Overview – Deinking & Bleaching

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Deinking essentially involves three steps:

1. Detachment of ink from fibers;
2. Removal of detached ink from pulp;
3. Water clarification for reuse and disposal of removed ink and contaminants.

Mechanical, chemical, and thermal forces are utilized to detach ink from the fibers. This is usually carried out in pulpers where strong agitating provides shear force. Steam or hot water and deinking chemicals are added to help dislodge ink from the fibers. Some of the commonly used deinking chemicals, their dosages, and functions are summarized in Table 1.

A detailed discussion of ink chemistry and the action of deinking chemicals is presented by Borchardt in two separate chapters (p. 13, p. 18). Some of the ink, like newsprint ink, is relatively weakly bonded to the fibers, and can be detached rather easily. On the other hand, toner or UV-cured ink may be strongly bonded to the fibers and cannot be detached easily in a pulper. Mechanical dispersion units or kneaders are needed to handle these inks.

The detached ink is subsequently removed from the stock by screening, cleaning, flotation and washing according to Seifert (p. 139). The removal efficiency of a given process will depend on ink particle size, shape and density. In general, based on particle size alone one can say that large size particles (greater than 150 microns) will be efficiently removed by

Table 1. Commonly Used Deinking Chemicals.

Chemical	Dosage, kg/MT	Function
Alkali	10 to 20	Helps in fiber swelling and ink release.
Silicate	15 to 25	Acts as a dispersant for released ink and also serves as a buffering agent.
Surfactant	2 to 15	Emulsifies or forms micelles and helps in the detachment of ink.
Dispersant	2 to 10	Keeps the detached ink in suspension.
Peroxide	5 to 20	Prevents yellowing of groundwood fibers. Brightens fibers.
Collector	2 to 10	Assists in collecting ink particles on air bubbles in flotation deinking.
Displector	2 to 15	Combination of dispersants

screens, intermediate size (approximately 25 to 150 microns) will be removed by cleaners and flotation and small size (less than 25 microns) will be removed by washers. However, there are many exceptions to this rule. For example, flat disk shape toner particles or soft gel-like ink particles can pass through screen openings. Flexographic ink disperses into fine particles under alkaline conditions and can get trapped in fiber crevices and lumens making them difficult to remove by washing or any other known process.

Fundamentals of flotation theory are reviewed by Thompson (p. 31) while the technology of flotation is summarized by Eriksson and McCool (p. 69). Bliss and Ostoja-Starzewski (p. 85) present the principles of washing. Fetterly gives an overview of dispersion and kneading (p. 253). Similarities and differences between dispersion and kneading are discussed in detail by Cochaux, Carré, Vernac, and Galland (p. 109).

Deinking of office papers is gaining more importance. Properties of toner particles and deinking of office papers is explained by Ling (p. 98). The topic is also studied extensively at University of Utah (p. 167) and University of British Columbia (p. 183). Borchardt (p. 122) discusses the chemistry of flexo deinking. Enzymes can help in the detachment of ink as explained by Klungness, Sykes and Abubakr (p. 155). Enzymatic deinking is reviewed in detail by Welt and Dinus (p. 235).

Considerable research is in progress to develop new ways to deink recovered papers or to improve existing technology. For example, magnetic deinking (p. 167), ultrasonic deinking (p. 271), laundry processes (p. 229), and bleaching of OCC pulp (p. 263). The latter two processes, namely, the laundry process and OCC bleaching, are already being conducted on a full scale. Results from the initial experiments with magnetic deinking and ultrasonic deinking appear to be promising, but more work is needed before a full scale commercial applications can be justified.

The final step in deinking is that of water clarification for disposal of removed inks and contaminants and reuse of water. Water clarification is briefly discussed by Seifert (p. 139). Dissolved air flotation (DAF) is generally used for the clarification of process effluents. Differences between flotation deinking and dissolved air flotation clarification are summarized in Table 2. Dispersed air flotation or flotation deinking is a *selective separation* process where by the addition of surfactants we try to enhance the attachment of bubbles to ink and contaminants, but not to the fibers and fines. Moderate degree of turbulence is necessary to prevent the entrapment of bubbles in fiber flocs. DAF on the other hand, is a *collective separation* process in which suspended solids are agglomerated by the addition of coagulating and flocculating aids. Once the chemicals are well mixed, a relatively quiescent condition in the clarifier is required to protect the bubble–floc agglomerates.

The objective of bleaching is to attack the color bodies and lignin in the pulp so as to improve brightness and color of the pulp. Usually, oxidative bleaching agents like hydrogen peroxide, oxygen and ozone, and reductive bleaching agents like sodium hydrosulfite and formamidine sulfinic acid (FAS) are used for this purpose. The chemistry of bleaching is reviewed by Hanchett (p. 197), Lachenal (p. 205) and Biermann and Kronis (p. 247).

Table 2. Flotation Deinking and Dissolved Air Flotation (DAF) Clarification.

	Flotation Deinking	DAF Clarification
Objective	Remove contaminants but not fibers.	Remove all suspended solids.
Approximate Bubble Diameter	0.1 to 1.0 mm	0.01 to 0.1 mm
Mechanism	Surface chemistry and wettability	Coagulation and flocculation
Fluid Dynamics in Cell	Moderately turbulent	Quiescent

An Introduction to Deinking Chemistry

John K. Borchardt

INTRODUCTION

Deinking is a series of unit operations designed to detach ink from cellulose fibers and separate the dispersed ink from the pulp slurry. Unit operations designed to promote ink detachment from cellulose fibers include pulping, kneading, and dispersion. Washing, flotation, screening, and centrifugal cleaning are the unit operations that separate dispersed ink from the pulp slurry. Some of these unit operations also play an important role in stickies removal. Bleaching is an additional unit operation or series of unit operations designed to improve pulp optical properties. As deinking mills close their water loops, efficient removal of dispersed ink from process water prior to recycle is important to prevent build-up of contaminants in the system. This build-up can result in lower pulp brightness and stickies agglomeration and deposition.

Deinking chemicals are process aids that enable expensive mill equipment used in these unit operations to operate more efficiently - often much more efficiently. Deinking is a multi-step process. Step 1 occurs in the pulper. In this step, the ink is detached from the cellulose fibers. While other variables have an effect, ink chemistry and pulper chemistry are the major factors determining the efficiency of ink detachment from fibers and the size of the dispersed ink particles. Dispersed ink particle size plays a major role in the efficiency of downstream unit operations (1). (See Fig. 1.) Kneaders and high consistency dispersion units can provide an additional dose of ink detachment and reduction of dispersed ink particle size later in the deinking process.

The ink is now dispersed in the aqueous medium. To minimize its redeposition on cellulose, the dispersed ink must be separated from the fibers. This is Step 2. The various unit operations used to accomplish this separation differ in efficiency depending on ink particle size. Screening, mechanical cleaning, flotation, and washing are used in various sequences to remove a wide size range of dispersed ink particles.

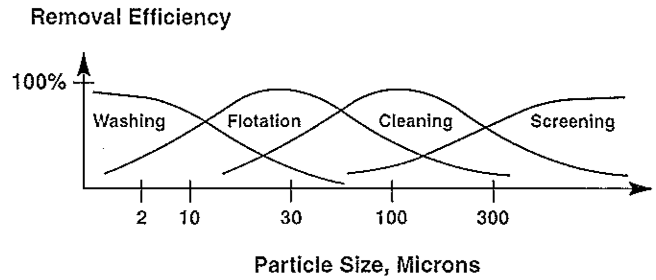

Figure 1: **Ink removal efficiency as a function of ink particle size for deinking unit operations (1).**

Step 3 of the deinking process is bleaching. Step 4 is process water clarification.

Overview of Deinking Chemicals

Deinking chemicals, their point of use, and their purpose are summarized in Table 1.

First we'll discuss surfactants. Then we'll review other chemicals used in various deinking unit operations and their purpose.

DEINKING SURFACTANT PERFORMANCE REQUIREMENTS

Deinking surfactants have to meet several performance criteria. These include:

- effectiveness of ink removal from cellulose fiber.

- dispersant properties.

- wash deinking - want a highly effective ink dispersant. For hydrophobic pigment particles such as carbon black, longer hydrophobe nonionic surfactants are most effective.

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