# Response of Offset News Inks to Deinking

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## ABSTRACT

*Deinking of about one-month old newspapers in the presence of commonly used deinking chemicals has been studied. Offset news inks are easily broken. Efficient separation of the ink particles is possible by washing or flotation process, though flotation gives better deinkability and less fiber loss than the washing. Ink particles tend to remain with the fine fraction of the recycled pulp. It may be economical to first separate the long fibre fraction and then treat the finer fraction for deinking by washing or flotation.*


## INTRODUCTION

Deinking involves two basic operations: detachment of ink particles from the fiber surface and removal of separated particles from the pulp slurries. The separation of ink particles from the pulp suspension is carried out mostly by two approaches, namely, washing and flotation. If the ink particles detached from the fibers during pulping are dispersed into individual particles or agglomerates finer than 15 μm they can be efficiently removed by washing (1,2). The flotation method is used efficiently for removal of surface-active particles in the size range of 10-150 μm. During flotation the ink particles get attached to the air bubbles and rise to the surface of the pulp suspension from where they are separated.

Cleaning and screening processes are sometimes used to separate larger ink particles along with coarse contraries present in waste paper such as sand, metal, clay, wax, asphalt, latex and rubber etc. Since presence of fillers, coating materials and other contraries are relatively small in old newspapers (ONP), washing and/or flotation are usually sufficient for deinking of ONP. The overall efficiency of a deinking process either by washing or flotation depends on the type of equipment, the amount of water used besides the extent of dispersion of ink particles during the pulping. In the present work the response of offset news ink to conventional deinking chemicals for dispersion of ink particles is studied. The efficiencies of separation of dispersed particles by washing and flotation are compared.

## EXPERIMENTAL

The black and white printed portions of about one month old editions of The Times of India' newspaper were used for this study. The sheets of newspapers were torn into small pieces by hand and disintegrated in a laboratory disintegrator for 15 minutes at 3% consistency and 45°C temperature. Prior to the disintegration deinking chemicals of four compositions as given in Table-1 were added to the stock.

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**Table-1 Compositions of deinking chemicals used as % on o.d. ONP.**

| Chemicals | DC1 | DC2 | DC3 | DC4 |
|---|---|---|---|---|
| NaOH | 1 | 1.5 | 1 | 1 |
| $Na_2SiO_3$ | 2 | 3 | 1.67 | 1.67 |
| EDTA | - | 0.7 | 0.5 | - |
| $H_2O_2$ | - | 1.5 | 1 | - |
| Active chemical* | 1 | 1 | 1 | - |

***Proprietary deinking chemical combining functions of dispersant and collector.**

For flotation deinking the disintegrated stock was diluted and deinked in a laboratory flotation cell similar to the one described by Ferguson (3). The laboratory setup consisted of a 1 litre graduated glass cylinder. For aeration a copper tube of 5mm inner diameter, folded into a spiral shape, was immersed by the cylinder reaching up to the bottom. Fine holes were drilled at the bottom side of the spiral portion of the tube. The whole unit was kept in a small plastic tub to collect the rejects. After a number of trials and errors it was observed that 3501/h airflow for 10 minutes gave good reproducible results. During the floation experiment the inky foam was constantly removed into the tub by manual skimming while the level of the stock was maintained by continuously adding extra water (100 ml). The flotation was conducted at 1% and 0.7% consistency. The collected foam was flittered on a buckner funnel and dried in an oven at 105°C.

The wash deinking was done in a 200-ml buckner funnel over a wire mesh. The amount of wash water used was varied from about 200 kg/kg pulp to 800 kg/kg. Seives of 100 and 40 mesh were used in the buckner funnel.

Handsheets of 40-50 g/m$^2$ were prepared in a laboratory sheet former from the pulp accepted after flotation or washing. The use of dilution water during sheet making was limited to 11 only to avoid washing away of ink particles at this stage.

## DEINKABILITY

The efficiency of any deinking operation may be defined as a ratio of amount of ink removed to the amount of ink present before deinking. The amount of residual ink after a deinking operation can be determined by several methods. Presence of large agglomerates of ink particles can be determined by a visual observation of a sheet of deinked pulp. An image analyzer can be used for quantification of size and size-distribution of such agglomerates. However, if the ink particles are finely divided, they are not visible in the sheets to the naked eye. Particles finer than 2 μm are not detected even by most image analyzers (2). The graying effect of very finely dispersed ink particles can be expressed in terms of absorption coefficients of light absorbing components of a sheet of paper. The absorption coefficient k of recycled newsprint may be expressed as

$$k_{recycled} = ak_{lignin} + bk_{dye} + ck_{ink}$$

Where a, b and c represent the concentrations of lignin, dye and ink respectively. Bleaching reduces the value of a , removal of dye reduces b and deinking reduces c. Further, the value of absorption coefficient is strongly dependent on the wavelength of the incident radiation. Jordon and Popson (4) have observed that for a near infrared incident radiation, absorption by a sheet of paper will be largely due to presence of pigment particles of ink. The absorption of IR by lignin or a dye is negligible. Thus, reflectance measurements of paper sheets at about 1000 nm can give a useful measure of effective concentration of ink particles in the sheet. The value of c under that condition will be

$$C = \frac{(K_{sheet})_{IR}}{(K_{ink})_{IR}}$$

The Technibrite Micro TB 1 C colorimeter (5) fitted with an IR filter (wavelength = 950 nm) uses this principle to provide values of effective residual ink concentration (ERIC) in sheets of paper. It may be mentioned that the ERIC value does not give a true concentration of residual ink. Besides the concentration of ink particles ERIC also depends on the kind of ink particles, size of the ink particles, the dispersion or agglomeration of the ink and the distribution of the ink in the sheet of paper. In spite of these limitations, ERIC shows a better correlation with ink removal in a deinking operation than the brightness. In the absence of any other better technique ERIC measurements have been used for determining residual ink concentration in the present study. Deinkability of a process step in which ink particle are removed in expressed as

$$D = \frac{E_{WD} - E_D}{E_{WD} - E_{UP}}$$

Where

$E_{WD}$ = ERIC value before ink removal.

$E_D$ = ERIC value after deinking.

$E_{UP}$ = ERIC value without presence of ink particles.

## RESULTS AND DISCUSSION

$E_{WD}$ and $E_D$ values were determined from the laboratory handsheets made from pulps before and after washing or flotation $E_{UP}$ has been taken for a standard unprinted newsprint sample. Table-2 shows the value of $E_{UP}$ and also $E_{WD}$ for different deinking chemicals.

Table-3 shows the effect of washing and flotation on deinkability of ONP. The chemicals charged for pulping were caustic soda, sodium silicate and active deinking chemical at 1%, 2% and 1% of old newspaper respectively. In the literature on recycled fiber processing, the dilution factor is defined from the inlet consistency for washing or flotation process expressed as kg of water per kg fiber present at the inlet. Dilution factor roughly represents the amount of inky effluent generated per unit mass of recycled fiber.

As seen from the table, the ONP responded easily to deinking process. The old newspaper had been printed by offset lithographic process. Usually such inks have 15-20% carbon black as pigment, about 60% mineral oil as vehicle, 10-20% binders and small amounts of aditives. Size range of ink particles obtained from disintegration of these newspapers appears to suit equally well for washing and flotation. Washing of pulp on wire finer than 40-mesh shows poorer ink removal with fibre yield remaining nearly same. It is also noticeable that while there is a large reduction in the ERIC values on deinking of the pulp the brightness values do not increase appreciably. This is easily verifiable by visual observation of the presence of the ink particles in the handsheets at different stages of deinking.

**Table-2 ISO brightness and ERIC values without and with the presence of ink particles.**

| | Bright-ness % | ERIC ppm |
|---|---|---|
| Standard newsprint (unprinted) | 62.7 | 47 |
| Handsheets made from disintegrated ONP before washing/flotation. Disintegration in presence of deinking chemicals | | |
| DC 1 | 42.6 | 993 |
| DC 2 | 47.6 | 849 |
| DC 3 | 49.4 | 785 |
| DC 4 | 42.0 | 791 |

Table-4 shows deinking results with an increased dose of caustic soda and sodium silicate. Hydrogen peroxide (1.5% on ONP) and EDTA (0.7% on ONP) were also added. We are able to see two important differences from the previous results. First, because of inclusion of peroxide, a bleaching agent, there is an increase in the brightness of recycled pulp. Second, ink removal efficiency of flotation process is better than that of washing process.

During experiments it was observed that the ink particles tended to remain with the fines fraction of the recycled pulp. Table-5 shows the concentration of ink particles with different fibre fractions. For these experiments disintegrated grey stock was fractionated in a Baur McNett classifier. Moe than 80% ink is removed from the +28 fraction during clasification. The removal of ink from this fraction remains nearly the same whether we add or do not add deinking chemicals at the time of disintegration of the stock. It may be economical to first separate the long fibre fraction and then treat the finer fraction for deinking by washing or flotation or a combination of both.

## CONCLUSION

1. Deinkability of ONP is dependent on several factors such as the composition and dose of deinking chemicals, the method of ink separation by washing or floation and the amount of water used.
2. Washing as well as flotation process can easily deink old newspapers printed by offset method.
3. Ink particles tend to remain with the fine fraction of the recycled pulp. It may be economical to first separate the long fibre fraction and then treat the finer fraction for deinking by washing or flotation or a combination of both. This will result in lower amounts of stock to be processed, reduced doses of deinking chemicals and lower pollution load.

**Table-3 Results of washing and flotation with deinking chemicals DC1**

| Dilution Factor kg/kg | Washing 100 mesh screen D % | Y % | B % | Washing 40 mesh screen D % | Y % | B % | Flotation D % | Y % | B % |
|---|---|---|---|---|---|---|---|---|---|
| 100 | | | | | | | 87 | 89 | 50.0 |
| 140 | | | | | | | 92 | 88 | 50.9 |
| 200 | 76 | 76 | 50.1 | 90 | 80 | 49.2 | | | |
| 300 | 78 | 75 | 50.9 | 90 | 79 | 48.3 | | | |
| 400 | 78 | 76 | 50.9 | 93 | 76 | 47.4 | | | |
| 600 | 81 | 76 | 51.0 | | | | | | |
| 800 | 81 | 76 | 51.2 | | | | | | |

D = Deinkability, Y = yield, B = ISO brightness

**Table-4 Results of washing and flotation with deinking chemicals DC2**

| Dilution Factor | Washing 40 - mesh screen D % | Y % | B % | Flotation D % | Y % | B % |
|---|---|---|---|---|---|---|
| 67 | 43 | 75 | 54.9 | | | |
| 100 | 43 | 77 | 56.2 | | | |
| 140 | | | | 98 | 88 | 62.1 |
| 200 | 49 | 78 | 58.2 | | | |
| 285 | 60 | 81 | 57.4 | | | |
| 400 | 74 | 76 | 56.3 | | | |

D = Deinkability, Y - yield, B = ISO brightness

**Table-5 Residual ink in different size fractions of fibres.**

| Mesh size | DC 3 | | | DC 4 | | |
|---|---|---|---|---|---|---|
| | Retained % | Brightness % | ERIC ppm | Retained % | Brightness % | ERIC ppm |
| + 28 | 43.7 | 54.6 | 171 | 43.2 | 44.6 | 178 |
| + 48 | 14.1 | 56.6 | 197 | 13.2 | 47.1 | 246 |
| + 100 | 6.7 | 58.5 | 223 | 6.7 | 46.3 | 414 |
| + 200 | 3.8 | 53.8 | 424 | 4.4 | 40.2 | 706 |
| - 200 | 31.7 | - | - | 32.5 | - | - |

## REFERENCES


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