4-1980

The Replupability of Secondary Fibers Containing Latex-Based Pressure – Sensitive Adhesives

William K. Forester
Western Michigan University

The Replupability of Secondary Fibers Containing Latex-Based Pressure - Sensitive Adhesives

by
William K. Forester

A Thesis Submitted
in Partial Fulfillment of
The Course Requirements for
The Bachelor of Science Degree

Western Michigan University
Kalamazoo, Michigan

April 1980

ABSTRACT

It is the purpose of this thesis to investigate possible means of rendering latex-based pressure sensitive adhesives innocuous in currently operating secondary fiber systems.

It has been found that certain solvents will effectively attack and disperse latex-based pressure sensitive adhesives when used in solutions of 0.5 to 1.0 percent depending on the end product.

This involves presoaking the contaminated stock prior to defibering for varying amounts of time depending on the amount of contamination, the type of adhesive present, the temperature and pH parameters currently in use in each specific system.

It is also evident that contaminant build-up on equipment may be problematic also depending on the amount of contamination, the percentage of dispersant and the amount of agitation involved in the pre-soaking reaction vessel. The amount of equipment build-up was found to be minimized by increasing the peripheral speed of the pre-soaking slurry, thus increasing the slurry to reaction vessel contact. Contamination build-up on the defibering device was not encountered.

TABLE OF CONTENTS

INTRODUCTION

Any type of recycled fiber, be they waste paper or clean mill broke, is considered "secondary fiber." Pulp cost is the greatest single factor introducing mills to consider the use of secondary fiber. (2)

A pressure-sensitive adhesive is permanently tacky and usually coated on various types of backing to form pressure-sensitive tapes. Pressure-sensitive adhesives also are used for labels, decals, wall coverings, and other end products. (3)

Most commercial pressure-sensitive adhesives are prepared in organic solvent systems. Toxicity, fire hazards and pollution are some of the reasons for the current major effort to change from solvent to water borne pressure-sensitive adhesives. (3)

The removal of these contaminants is complicated by several factors. First, the monitary justification of the removal of such contaminants is of prime concern. Few existing operations can justify an increase of five dollars/ton. Second, the quantities of these contaminants is very low, (25 ppm or less). Third, if the degree of dispersion and the form of the contaminant is small enough it will not be detected in the end product. If the contaminant agglomerates it will cause problems ranging from adherence to the forming wire and felts to picking on a printing press, web fed offset being

most critical. It is generally accepted if a press run of 10,000 can be achieved without wash up the base stock is acceptable. (1)

LITERATURE SURVEY

Historical Introduction:

Commercial latex adhesives are based on various polymers including styrene/butadiene (SBR), polyvinyl acetate, acrylic and other types as well. (3)

Synthetic SBR latexes were first produced and sold for an "adhesive" end-use in 1946; the application was a binder in pigmented coating for printed papers. Two years later SBR latexes were used commercially as binders (vehicles) in water-borne interior flat paints. SBR latexes today have a history of successful use in paper coatings, paints, carpet back coatings, pigment printing inks, and many other uses.

Recently, these SBR latexes have been showing utility in more conventional adhesive applications. They are proving to be excellent economical replacements for acrylic, polyvinyl acetate, and other established latexes in water-borne adhesives. (3)

The attempts of removal have included; screening, flotation, solvent dispersion, detackification and the use of colloidal systems to mask or remove the contaminants, all of which fall short when applied to an existing recycling operation. (1)

The size of the contaminant is a critical requirement of existing removal techniques and product quality.

If the contaminant particles remain large or agglomerate, the currently accepted screening methods would remove a higher percentage of the contaminant. Lowering the particle size and dispersing the contaminants would let them pass through the system undetected.

Physical size is then a requirement which could be optimized in the pulper by increasing the size of small particles or by dispersing the contaminant into a very small particle, then masking the small particle so as not to interfer with the production or converting process. These systems would not incorporate any additional mechanical equipment and would raise the cost of effecting the unwanted characteristics of this contaminant very little.

A second approach is the Riverside Process. (4) This process involves the use of a hydrocarbon solvent which is distilled and recovered.

This idea has been researched and the results were very acceptable. However, because the non-plastic contaminants in the furnish are not affected, a fine screening and centrifugal cleaning system are still required. The additional cost of such a process makes it economically unacceptable. (1)

Furthermore, because of the number of formulations of pressure - sensitive adhesives, either system would affect all, based on a common physical characteristic such as tack.

The Chemistry of Latex-Based Pressure - Sensitive Adhesives

Latex-based pressure-sensitive adhesives are formulated from Acrylic, poly vinyl acetate, or styrene/butadiene latexes. In preparing these adhesives, the latex is modified with one or more tackifying resins, a plasticizer and a viscosity control additive. By varying the balance of these components, the adhesive can be designed for a specific application. (3)

Factors Affecting Repulpability of Broke

Temperature: The optimum temperature is 160° F. However, latexes are best removed from the system at temperatures below their glass transition temperature. (Temperature of a latex above which the polymer remains flexible.) (2)

Time: Varies with stock to be pulped, pH, consistency and temperature. (2)

pH: The best pH for repluping is on the alkaline side. However, latexes are alkali sensitive, and can coagulate at low pH. (2)

Consistency: Optimum repulping consistency should be 4 to 5 percent. Fiber to fiber, particle to fiber, and particle to particle disintegration is dependent upon consistency, but must be kept on this low end for various reasons, i.e. power consumption is too great at high consistencies.

Shear Forces: These forces are induced by impellors, and the direction is dependent upon speed of the impellor, the impellor angle, and the shape and design of the vessel. (2)

Wettability of the Substance: The wettability of a substance depends mainly upon any surface sizing materials present. Once the surface is "wetted" then the rate of diffusion of water into the broke is not aided by agitation, but related to the first four variables mentioned above. (2)

Experimental Procedure

The evaluation of the degree of contamination will be Tappi RC-282.

<u>Constants:</u> (as per RC-282)

1. Pulping time
2. Consistency

<u>Variables:</u>

1. Temperature (RC-282)
2. pH...... 7.5 - 12.0 (0.5 increments)
3. Dispersant
    a. Methylenechloride
    b. Orthodichloridebenzene
    c. Ross Barber (Exlir I.R.) (Proprietary)
    d. Petroleum Ether
    e. Solvox - 909 (Solvox Mfg. Co., Milwaukee, Wis.)
    f. Methylenechloride & Toluene

The first two variables will be investigated to determine optimum size developement. The third and fourth variables will be applied at the predetermined conditions.

EXPERIMENTAL PROCEDURE

Materials Used

Adhesive: Findley 139-339 (Latex-based non-repulpable)

Paper: 25 pt. High ground wood content.

Chemicals: Methylene Chloride, Toluene, Petroleum Ether, Ross Barber (Elixr I.R.), Orthodichlorobenzene, Solvox 909, Na_2CO_3 for pH control surfactants.

Equipment Used

Waring Blender: Gallon size, for repulping vessel.

Beaker: One Liter.

Magnetic Stirrer and Hot plate combination.

Buckner Funnel: 19 cm.

Drying Oven: 105^{o} C.

Sample Preparation

The samples were made prior to each set of evaluations.

The adhesive was applied to one side of the base stock using a No. 30 draw rod, this equals 47 grams/meter^2 of adhesive.

The samples were air dried for two hours, then pressed together to make an adhesive sandwich.

The 9 x 12 sandwich was cut into 1/2 x 9 inch strips for evaluation.

Presoaking Conditions

The presoaking involved placing 500 ml of 140^{o} tap water

in a liter beaker. To this was added Na_2CO_3 to buffer the solution at a pH of eleven. This solution was placed on a magnetic stirring hot plate to maintain the temperature throughout the presoak, a stirring magnet was added and the solution was gently swirled.

Presoaking Procedure

Once the solution had reached 140^{o}, one 1/2 x 9 inch adhesive sandwich and six 1/2 x 9 inch strips of blank base stock were cut into 1/2 x 1/2 inch squares and added to the solution. This is equivalent to a 3% slurry of which 3%, by weight, of the total o.d. fiber charged was adhesive.

Defibering, Draining, and Drying Procedure

The solution was gently swirled for 15 min. then placed in a one gallon waring blender. The blender was run at low speed for 30 sec. This subjected the slurry to a much larger amount of horse power than would be encountered in a full scale operation, but was my only means of simulating a pulping vessel on a laboratory scale, with the small sample size used.

The defibered slurry was then drained on a 19 cm. filter paper placed in a buckner funnel. Once a mat formed, another filter paper was placed on top and the pad dried on a

hot plate for approximately 1 minute on each side. The pad was then placed in a drying oven at 105^{o} for 24 hours.

Contamination Evaluation

When the 24 hours of drying had elapsed the pads were removed and evaluated as per Tappi dirt count T-213. This involves counting spots of equal size and calculating a percentage of total area contaminated. This procedure does not differenciate between number and size of spots, but combines both yielding percent of total area.

Dispersant Evaluation

First temperature and pH were investigated to determine optimum size developement, this was an optical evaluation. Next, six dispersants were envisaged by adding them separately to the presoaking solution in 0 to 1% concentrations of the solution, in 0.2% increments.

DATA AND RESULTS

It was expected from the beginning of the experimentation that a means of effecting these contraries would be useful only when applied to currently operating parameters. These parameters involve not knowing the chemical formulation of the adhesive or in what percentages they are present. This limited my ability to predict a dispersant which would be compatible with a specific operation and also render these contaminants harmless to the operation.

In Figure 1 the results display the effect of the different dispersants when applied in a 1% solution by volume. From these results the experimentation was limited to solvox 909, and orthodichlorobenzene.

Figure two shows the effect of decreasing amounts of this dispersant, which at any level, could be acceptable depending on the end product, cleaning equipment, and products end use. Orthodichlorobenzene is a chlorinated aromatic which at even the lowest concentration must be handled with care and expected to be noticed because of its extreme odor. For these reasons it is felt this solvent would be unacceptable in any amounts, unless a system was devised to handle this specific chemical.

Figure three shows an even lower percent of contamination at equal percentages of solution using Solvox 909. A

wire cleaning solution which has proved itself compatable with many currently operating systems and deinking operations. Again any of the displayed solution percentages may be acceptable depending on the amount of contaminant which can be tolerated in a given system.

Total Area Contaminated
vs.
Solvent Used

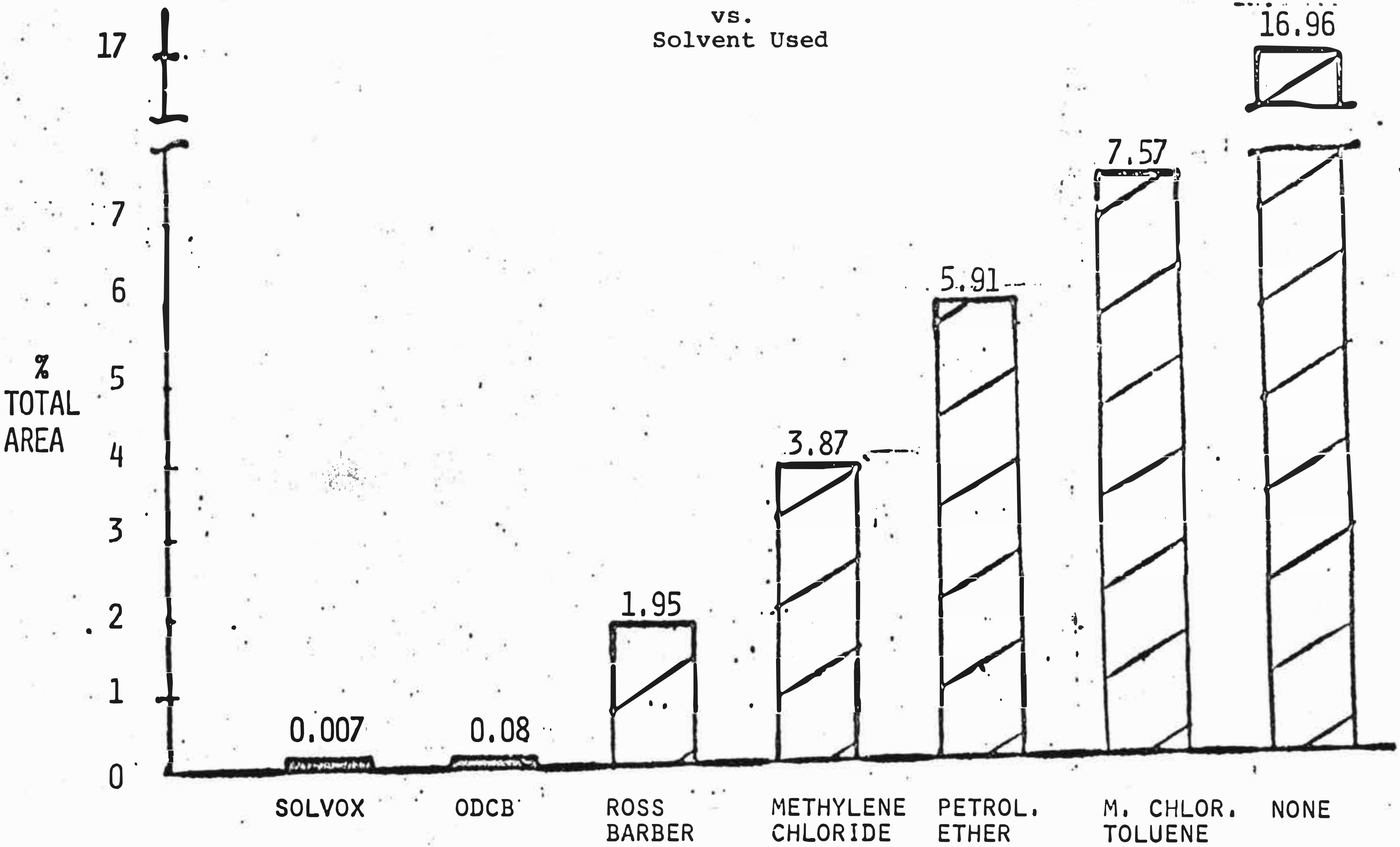

Figure 1

Area Contaminated
vs.
Percent Orthodichloride

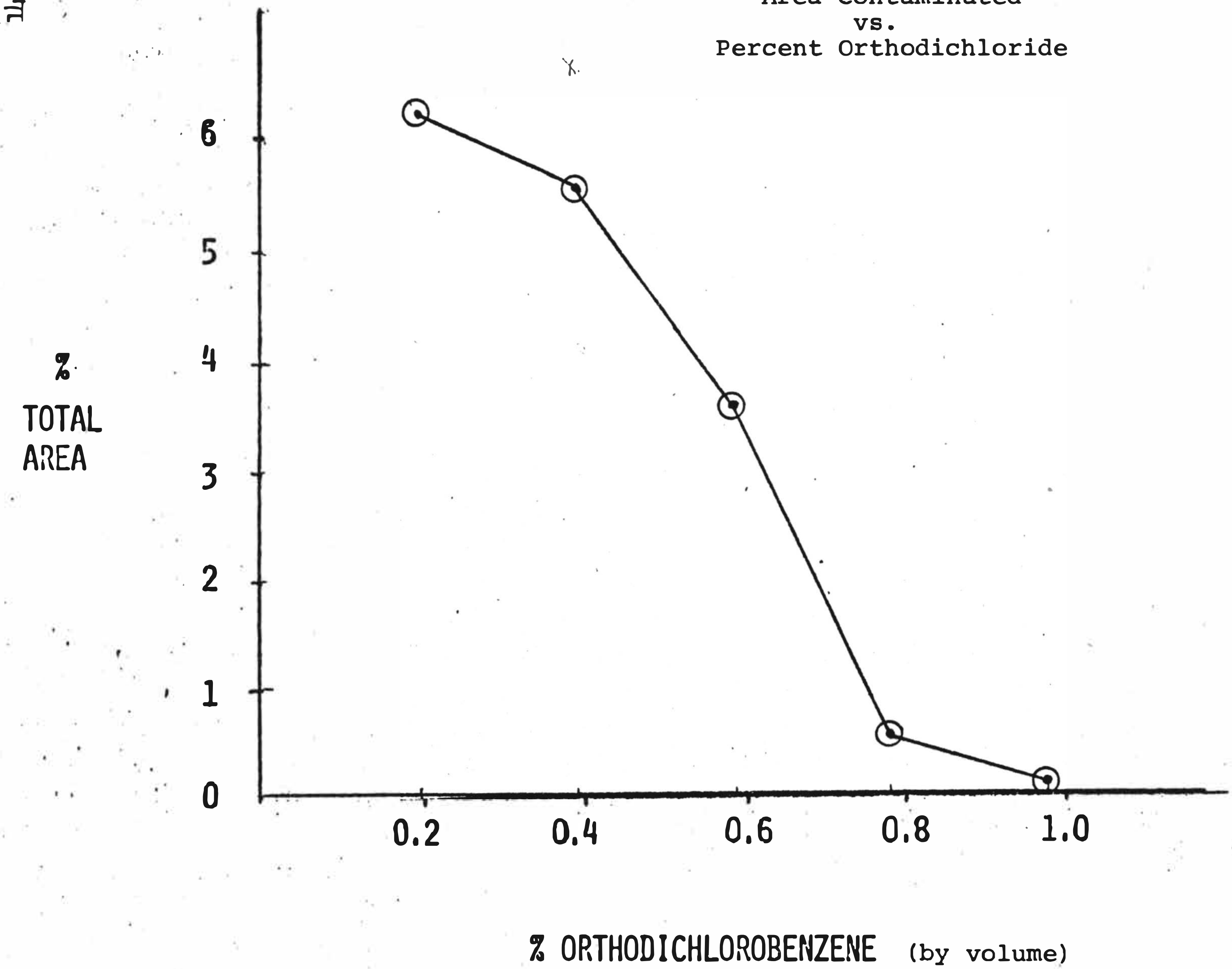

Figure 2

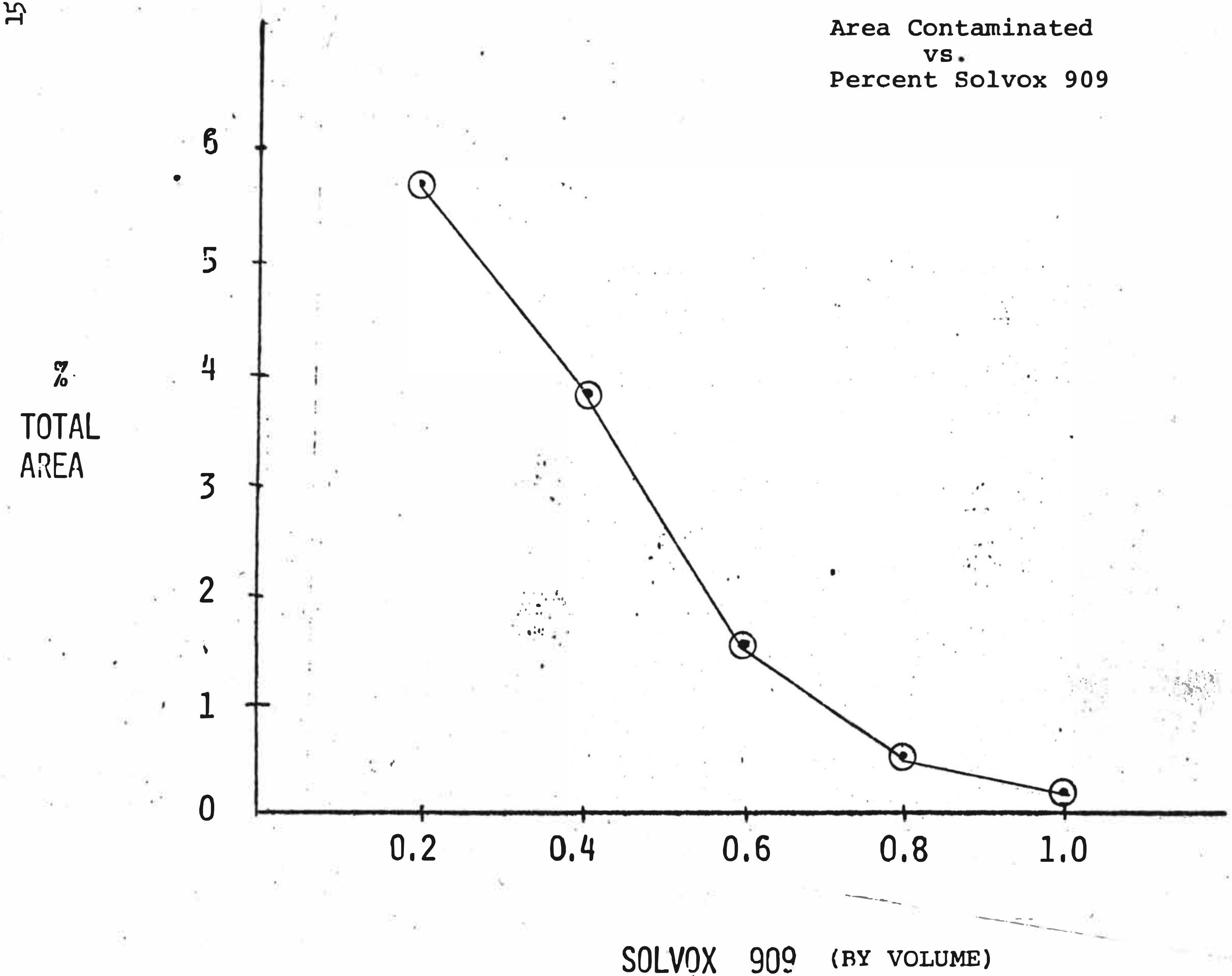
Area Contaminated
vs.
Percent Solvox 909
%
TOTAL
AREA
6
5
4
3
2
1
0
0.2
0.4
0.6
0.8
1.0
SOLVOX 909 (BY VOLUME)

Figure 3

COST EVALUATION

This cost evaluation is based on the contaminants being less than 0.1% of the total fiber.

These costs are based on maintaining an constant amount of contaminant and changing the solution concentration to meet the cosmetic requirements of the end product. Displayed are the concentrations used to produce the lowest percentage of contamination.

Orthodichlorobenzene

Amount Fiber (lbs.)	0/0 Contamination	Total Adhesive (lbs.)	Dispersant Needed for 1% Soln.	Cost/ ton
2000	0.1	2 lbs.	2.6 gal.	$9.98
2000	0.05	1 lb.	1.3 gal.	$4.99

Solvox 909

Amount Fiber (lbs.)	0/0 Contamination	Total Adhesive (lbs.)	Dispersant Needed for 1% Soln.	Cost/ Ton
2000	0.1	2 lbs.	2.6 gal.	$10.00
2000	0.05	1 lb.	1.3 gal.	$ 5.00

DISCUSSION of RESULTS

From the obtained results it can be determined that these dispersants affected the contraries in the required manner when applied at the given concentrations. Also, any of the tested dispersants may decrease contamination to a tollerable level depending on type and concentration.

CONCLUSIONS

This study evaluated the percent removal at different concentrations which is only one parameter involved in re-pulping. It can be concluded that Solvox 909 used at the proper concentration can positively effect these contraries and render them innocuous to this system.

RECOMMENDATIONS

Further study should be done comparing percent contamination to solution concentration, also, machine build up is an important parameter when considering a recycling system. Other types of adhesives must also be applied to determine if this is an exception or applicable to many contraries.

LITERATURE CITED

1. Personal Interview (proprietary)

2. Cordell, W., Student Thesis, Western Michigan University, Kalamazoo, Michigan, April, 1978.

3. Jahn, R.G., Adhesive Age, December, 1977, pp. 35-37.

4. Johnson,A.E., "What the Polysolv Process Is and How it Works", Paper Trade J., Vol. 153, No.40: 55 (Oct. 6, 1969).

APPENDIX ONE

TEMPERATURE and pH EVALUATION

TEMP.					
140		6		12	
120	2		8		14
100		5		11	
80		4		10	
60	1		7		13
40		3		9	
	5	7	9	11	13

pH

EVALUATION NUMBER

The following conclusions were made from the 14 evaluations:

A.) Adhesive tack increased with pH.

B.) Temperature dosent effect tack as much as pH.

C.) In order to insure compatibility with a currently operating system a temperature of 140^{0}F. and a pH of 11 will be used.

Dispersant Evaluation Data (1% solutions by volume)

All spot count figures are the total of two samples counted on both sides and averaged.

Dispersant	No. Spots	Area MM^2	Total Area (MM^2)	% Total Area
Solvox	1	2	2	0.007
O.D.C.B.	5	5	25	0.08
Ross	16	25	400	
Barber	2	78.5	157	
	18		557	1.95
Methylene-	111	5	555	
Chloride	55	10	550	
	166		1105	3.87
Pet.	10	153.94	1539.38	
Ether	29	5.00	145.00	
	39		1684.38	5.91
M. Chloride	1	50.26	50.26	
& Toluene	1	78.54	78.54	
	4	19.63	78.52	
	185	5.00	925.00	
	2	50.26	100.52	
	93	10.00	925.00	
	288		2157.84	7.57
None	51	38.7	1973.7	
	3	153.9	461.7	
	62	38.7	2399.4	
	116		4834.8	16.96

Total area of the sample is 28,565 mm^2

Solvox 909

Run No.	Ml. Solvent	% of Slurry	No. of Spots	Area MM^2	% of Total Area
1	1	0.2	318	1590	5.58%
2	2	0.4	221	1105	3.87%
3	3	0.6	218	436	1.53%
4	4	0.8	150	375	1.31%
5	5	1.0	1	2.0	0.007%

O.D.C.B.

Run No.	Ml. Solvent	% of Slurry	No. of Spots	Area MM^2	% of Total Area
1	1	0.2	430	1780	6.24%
2	2	0.4	315	1637	5.74%
3	3	0.6	415	1043	3.66%
4	4	0.8	26	144.6	0.5 %
5	5	1.0	5	25.0	0.08%