higher limit. The optimum value for the flotation time comes out to be 10 minutes. Similarly, the optimum value of chemical dosage comes out to be 1.2%. From the results, it is evident that the used chemicals can be classified in two categories:

- Oleic acid, Palmitic acid and Stearic acid show a behavior where the ink goes on accumulating on the fixed size air bubbles with the increase in chemical dosage and reaches to an optimum dosage of chemicals. Beyond this point, the ink agglomerates size is more and is not sustainable on the air bubble. This large size ink agglomerates goes back in to the system leading to lower deinkability factor with increased dosages.

- Jinex surfactant shows a behavior where perhaps the surfactant is not only helping the ink agglomeration but also forming intermediate size agglomerate with dust or fines. The size of agglomerate with dust, fines or ink is such that it goes out on the air bubbles forming foam and leads to relatively cleaner pulp resulting in increased deinkability factor.

It has been observed that the loss of fines is relatively more with this surfactant in comparison to Oleic acid, Palmitic acid and Stearic acid, which is probably possible with the above reasoning.

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