

## Case Studies

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2B

CASE STUDIES  
FOR  
TEXTILE PRINTING

Textile Printing- The application of color to a fabric in a design or pattern (localized dyeing)

Modern printing generally incorporates one of the following techniques:

1. Flat-bed Screen Printing
2. Rotary Screen Printing
3. Engraved Roller Printing
4. Heat Transfer Printing

FLATBED SCREEN	ROTARY SCREEN	ROLLER	HEAT TRANSFER
-WOVENS, SOME KNITS	-WOVENS & KNITS	-WOVENS	-KNITS
-SLOW	-VERY FAST	-FAST	-SLOW
-IMPROVING DETAIL	-BETTER DETAIL	-EXCELLENT DETAIL	-EXCELLENT DETAIL
-LARGE REPEATS	-SMALL REPEATS	-EXPENSIVE ROLLERS  -LONG RUNS	-GREAT FOR SMALL YARDAGES
17%	50%	26%	7%

## WASTE CHARACTERISTICS FOR TEXTILE PRINTING

### Hard to Treat Wastes

Color from Dyes or Pigments

Toxic Organic Chemicals

Metals

Phosphates

### Dispersible Wastes

Print Paste Components

Thickeners, Binders, Humectants, etc.

### Hazardous or Toxic Wastes

Metals

Organic Solvents

### High Volume Wastes

Scour and Afterwash Water

(Hot, Warm and Cold)

## MAIN PROBLEMS IN PRINTING

COLOR - Dye and Paste Dumps; Clean-ups

METALS - Dye Dumps; Screen Making; Photo Developing

SUSPENDED SOLIDS - Print Paste and Clear Discards

SOLVENTS - Emulsion Thickeners and Clean-ups

HOT WATER - Afterwashing

BOD - Desizing; Print Paste and Clear Discards

FOAM (Floating Solids) - Carpet Printing

## STEPS IN PRINTING PROCESS

1. Preparation of Print Paste
2. Printing of Fabric
3. Drying
4. Fixation of Dyestuff
5. Washing - off

## Preparation of Printing Pastes

Type of specific formulation used depends on the fiber, the colorant system used, to some extent, the type of printing machine.

Typical ingredients used include:

dyes or pigments

thickeners

binders, cross-linking agents

sequestrants

dispersing agents - surfactants

water-retaining agents (humectants)

adhesion promoters

defoamers

catalysts

hand modifiers

## DYESTUFFS USED IN PRINTING

SAME AS THOSE USED IN DYEING

SPECIAL REQUIREMENTS

HIGH SOLUBILITY, DISPERSIBILITY

EXCELLENT WETFASTNESS

COTTON - REACTIVES, VATS, NAPHTHOLS

WOOL - ACID, METALIZED

NYLON - ACID, METALIZED

ACRYLIC - CATIONIC

ACETATE - DISPERSE, CATIONIC

TRIACETATE - DISPERSE

POLYESTER - DISPERSE

QIANA - ACID, DISPERSE

## AUXILIARY CHEMICALS

THOSE NECESSARY FOR FIXATION OF DYE INTO FIBER

REACTIVES - ALKALI

VATS - REDUCING AGENT

ACIDS - ACID

CATIONIC - ACID

DISPERSE - CARRIER

DO NOT INCORPORATE STRONG ACID, BASES, OXIDIZING AND REDUCING AGENTS IN PRINT PASTE.

ACID AGER

LATENT REDUCING AGENTS

(SODIUM SULFOXYLATE FORMALDEHYDE)

## Thickener Systems

### Natural Polymers

#### Polysaccharides

- Starch
- Cellulose
- British Gums
- Starch Ethers
- Seed Gums
- Alginates
- Exudate Gums
- Xanthum Gums

### Emulsions

Oil-in-water

Water-in-oil

### Synthetic Polymer Thickeners

CMC

Polyacrylic Acid (Acrylics)

EMA (Monsanto)

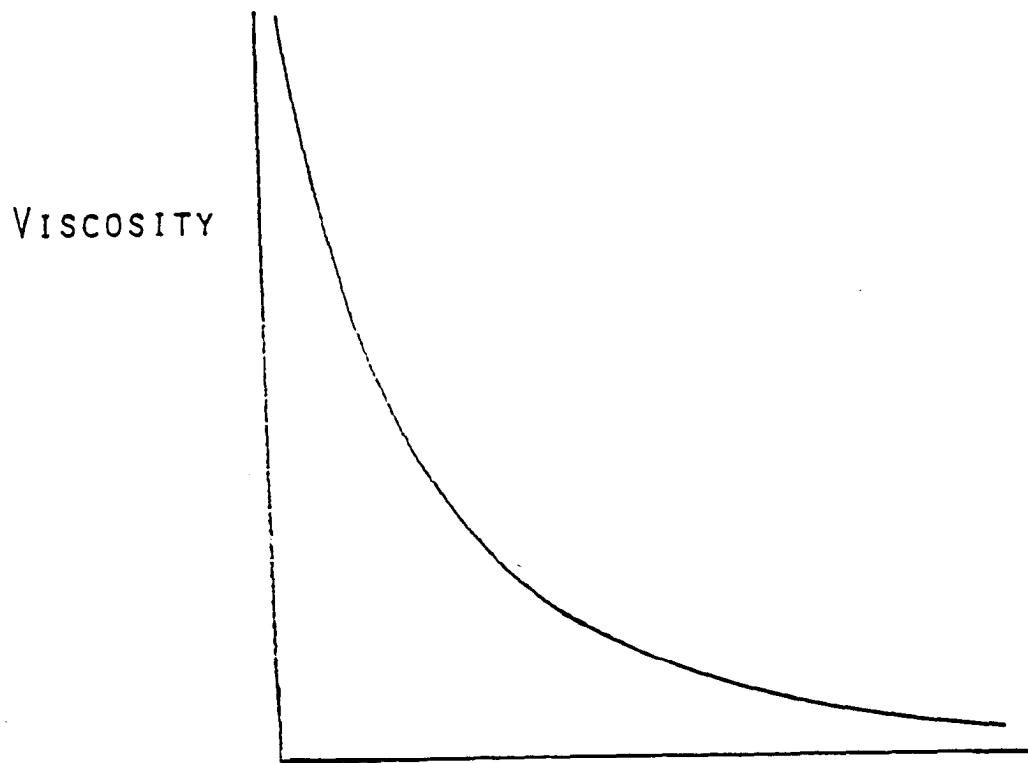
Mixed Monomer Thickeners

## THICKENING AGENTS

**MUST HAVE PSEUDOPLASTIC FLOW BEHAVIOR**

**LOW SHEAR = HIGH VISCOSITY**

**HIGH SHEAR = LOW VISCOSITY**



**PSEUDOPLASTIC BEHAVIOR**

## Binders

A product of high molecular weight which is capable of forming a three-dimensional film used to hold the pigment particles in place on the surface of a textile substrate.

-not necessary when using dyes

-very important in determining fastness properties

Normally synthetic (latex) compounds

Acrylics

Vinyl Acetates

Butadienes

Self-crosslinking agents

Methylolacrylamide

Methylolmethacrylamide

## Sequestering Agents

These are compounds which react with metallic ions in such a way that the metal becomes part of a complex

EDTA - most popular to use with dyes

Calgon - often used to soften water

## Dispersing agents

Surfactats - used to disperse solid particles, promote paste stability, and increase paste penetration into the fiber.

Similar in use are protective colloids- increasing paste stability.

### Surfactants can be

Anionic	S-	(acidic)
Cationic	S+	(basic)
Nonionic	S	(neutral)

## Humectants

Materials added to print paste formulations to prevent water evaporation from the paste - preventing "skin-over" and paste instability

### Typical Humectants

Ammonia

Triethanolamine

Polyalcohols

Ethylene glycol

Glycerine

Urea

## Adhesion Promoters

Increase adhesion of binder system to substrate

i.e. Pigment printing of fiberglass is enhanced  
by using aminosilane

## Catalysts

A chemical formulation to increase the speed of a chemical reaction.

May be included in print paste formulation for the binder or for reactive, sulfur, or vat dyes.

May be acidic or basic.

## Defoamers

Added to print pastes to minimize formation of foam (before foam printing).

Often silicone surfactants have been used - however any compound which decreases bubble formation in the print paste and exhibits no adverse effects can be used.

## Hand Modifiers

Normally softeners because binders tend to stiffen the fabric.

## **REASONS FOR SCOURING**

**REMOVE THE THICKENING AGENT**

**REMOVE AUXILIARIES**

**REMOVE EXCESS DYESTUFF**

**IMPROVE BRILLIANCE OF PRINT**

**IMPROVE FASTNESS PROPERTIES OF  
PRINT**

## **PROBLEM**

**BACK STAINING OF UNDYED AREAS**

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 1

Description - A survey of dyes in the mid 1970's showed that 95% of the copper in an N.C. company's effluent originated from 13 dyes. They were:

<u>Dye</u>	<u>Percentage</u>	<u>Cu Content</u>
Belamine F Red 3BL	4.00	
Belamine B Blue LT	3.68	
Pyrazol F Violet MXD	3.00	
Solantine Brown BRL	3.00	
Atlantic Blue 8 GLN-K	2.70	
Atlantic Resinfast Blue 2R	2.50	
Sirius Supra Turquoise LG	2.29	
Superlitefast Blue 2GLL	1.00	
Direct Navy OFS	0.70	
Belamine Red 3BL	4.00	
Solophenyl Brown BRL	3.00	
Fastolite Blue L	2.70	
Atlantic Black NR	1.50	

**All of the previous dyes have copper as a part of the dye molecule structure.**

**Possible Courses of Action:**

**(1) Substitute for metal containing dyes with non-metal dyes.**

**(2) Insure maximum fixation of dye by optimizing all processing parameters such as time and temperature of fixation, pH, salt concentration, and auxillary chemicals content.**

**In this case, direct dyes with non-metal content were substituted where possible, therefore, reducing the metal content discharged.**

## PIGMENTS IN TEXTILE PRINTING

In some cases, textile printing companies may use metal containing pigments which may not appear in the Color Index. Here also the copper is bound as an integral part of the chromophore molecule.

<u>Pigment</u>	<u>Percentage &amp; Content</u>
Inmont Respad Green GB3W	0.80
Inmont Respad Blue G3W	1.40
Inmont Respad Blue GH3W	1.35
Inmont Respad Blue GL3W	0.10
Inmont Respad Violet V3W	1.15
Inmont Respad Grey R3W	0.10

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 2

Description - PCA International, Inc. is a color portrait processing firm. PCA has undertaken a number of projects to recover and recycle process waste especially silver recovery.

#### Courses of Action:

(1) An electrolytic recovers silver from the color negative film fixer solutions. The process results in a 96% reuse of the fixer solutions.

(2) Color developer is regenerated using an ion exchange system. Total processing results in an 84% recovery of the color developer solution.

(3) Spent bleach solutions are recovered and regenerated by chemical additions, attaining 90% reuse capability.

#### Savings:

PCA saves over \$1.1 million each year in reusing process solutions. Silver recovery adds another approximate \$800,000 per year.

As can be seen, this study easily relates to the photographic processes used in textile printing screen design and manufacture.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 1

Description: American Colors coats or prints on fiberglass. Waste acetone is generated during the coating or printing process.

Courses of Action:

(1) Waste acetone is distilled and recovered at approximately a 70% rate. This reclaimed solvent is used in equipment cleanup.

(2) The volume of solvent has been reduced by process modifications, especially going from light to dark coatings. This yields an overall reduction in cleanup waste.

Savings:

American Colors cut production costs by reducing volumes of waste solvent and reclaiming what solvent waste was generated. The net savings were many thousands of dollars per year.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 4

Description: Thiele - Engdahl, Inc. uses printing inks. In equipment cleanup the company uses isopropyl acetate.

#### Courses of Action

Thiele-Engdahl uses solvent twice for cleanup before recovery and reuse. The solvent is recovered on-site using batch distillation. Distillation bottoms are sent off-site for disposal.

#### Savings:

Before the distillation system the company sent 5,000 gallons of used solvent to off-site disposal every 45 days. Since reclaiming and reuse reduce both the volume of waste and the volume of virgin solvents purchased, significant savings result, paying for the distillation system in 2 years.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 5

Description: Lenoir Mirror Co. uses xylene solvent in equipment cleanup.

Courses of Action:

The company reduced their waste costs by recovering and reusing spent solvent on-site. Approximately 95% solvent was recovered by distillation and still bottoms are sent to an incinerator.

Savings:

Lenoir Mirror saves over \$5,000 per year in material and disposal costs. Total system payout will be thirteen months.

This overall case relates to solvent recovery in printing from screen and machine cleanups.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 6

Description: American Enka Co. (now BASF) produces nylon yarn. Isopropyl alcohol was used as a solvent for a fatty amine. Previously the company employed an outside firm for the distillation and reuse of solvent. Average solvent losses were 15% with some as high as 40%. The solvent was also often contaminated and required analysis before reuse.

#### Courses of Action:

The company purchased a used distillation system for \$7,500.00. Some modifications were made to the unit for use with their product.

#### Savings:

Initially this resulted in a \$90,000.00 per year savings over their previous contract fees. They also obtained a much superior recovered solvent at a 90% efficiency rate. They now use far more of the recovered alcohol and also utilize the still bottoms as an asphalt emulsifier in another product line. Total payback for the project was approximately one month.

This project also relates to solvent recovery and reuse possible by textile printing operations.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 7

Description: Rexham Corp. prints product labels using alcohol/acetate based formulations using flexographic printing techniques.

Courses of Action:

The company was able to reduce its waste generation through process modification. Rexham substituted water based inks for the traditional solvent based materials. The net result was to reduce the quantity of solvent waste generated and the quantity of solvent released to the atmosphere. However, gloss finish labels could not be printed this way. There was also a net decrease in printing speed using the water-based inks.

Savings:

This modification did not require Rexham to incur any large capital costs; however, some operator retraining was required. Because the company also purchased an on-site distillation system for solvent recovery for \$16,000, Rexham Corp. saves \$15,000 per year in virgin solvent costs and \$22,800 per year in waste disposal costs. Total pay-back for the process modifications and solvent recovery systems was 5 months.

As can be seen, this example relates directly to many textile printing operations.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 8

Description: RJR Archer, Inc. is a paper printing operation. The company was having a great deal of problems with air emissions from its printing presses.

Courses of Action:

RJR Archer installed a carbon adsorption system to capture and recover 98% of the solvents lost to the atmosphere from drying ovens. This amounted to an average of 2,655 gallons per day. This solvent could be either reused or sold. By properly recirculating air exhaust from its drying ovens before distillation, the size of the system was smaller than originally predicted.

Additionally, all inks formulations were reviewed and reformulated using a maximum of two solvents per blend, therefore increasing the recovery system efficiency.

Savings:

RJR Archer saves over \$6,300 per day in solvent costs. The payback for the \$4.3 million recovery system was 2.5 years. After payback, RJR Archers estimated an annual \$1.7 million net cost savings.

Air emissions are also very important to a number of textile printers.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 7

Description: United Piece Dye Works is a textile dyeing and finishing operation located in North Carolina. The company because of its processing operations had a problem with phosphorous containing materials in its effluent.

#### Courses of Action:

The company was able to meet stringent discharge limits on phosphorous by making chemical substitutions in their production processes. Initially, a detailed chemical analysis and evaluation of their processing was performed to identify sources of phosphorous. Where possible, non-phosphorous or non-phosphate containing chemicals were substituted.

#### Savings:

Through this substitution, the use of hexametaphosphate was reduced and the use of phosphoric acid was totally eliminated. The level of phosphorous in the company's effluent was reduced from 7.7 mg/liter to less than 1 mg/liter. United Piece Dye Works was able to meet these effluent limits without any capital expenditure for phosphorous removal or quality reduction in their products.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 10

Description: Ellen Knitting Mills, a North Carolina hosiery company, was discharging spent dye bath water to a municipal sewer system. The water temperature of 130° F. caused many problems for the sewer treatment system.

#### Courses of Action:

The company decided to purchase a heat reclamation system. This type system is generally only cost effective if there is a sufficient flow of water at a high enough temperature. The net result of this action was reduced thermal pollution, reduced waste treatment costs and recovery and reuse of energy.

#### Savings:

The company invested \$100,000 in a heat recovery and exchange system reducing the effluent temperature from 130°F to 70°F. This removed heat was used to preheat incoming feed water for dye tubs from 55°F. to 105°F. This preheating operation alone saved approximately 52,000 gallons of fuel oil per year. Total payback for the system was two years.

## CASE STUDIES FOR TEXTILE PRINTING

### CASE NO. 11

Description: Kemp Furniture used several process modifications to reduce their overall waste volume. As a furniture manufacturer, the traditionally used solvent-based inks to print wood grain on plywood and fiberboard.

Courses of Action:

With only minor changes in operating procedures, the company substituted water-based inks for the solvent-based inks.

Savings :

The net result of this initial change was to reduce solvent waste by 30 - 40%. These waste solvents were reused, where possible, to clean pumps and piping. This was all accomplished with no major capital outlay. Off-site recovery of solvent was used and this solvent reused in processing.