

# Recyclability of UV and EB Printed and Coated Paper

By David J. Korn

## Editor's Note:

*UV and EB are continuing to grow as many companies are discovering the advantages of these technologies. One of the biggest advantages is the fact that they are virtually 100% solvent and VOC-free; hence, they are environmentally friendly. However, despite the environmentally friendly tag, there are still some misconceptions that revolve around the recyclability of paper and other substrates that have been coated with UV- or EB-curable coatings or that contain UV- or EB-curable inks.*

*In 1992, RadTech commissioned the Beloit Corporation to perform a study to dispel the misconceptions of these technologies related to recyclability. The results of this study were presented at the 1992 RadTech Conference and are reprinted in this edition of the RadTech Report to, once again, quell the myths regarding this issue.*

The studies presented in this paper were performed by the Beloit Corporation, Fiber systems Division, in Pittsfield, Mass. They represent a series of pilot deinking trials performed on printed and coated paper containing a variety of ink and coating combinations. Included in the evaluation of the more widely used "conventional" ink systems were ultraviolet (UV)- and electron beam (EB)-cured inks and coatings.

The objective of these trials was to determine the behavior of the various ink and coating combinations in terms of repulpability and deinkability. The results indicated that all combinations were easily repulpable within normal operating parameters. In addition, most samples responded well to deinking operations such as flotation and cleaning. This work represents a major effort in addressing the recycling concerns of current and future users of UV and EB curing (drying) in the paper and graphic arts industries.

## Introduction

There is a general perception that paper and/or board products printed with UV or EB-cured inks and coatings cannot be recycled as compared to conventionally cured systems. From the paper mills to the waste brokers, the consensus is that landfill or incineration are the only ways to deal with such waste. In an effort to respond to these perceptions, RadTech, the industry group for companies involved in UV and EB processing, commissioned the Beloit Corporation to do a "blind" study of various printed and coated papers to help understand ink and coating behavior relative to repulping and deinking. The list of raw materials that were evaluated can be seen in Table 1.

The studies investigated a limited number of inks, coatings, and substrates. Issues such as coat weight and substrate variations were beyond the scope of this investigation. However, due to the demonstrated success with the wide cross section of materials used in these studies, there is good reason to believe that UV and EB inks and coatings do not present a dilemma for the paper recycling industry. In fact, previous mill scale trials have shown that various levels of this waste can be incorporated into a mill's standard furnish (blend) with no processing problems or detrimental effects on product quality.

## What is a UV or EB ink?

UV and EB inks and coatings are solvent-free, making them environmentally friendly. Being 100% solids

TABLE 1

### Raw materials

Inks	Coatings			
	Waterbase	Waterbase Catalyzed	UV	EB
Heatset (Publication)	X	X	X	
Waterbased (Flexo)	X		X	
EB				X
UV	X		X	
Conventional (Sheetfed Offset)	X	X	X	

(negligible VOCs), they are dried instantaneously by exposure to UV light or a beam of electrons. They produce an ultra smooth, high-gloss appearance with excellent abrasion and chemical resistance. The following chart will show the major differences in composition between “conventional” inks and UV and EB inks:

**Ink and Coating Components**

**Conventional**

- Resins (*i.e.*, alkyd, phenolic)
- Solvent (25-50% hydrocarbon/water)
- Pigments
- Additives (*i.e.*, catalyst)

**UV/EB**

- Oligomers (prepolymers)
- Monomers (reactive diluents)
- Pigments
- Additives (*i.e.*, photoinitiator)

**Experimental Procedure**

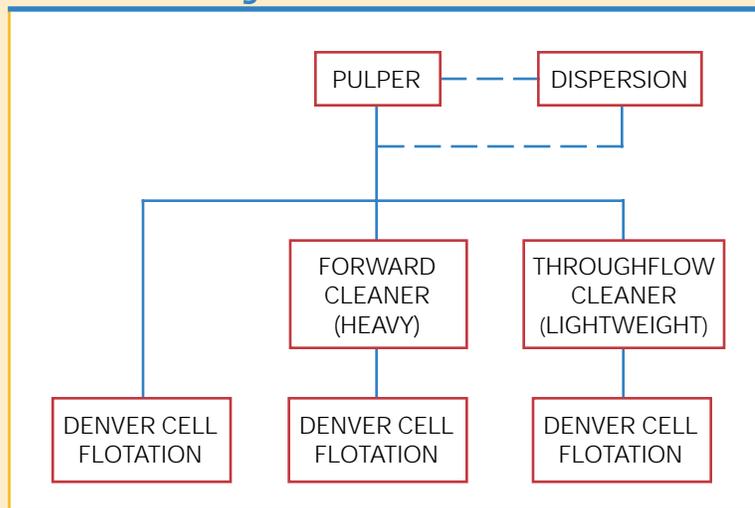
The materials evaluated in this study were gathered from a wide variety of printers. Each sample was individually investigated (*i.e.*, no blending of the samples in the pulper furnish.) Batch pulping was performed on approximately five pounds of each sample using a scaled down version of a commercial Shark pulper. Pulping conditions were at 5% consistency at a pH of 9-10 and 1.0% surfactant to aid in flotation. Total pulping time was 15 minutes at 120°F. The resultant slurry was split into three batches for subsequent cleaning and flotation. A general flow diagram for the trials is shown in Figure 1.

Bench scale flotation was performed with a laboratory Denver Cell for three minutes to simulate a commercial flotation plant. The stock was at approximately 1% consistency and 100°F.

Forward centrifugal cleaning was performed to remove ink specks and coating flakes with a specific gravity greater than one. Throughflow

**FIGURE 1**

**General flow diagram for the trials**



**FIGURE 2**

**TAPPI dirt speck content**

Paper Grade	PPM (> 200 microns)
Industrial Towel	200-1,000
Household Towel	50-400
Napkin	30-250
Writing Paper (office pads)	10-150
Facial	10-100
Fine Paper (stationary, copier)	< 5-10

Tissue Grades

Note: Tissue grades generally require less than 500 ppm.

centrifugal cleaning, sometimes referred to as reverse cleaning, was utilized to remove lightweight ink and coating contaminants.

In two of the 11 samples evaluated, dispersion (mechanical disintegration of ink and coating particles) was performed using a 12" single disk refiner at 30% consistency. This step was done prior to cleaning and flotation. Laboratory washing was carried out using a 150 mesh Tyler

screen and washing with fresh, reverse osmosis treated water for 15 minutes.

The sample preparation and testing performed by Beloit conformed to Tappi Standard Procedures (Figure 2). The only exception was the extensive image analysis used to evaluate pulping, cleaning, dispersion and flotation effects on the various raw materials (Table 2). This image analysis testing was performed using an Optomax V HR Image Analyzer. The

**TABLE 2**

**Brightness profile (G.E. Test)**

Ink/Coating	Pulper	Disp.	Flotation	Heavy Cleaning + Flotation	Light Cleaning + Flotation
Heatset/UV	63.4		81.4	84.6	
Heatset/WB-CAT	66.3		77.9	77.5	78.1
Heatset/WB	57.3		80.3	80.8	80.2
WB/UV	30.4 <sup>1</sup>		24.4 <sup>1</sup>	51.8	56.1
WB/WB	23.6 <sup>1,2</sup>		43.1 <sup>1</sup>	19 <sup>1</sup>	52.9
EB/EB	77.3		81.9	80.8	80.5
EB/EB*	77.8	74.5		76.9	72.5
UV/UV	75.9		83.4	82.7	82.3
UV/WB	75.9		85.0	83.5	82.4
UV/WB*	75.4	70.2	80.2	80.8	80.2
Convent/UV	71.2		81.5	77.7	77.2
Convent/WB-CAT	72.7		81.9	81.0	79.5
Convent/WB	70.2		78.2	76.9	78.9

Notes: A) Brightness of 70-80 required for tissue grades.  
 B) Brightness of 80-85+ required for fine paper grades.

Dispersion Trial 1. Problems peeling off filter  
 2. Infinite washing gave only 72.7

myriad of information derived from these analyses, among others, helped conclude what deinking systems would be required to achieve “general tissue quality” and “fine paper quality” grades. This information is summarized in Table 3.

**Results**

1. UV and EB inks and coatings are easily repulpable (capable of being defibered.)
2. It is clearly understood that all the materials evaluated in this study could be recycled into low-quality board grades.
3. For recycling into tissue grades, in general, a system containing flotation and centrifugal cleaners is required. UV inks (when utilized at 100% furnish level), and conventional inks with water-based coatings also require dispersion.
4. For recycling into fine paper grades, most ink and coating combinations require dispersion to further break down the ink specks and subsequent flotation to remove them. One possible exception to this is the heatset ink with water-based coating, which may only require additional cleaning without the need for dispersion.
5. The sample containing water-based ink with water-based coating may *not* be possible to recycle into fine paper due to unacceptable brightness (difficulty in removing enough very fine ink particles even with infinite washing.)

**Conclusion**

UV- and EB-printed and coated paper can be recycled into tissue and/or fine paper grades using commercially available equipment. ▶

—Energy Sciences, Wilmington, Mass. From a paper by David J. Korn presented at the RadTech 1992 conference.

**TABLE 3**

**Equipment for deinking various wastepaper \***

Ink/Coating	System for Tissue	Additional Equipment for Fine Paper
Heatset/UV	FLO, CL(h), CL(h)	DISPERSION, FLO
Heatset/WB-C	FLO, CL(h), CL(l)	DISPERSION, FLO
Heatset/WB	FLO	CL(h), CL(h)
WB/UV	FLO, CL(h), CL(l)	DISPERSION, FLO
WB/WB	FLO, CL(h), WASH	QUESTIONABLE
EB/EB	FLO, CL(l), CL(l)	DISPERSION, FLO
UV/UV	FLO, DISPERSION	FLO
UV/WB	DISPERSION, FLO	DISPERSION, FLO
Convent/UV	FLO, CL(h)	DISPERSION, FLO
Convent/WB-C	FLO, CL(h), CL(h)	DISPERSION, FLO
Convent/WB	DISPERSION, FLO	DISPERSION, FLO

Notes: CL(h) = Heavyweight Cleaners \* 100% Furnish  
 CL(l) = Lightweight Cleaners