The Adhesive and Sealant Council, Inc.
1999 Spring Convention and EXPO
April 11-14
Sheraton Centre Toronto
Toronto, Ontario CANADA

RECYCLING EVALUATION OF NEW-GENERATION ENVIRONMENTALLY BENIGN PRESSURE SENSITIVE ADHESIVES

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Pilot Testing and Recycling Evaluation of New-Generation Environmentally Benign PSAs

ASC Convention
April 11-14, 1999
Toronto, Canada

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Partnership among:

USPS, USDA, Industry,
& Universities

USPS Objectives

- Develop Pressure Sensitive Adhesive (PSA) Postage Stamps that:
  - Meet USPS performance scecifications
  - Do not cause problems during recycling operations
- Recycle Pre- and Post-Consumer PSA Stamp Materials into Printing and Writing Grade Paper

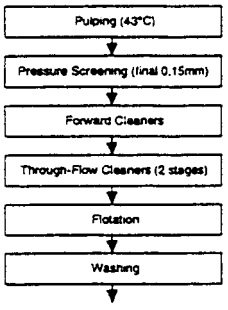
Problem Statement

- Pressure Sensitive Adhesives (PSA) contribute to the "Stickies" problem in recovered fiber mills.
- Can a PSA be designed that will be efficiently removed under normal processing conditions?

Project History

- USPS initiated the project in 1994
- Adhesive manufacturers submitted samples for evaluation
- Initial laboratory trials were followed pilot plant trials

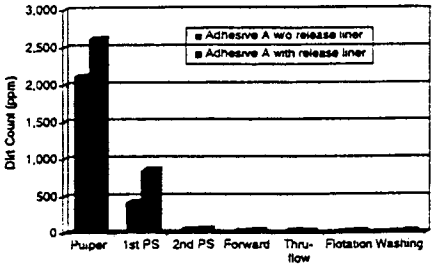
Phase III: Process



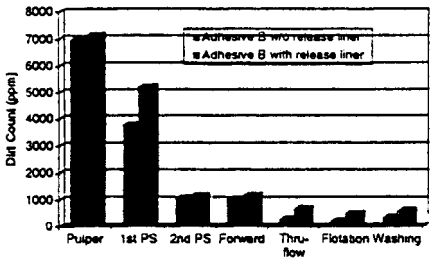
Results

- **14 experimental adhesives evaluated**
- **Evaluation based on processablity, removal efficiency, and adhesive dirt count**
- **Three adhesive types - rubber, acrylic, and floatable/screenable** acrylic

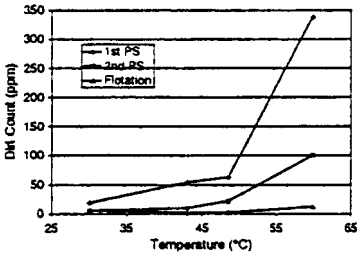
Removal of "Good" PSA During Processing



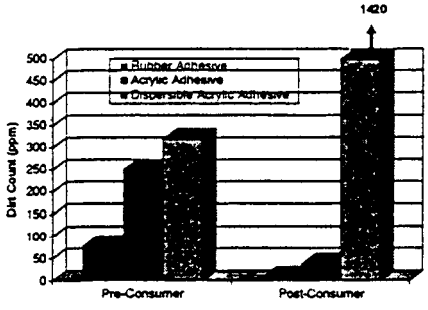
Removal of a "Bad" PSA During Processing



Effect of Temperature on PSA Removal



Average Dirt Count After Washing



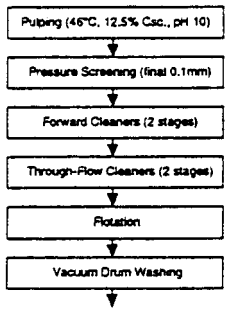
Conclusions from Phase III

- **Several of the experimental adhesives are efficiently removed by 0.15 mm pressure screening**
- **Processing temperature is important**
- **Release liner seems to result in smaller particles during pulping, resulting in poor removal efficiency**

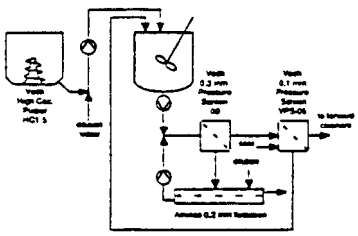
Phase IV: Process Redesign

- **Change final screen to 0.1 mm slots**
- **Add fiber recovery**
- **Bring yield to 75-85%**
- **Second forward cleaner stage**

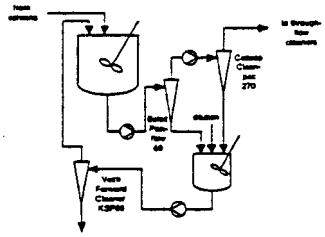
Phase IV: Process Redesign



Phase IV: Pulping and Screening



Phase IV : Forward Cleaners



Status

- **Currently pilot testing experimental PSAs**
- **Whole Stamp Construction, Pre-consumer and Post-consumer**
- **Three Types of Inks: Offset, Intaglio and Gravure**
- **Developing a mill trial protocol**

CONCLUSION

- SCREENABLE
- SCREENABLE
- SCREENABLE

Acknowledgements

- USPS: Joe Peng, Raj Kumar, Mike Barr ...
- STR: Lynne Thoma, Don Donnermyer...
- FPL: Bob Kelley, Chuck Hillary, Dave Pierce, Dick Shilts, Sara Spielvogel, Tim Nelson, Oakley Biesanz, Mike Dickerson, Steve Hubbard, Gerry Cook, Nancy Ross Sutherland...
- Industry: Lou Wilhelm, Mike Pikulin, Don Seiter, Ken Wolfe, Mike Landa, Loreen Ferguson...

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Recycling Evaluation of New-Generation Environmentally Benign Pressure Sensitive Adhesives

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ABSTRACT

As a result of a United States Postal Service (USPS) initiative, a work team was formed consisting of representatives from USPS, Forest Products Laboratory (FPL), Specialized Technology Resources, Inc. (STR), and industry. The industries represented included papermakers, paper recyclers, paper collectors, equipment manufacturers, paper users, adhesive manufacturers and chemical suppliers. The objective of the work team is to develop new and innovative solutions to problems associated with recycling paper containing pressure sensitive adhesives (PSAs). Based on criteria developed by the work team, the adhesive industry formulated new PSAs that are largely removed by screening stages of recycling processes. Protocols were also developed to evaluate newly formulated adhesives. This paper describes a pilot-scale recycling sequence used to assess removal of contaminants from feed stocks containing PSAs. The process sequence involves high consistency pulping, pressure screening, forward and reverse cleaning, and washing and flotation deinking. Fourteen newly formulated adhesives have been evaluated using this pilot-scale protocol.

INTRODUCTION

Removing contaminants from recovered paper pulps is one of the biggest environmental challenges facing the paper industry. It is also one of the major technical barriers to paper recycling. Despite advances made during the past few years, contaminants from adhesives cause major problems during both recycling of paper and subsequent papermaking. Stickies are undesirable recovered paper components that come from pitch, ink, plastic films, converting aids, paper coating, and adhesives. These contaminants are called stickies by papermakers, because they stick to paper machine felts and wires and cause many operating problems. A large fraction of the stickies is PSAs, which are found in products such as labels, tapes, and some postal materials.

Since the USPS currently purchases about 12% of the domestic PSA production, the USPS can play a significant role in guiding adhesive development. The main objective of the USPS's program for environmentally benign PSAs is to develop postage stamp adhesives that are

environmentally benign. For the purposes of this project, environmentally benign PSA is defined as an adhesive that places no additional burden on recycled paper mills. Additionally, the adhesives have to fulfill all other USPS specifications, shelf life, permanence, and philatelic.

The goal is to develop PSA stamp products that can be successfully recycled into paper products in a typical recycling facility, particularly those plants supplying pulp for printing and fine grades of paper. This paper describes some of the program's major issues, team efforts, and final products.

DISCUSSION

Despite the fact that PSA stamps are very popular with the general public, there are some serious concerns regarding their environmental impact. To address these concerns, the USPS in conjunction with FPL, STR, and paper industry representatives, organized several national PSA meetings to incorporate the input of the adhesive manufacturing industry and the paper manufacturing industry (1,2,3). The issues raised and discussed included: defining the problem, communication, education, source quality control, recyclability standards for PSAs, paper industry perspective, end-product specifications, and the role of technology. The meetings concluded that problems caused by stickies are best resolved through combined efforts of the adhesive industry, the paper industry, and the process equipment manufacturers.

Keeping in mind the criteria set by the paper industry, the adhesive industry is striving to formulate new PSAs that are mostly removable in the screening step. The work team met several times to discuss and decide on the image analysis and pilot plant testing protocols to use to evaluate the newly produced adhesives on a small scale. The team agreed that there is a need for a standard method for testing, more information on the removal efficiencies during recycling unit operations, and a reasonable method that combines pilot testing and image analysis.

As a result of all these combined efforts, a pilot-scale separation sequence was developed to assess the removal of adhesives from the feed stock containing PSAs. This pilot-testing protocol simulating a typical recycling operation included high consistency pulping, coarse and fine pressure screening, forward and reverse cleaning, and washing and flotation deinking. Modified TAPPI standard dirt counts were developed, and handsheets were made from pulp samples after each unit operation and on paper samples from the paper machine runs. The protocols simulating typical recycling operations and using preconsumer, postconsumer, and control stocks were further refined to reflect optimum operating conditions such as temperature, consistency, screen size, repulping energy, and chemical additives.

Current efforts involve laboratory testing of commercially produced PSAs, stamp print and finish trials, mill-scale recycling trials, and development of the final specification and approved product list for PSA stamp production. In addition to being recyclable, the final specification includes stringent USPS performance requirements. These stamp requirements include permanent adhesion to envelop substrates and ability to withstand long-term aging (archive ability).

Results of this work team were presented by all participants at the 1998 TAPPI Recycling Symposium cosponsored by the USPS and FPL and held in New Orleans on March 8-12, 1998 (4). In addition, invited presentations were given at the 1998 PIRA Deinking Conference in England (5) and the PTS/CTP Deinking Symposium in Germany (6). Plans are underway to present the final results of this project at the TAPPI Recycling Symposium to be held in Washington, DC, March 5-8, 2000.

CONCLUSIONS

Although the USPS's role in initiating this program was essential; the cooperative partnership stemming from this research program has resulted in progress towards resolving environmental problems caused by PSAs. Involving all parties in defining and solving this environmental problem has proven to be effective. Specific accomplishments of this cooperation include new testing protocols for the recyclability of PSAs and a database of information on the newly formed PSAs. Although the initial effort of this work were directed at modifying adhesives for stamps, it is anticipated that the results and recommendations resulting from this research program will be applied to labels, stickers, and a wide range of similar PSA products.

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Problem 3 **Develop new recyclng technologies to increase the use of wastepaper.**

FY 1999 Research Attainments

AbuBakr. Said; Houtman, Carl: Bormett, Dave; Ross Sutherland, Nancy; Peng, Joe. 1999. Recycling evaluation of new-generation environmentally benign pressure sensitive adhesives, In: The Adhesive and Sealant Council, Inc., 1999 spring convention and expo; 1999 APRIL 11-14; Toronto, Canada Bethesda, MD: Adhesive and Sealant Council, Inc.: 3 pp.