Comparison of Deinking Behaviour of Glazed Newsprint with ONP

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Relationships between efficiency and operating parameters have been studied for flotation deinking of weekly inserts in national dailies. These papers contain heavy printing of both text and pictures in coloured and black inks on glazed newsprint. These papers are similar in nature to most news magazines. Laboratory experiments have been conducted at varying doses of chemicals, temperature during disintegration, and yields of deinked pulp. The efficiency of deinking has been evaluated in terms of brightness and effective residual ink concentration (ERIC-950). We have observed that repulping of color-printed glazed newsprint at 60 °C show a poor deinking efficiency. The ink particles and the pulp fibers remain agglomerated and the separation of ink by flotation is difficult. The efficiency of flotation deinking improves when the temperature of repulping is increased to 90 °C. An efficient dispersion of ink particles during repulping is critical for bleaching of flotation-deinked pulp.

INTRODUCTION

Newspapers printed in black ink by offset process are relatively easy to deink. Typically, disintegration of wastepaper in the presence of sodium hydroxide, sodium silicate and hydrogen peroxide at temperatures between 45 to 60 °C (1,2), and flotation with 0.6 to 1% surfactant dose (3) is adequate.

ONP supplies to the recycled mills nowadays have increasing proportions of color-printed newspapers and magazines that show different deinking behavior from black printed offset papers. We may identify two major differences between these two types of wastepaper supplies. First, the glazed newsprint has higher ash content than the ONP. Second, the colored inks used in printing of glazed newsprint generally contain synthetic binders that dry oxidation, heat setting, or radiation curing, whereas, the black inks used in printing of newspapers dry mainly by absorption. In one study, deinking of magazines that were printed using UV varnishe gave large specks (4).

DEINKING EXPERIMENTS

For this study, we used colored pages of Sunday inserts of national dailies printed on glazed newsprint. The papers used were one to two months old. They were printed by offset process on a lightweight coated (LWC) grade with a basis weight of 57 g/m2 and ash content of 30%.

Besides adding typical doses of sodium hydroxide, sodium silicate and hydrogen peroxide, we used blends of stearic, palmitic, and oleic acids in equal proportions as collector chemicals. For deinking of newsprints, effective ink collector systems are blends of fatty acid derivatives with chain length ranging from 16 to 18 carbon atoms. There appears some synergistic effect between various chain lengths, as single chain length derivatives are not found as effective (3).

Deinking process consists of two major steps: detachment of ink particles from the fiber, and separation of these particles from the fibers by washing or flotation. In the present study, we used a laboratory disintegrator to function as pulper where detachment of ink particles from fibers takes place, and a 1-L measuring cylinder to function as flotation cell. Though the apparatus used in the laboratory is quite different from the full-scale deinking units, results of laboratory studies provide useful information on the interactions of wastepaper, deinking chemical and other operating parameters. We used the following general procedure:

Repulping

For each experiment, we took 60 g (o.d.) wastepaper, torn it into small piece by hand and mixed thoroughly. Required amounts of caustic soda, sodium silicate, fatty acids, EDTA and hydrogen peroxide were weighed and dissolved in 500 ml hot water in the same order as given above. The chemicals charged during repulping in different deinking trials are given in Table 1. The waste paper was mixed with the solution of the chemicals and diluted further to 3% consistency by adding hot water. The sample was then disintegrated in the laboratory disintegrator for 10 min. The disintegrated stock was diluted with hot water to 1% consistency.

Table 1 : Chemical doses and repulping conditions charged different deinking trials.

Exp. No.	NaOH (%)	Na2SiO3 (%)	Soap Solution (%)	EDTA (%)	H_2O_2 (%)	Disintegration Temp. °C	Retention Time (min.)
1	1	2.5	1	0.5	1	60	0
2	1	2.5	0.6-1.8	0.5	1	60	0
3	1	2.5	1	0.5	1	60	30
4	1	2.5	1	0.5	1	90	30
5	1	2.5	1	0.5	1	120	30

Note: Disintegration time was 10min in every trial.

Flotation

Flotation was carried out at 1% consistency in a flotation cell shown in Figure1. A perforated copper tube was used for aeration. The size and speed of bubbles was further controlled by varying pressure and flow rate of air. The inky foam was removed continuously by hand maintaining the level of stock in the cell by adding water to it periodically. The temperature during flotation was between 35°C and 40°C and pH was between 8.5 and 9. After flotation for a certain period, the deinked stock was transferred to a bucket. Total volume and consistency of the deinked stock were determined to get the yield of the deinked pulp. From a number of trials, we observed that flotation for about 8 minutes using upstream air pressure of 3.7bar and airflow rate of 360 L/h produced effective and reproducible deinking of the pup.

Evaluation of Deinked pulp

Effective residual ink concentration (ERIC 950), brightness, and L*, a*, b* color coordinates were measured from the pulp samples before and after flotation to determine the extent of ink removal during deinking process. A Technibrite Micro TB1C (6, 7) colorimeter was used for these measurements. The ERIC-950 (specific absorption coefficient of pulp for infrared radiation of wavelength 950 nm) represents a measure of the effect of residual ink and not the actual amount of ink. Since we used wastepaper printed in colored ink for this study, we also evaluated the effect of deinking on the change of the color of paper.

For determination of optical properties, laboratory sheets of 200 g/m2 were prepared from the pulp samples obtained before and after flotation on a British sheet former. The standard procedure for sheet making was used except that the volume of the dilution water was kept very low (800 ml per sheet) to avoid the washing of the pulp during sheet making and affecting the results of flotation deinking. This low volume of dilution water ensured maximum retention of fibers, fines, and ink particles in the sheet. The low grammage sheets (20 25

Table 2 : Effect of flotation yield on the deinkability of color-printed glazed newsprint.

Flotation Yield (%)	ERIC Value	Brightness (%)	L*	a*	b*	E*	D (%)
100(AR)	930.8	46.5	75.3	-1.1	4.1		
96.1	630.4	50.2	78.0	0.8	3.3	3.4	36.9
95.2	603.7	50.6	78.9	-2.2	3.5	3.9	40.2
93.8	629.5	51.8	79.1	-1.5	3.9	3.8	37.0
90.7	602.6	50.6	78.6	-1.8	4.1	3.4	40.3
88.0	613.1	51.9	79.3	-0.8	3.1	4.2	39.0
77.6	601.4	50.6	79.4	-1.8	4.1	4.2	40.4
74.4	511.8	53.2	80.5	-2.7	4.7	5.4	51.4
67.3	533.2	53.1	80.0	-2.3	4.4	4.8	48.8

Note: 1. AR-After repulping, 2. AF- After flotation,
3. E*- Color difference of the deinked pulp with its respective gray stock. 4. D- Deinkability, %

Table 3 : Effect Soap solution dose on deinkability of color-printed glazed newsprint.

Soap S. Dose (%)	Stage	Flotation Yield (%)	ERIC Value	D (%)	Brightness (%)	L*	a*	b*	ΔE*
0.6	AR		937.3		46.6	76.5	-1.4	4.0	
	AF	93.6	698.2	29.1	48.6	78.1	-1.2	5.1	1.9
0.9	AR		916.3		49.5	77.6	-1.2	3.0	
	AF	93.8	576.6	42.5	53.6	80.5	-1.1	4.0	3.1
1.5	AR		948.5		46.8	76.0	-1.2	3.4	
	AF	88.1	593.0	42.7	51.4	79.5	-1.3	4.6	3.7
1.8	AR		898.2		48.5	77.2	-2.6	3.6	
	AF	85.7	596.0	38.6	53.0	80.1	-1.5	4.6	3.2

Note: 1. AR-After repulping, 2. AF- After flotation,
3. ΔE*- Color difference of the deinked pulp with its respective gray stock. 4. D- Deinkability, %

g/m2) required for measurement of ERIC 950 were made on a filter paper using the following procedure: The drain valve of the British sheet former was closed and the lower part of the machine was filled with water until the wire was flooded. A toughened filter paper of 185 mm diameter was laid on the wire and pressed gently to remove wrinkles or any trapped air between the filter paper and the wire. The upper cylinder of the machine was raised over the wire and closed. Thoroughly mixed pulp slurry containing 0.4g to 0.5g solids in 300ml was poured gently into the upper cylinder and allowed to become stationary. The water from the machine was then drained. The sheet machine was opened and the filter paper with the sheet formed on it was removed from the machine and laid on a few dry blotting papers. When both sheet and filter paper dried, the sheet was gently removed from the filter paper.

For comparison, we also measured the ERIC 950, brightness, and color coordinates for unprinted portions of the wastepaper. For this purpose, the unprinted trims of the wastepaper were disintegrated with the deinking chemicals in the same way as done for other samples. The disintegrated stock was washed with water on a

Table 4 : Optical properties of different fiber fractions of gray stock repulped at 60°C and 90°C temperatures.

Stage	ERIC Value	Brightness (%)	Color Coordinates L*	a*	b*	D (%)	
Unprinted trims	116.1	61.1	86.7	0.6	7.2		
After pulping at 60 °C	930.8	46.5	75.3	-1.1	4.1		
Bauer-Mc	R28	556.4	53.2	80.5	-1.5	5.3	47.5
Nett Fractionation of	R48	610.4	50.83	79.4	-2.5	5.9	41.1
stock pulped at	R100	698.2	47.86	77.8	-2.3	6.0	30.6
60 °C	R200	924.6	45.9	76.5	-2.0	6.1	3.6
After pulping at 90 °C		954.7	41.6	74.9	-2.2	8.1	
Bauer-McNett	R28	163.5	47.29	80.3	1.1	10.8	94.3
Fractionation of	R48	261	45.08	79.0	0.0	9.7	82.7
stock pulped at	R100	448.3	45.3	77.9	-1.0	8.5	60.4
90 °C	R200	928.4	42.4	75.8	-1.6	7.8	3.1

Note: R28- Fiber fraction retained on 28-mesh screen
R100- Fiber fraction passed 48-mesh screen and retained on 100-mesh screen
R48- Fiber fraction passed 28-mesh screen and retained on 48-mesh screen
R200- Fiber fraction passed 100-mesh screen and retained on 200-mesh screen

Table 4 : Effect of repulping temperature on deinkability of color-printed glazed newsprint .

Repulping Temp. °C	Stage	Flotation Yield(%)	ERIC Value	Brightness (%)	L*	a*	b*	E*	D (%)
60°C	AR		996.5	44.8	75.5	-1.6	4.2		
	AF	86.8	623.4	49.9	78.6	-3.1	4.6	3.5	42.4
	AF	82.8	674.1	.49.9	78.9	-3.1	5.0	3.8	36.6
90°C	AR		954.7	41.6	74.9	-2.2	8.1		
	AF	91.7	580.0	48.1	79.2	-3.8	7.4	4.6	44.7
	AF	89.5	426.8	49.5	79.8	-2.6	6.5	5.2	63.0
120°C	AR		938.8	41.9	75.0	-2.2	6.8		
	AF	80.2	401.6	49.3	80.5	-1.4	8.5	5.8	65.3
	AF	76.3	392.2	50.7	81.6	-1.6	8.8	7.0	66.4

Notes : 1. AR-After repulping, 2. AF- After flotation,
3. ΔE*- Color difference of the deinked pulp with its respective gray stock. 4. D- Deinkability, %

buckner funnel over 300-mesh screen, And the washed pulp was used for the preparation of laboratory sheets required for measurement of ERIC and other optical properties. (Table 4 shows optical properties of the handsheet prepared from unprinted trims)

RESULTS AND DISCUSSION

Deinking efficiency

The efficiency of flotation deinking was calculated from the measured values of ERIC 950 as given in equation 1.

Where

EWD ERIC 950 of pulp before deinking

ED - ERIC 950 of deinked pulp

EUP - ERIC 950 of unprinted trims

Flotation is a solid-solid separation process like screening or classification. The efficiency of separation increases as the total mass of rejects is increased. Table 2 show that the deinking efficiency and the brightness of deinked pulp increase as the yield form the flotation is allowed to decrease. In these experiments, varying airflow, air pressure, and time of flotation reduced the yield. The deinking efficiency shows a quick rise in the beginning and then tapers off with further reduction in yield. The limiting value of flotation efficiency is determined by the efficiency of detachment of ink particles from fibers in the disintegration stage.

Increasing the dose of soap solution from 0.6 to 0.9% on the weight of wastepaper shows an increase in deinking, but a dose beyond 0.9% does not show any improvement (Table 3).

Effect of temperature during disintegration of wastepaper on flotation deinking

When the temperature for disintegration of wastepaper was 60°C, the deinking efficiency was low even at low yields of deinked pulp indicating a poor separation of ink particles from the fiber surface. Table 4 shows a Bauer-McNett classification of the gray stock repulped at 60°C and 90°C into different fiber fractions. Even the coarsest fraction (R28) shows a high value of effective residual ink concentration confirming inefficient ink

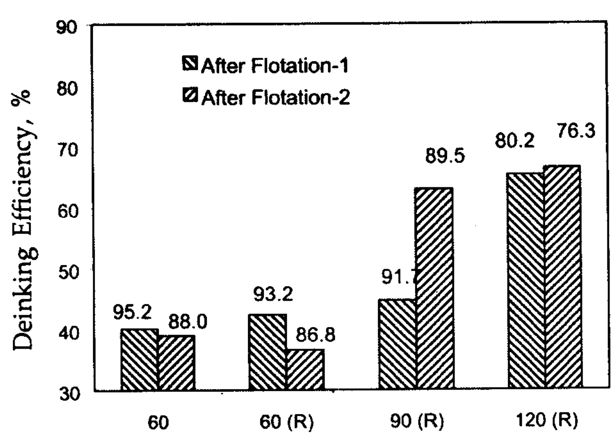

Figure 1 : Effect of repulping temperature on deinking efficiency on flotation deinking of color-printed glazed newsprint.

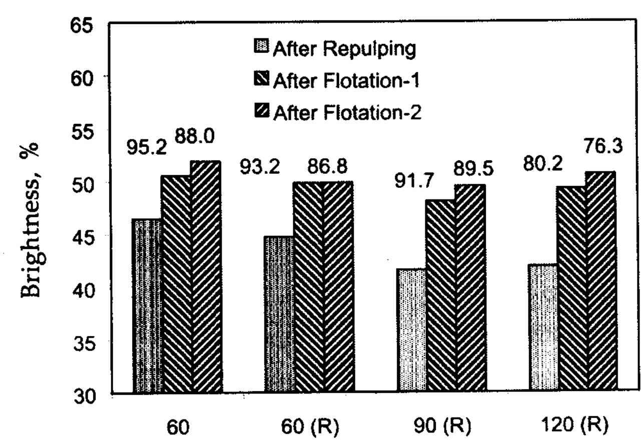

Figure 2 : Effect of repulping temperature on brightness on flotation deinking of color-printed glazed newsprint.

Table 5: Conditions of bleaching of deinked pulp after flotation stage.

	Chelating stage	Peroxide (P)	Hydrosulfite (Y)
Bleaching Agent, %	-	2	1
NaOH, %	-	1.3	-
Na_2SiO_3, %	-	2.5	-
Chelant, %	0.2	-	-
Consistency, %	5	15	3.5
Time, min	60	60	60
Temp, °C	60	60	60
Initial pH	7	-	7
Total Alkanity/H_2O_2	-	0.8	-

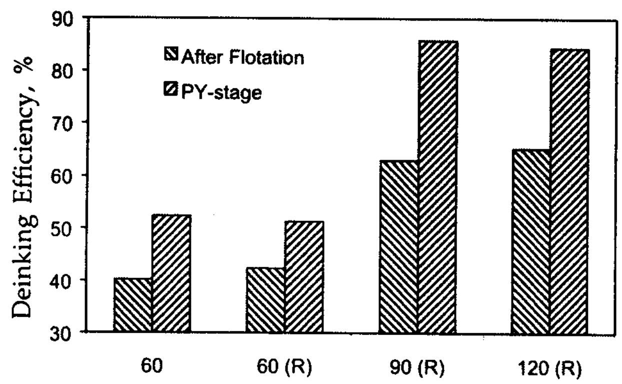

Figure 3 : Effect of deinking efficiency of bleaching of flotation deinked pulp of color-printed glazed newsprint.

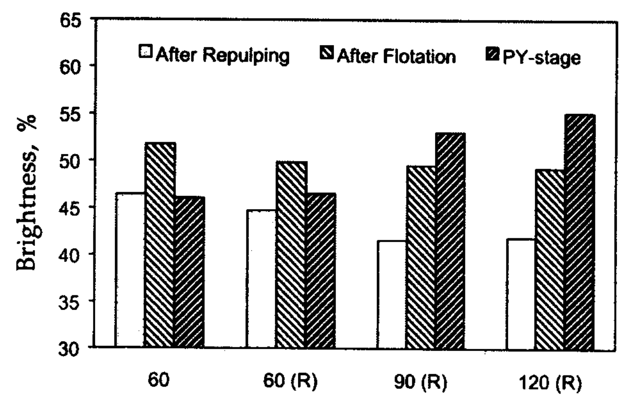

Figure 4 : Effect on brightness of bleaching of flotation deinked pulp of color-printed glazed newsprint.

fiber separation during repulping.

To see if the temperature of the stock during repulping had any effect on the ink fiber separation, the wastepaper was disintegrated at three different temperatures, viz., 60°C, 90°C and120C. We followed the following sequence for these experiments: the wastepaper was disintegrated in water at 3% consistency, the stock was dewatered and the deinking chemicals were added such that the consistency of the stock became 12%, this stock was maintained at the desired temperature for 30 min. For treatment at 60°C, stock in plastic bags was placed in thermostatic water bath. For 90C and 120C, an auto clave was used. After 30min, hot water was added to reduce the consistency of stock to 3%. This stock was disintegrated for 10min in the laboratory disintegrator. The temperature of the hot water used for dilution was 60°C for treatment temperature of 60C and 80°C for treatment temperatures of 90°C and 120°C. After repulping the inky stock was flotated at constant air pressure and air flow rate (3.7 bar and 360 L/h), only the flotation time was varied from 7min to 10 min.

Figures 1 and 2 show the effect of repulping temperature on deinking efficiency and the brightness of the deinked pulp. Disintegration of wastepaper at elevated temperature shows improved detachment of ink particles from the fiber surface. After flotation, the stock disintegrated at 90°C and 120°C was about 7.5% points brighter than the stock that was disintegrated at 60C. Ink specks were clearly visible on the handsheets made from the pulp that was deinked at 60°C, but on the handsheets made from pulp deinked at 90°C or 120°C no such specks were visible. The treatment of the stock at 120°C did not show much improvement in deinking efficiency, but it showed a greater loss of useful fiber during flotation.

The pulps repulped at 60°C and 90°C, were classified into four fractions in a Bauer-McNett classifier. The fines fraction of the pulp, i.e. the fraction passed through 100-mesh screen and retained on 200-mesh screen (R200) has nearly the same residual ink concentration as the whole pulp regardless of the repulping temperature. However, the concentration of the residual ink in coarser fractions of the pulp depends on the repulping temperature. The coarse fraction (R28) of the stock repulped at 60°C has much higher residual ink concentration than the coarse fraction of the stock repulped at 90°C. This suggests that for the stock repulped at 90°C, the ERIC value of R28 fraction (Table 4) was close to the ERIC value of unprinted trims indicating complete removal of ink particles from the fiber surface.

Table 6 : Effect of bleaching on deinkability of color-printed glazed newsprint.

Pulping Temp.C	Stage	Flotation Yield (%)	ERIC Value	Bright. (%)	L*	a*	b*	E*	D (%)
60°C	AR		930.8	46.5	75.3	-1.1	4.1		
(retention	AF	93.8	629.5	51.8	79.1	-1.5	3.9	3.8	37.0
time	P-stage		630.6	46.76	76.4	-2.0	4.0	1.4	36.9
0 min)	PY-stage		504.2	46.08	75.8	-1.1	3.0	1.2	52.4
60°C	AR		996.5	44.8	75.5	-1.6	4.2		
(retention	AF	86.8	623.4	49.9	78.6	-3.1	4.6	3.5	42.4
time	P-stage		607.2	45.0	76.0	-3.0	5.1	1.7	44.2
30 min)	PY-stage		544.6	46.6	77.0	-2.8	4.9	2.1	51.3
90°C	AR		954.7	41.6	74.9	-2.2	8.1		
(retention	AF	89.5	426.8	49.5	79.8	-2.6	6.5	5.2	63.0
time	P-stage		386.4	49.1	79.6	-2.2	7.0	4.8	67.8
30 min)	PY-stage		235.5	53.1	81.9	-3.5	6.8	7.3	85.8
120°C	AR		938.8	41.9	75.0	-2.2	6.8		
(retention	AF	80.2	401.6	49.3	80.5	-1.4	8.5	5.8	65.3
time	P-stage		302.7	52.1	81.8	-2.2	8.1	6.9	77.3
30 min)	PY-stage		244.2	55.1	83.5	-3.4	7.5	8.6	84.4

Note: 1. AR-After repulping, 2. AF- After flotation, 3. ΔE*- Color difference of the deinked pulp with its respective gray stock. 4. D- Deinkability, %

Effect of Bleaching of Deinked Pulps

The deinked pulps were also bleached using PY-stage (hydrogen peroxide followed by sodium hydrosulfite). The conditions of bleaching are given in Table 5 (5). For these experiments, we used the pulps that were subjected to different temperatures during disintegration stage and subsequently deinked by flotation. The pulps that were processed at 90°C and 120°C during disintegration responded to bleaching better than the pulp that was disintegrated at 60°C. A significant decrease in the ERIC value after Y-stage bleaching was also observed (Figures 3 and 4).

CONCLUSION

1. Repulping of color-printed glazed newsprint at 60 °C show a poor deinking efficiency. The ink particles and the pulp fibers remain agglomerated and the separation of ink by flotation is difficult. The efficiency of flotation deinking improves when the temperature of repulping is increased to 90 °C.

2. The classification results of the stocks repulped at 60°C and 90°C, indicates that during deinking of old magazines a repulping temperature up to 60°C is not enough. Repulping temperature of 90°C or greater gives a good deinking efficiency for deinking of color printed glazed newsprints.

3. An efficient dispersion of ink particles during repulping is critical for bleaching of flotation-deinked pulp.

4. Optical measurements, like brightness, color and also ERIC-950, for assessment of deinkability of pulps after any deinking operation should be used with caution. The specks size and their quantity affect the optical values very differently with compare to virgin pulps. There is need for standardization of use of these parameters for quality assessment of deinked pulp.

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