Abstract
The paper describes the development of a cleaning procedure for household trash that provides fiber suitable for corrugating medium. Blending this recovered fiber with equal parts of neutral sulfite semichemical pulp or treating a 100% reclaimed fiber medium with 0.0% starch resulted in corrugating medium that showed satisfactory performance on an experimental single facer in terms of runnability and bonding. Flat crush resistance of the A-flute single-faced material was approximately 24 psi.

Corrugating medium from household trash
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Wood fiber from wastepapers has always been a valuable raw material, presently supplying approximately 21% of the U.S. fiber needs annually. In the last several years, interest in utilizing wastepapers has increased, but is limited by lack of economical systems to segregate papers into specific grades and technical developments for processing and utilizing this raw material.

Many paper and paperboard products contain fiber from wastepaper, but paperboard containers use the greatest amount in terms of volume. Corrugating medium holds a special interest because it is produced in substantial quantity, is presently made from a variety of furnish, and does not require as high a degree of cleanliness as printing papers. Some 9.4 million tons of corrugating medium were produced in 1970, with 1.5 million tons coming from secondary fiber sources (1). These sources were mainly container plant cuttings, which can be used in many paper products besides corrugating medium. Because used corrugated boxes are in demand, boxes would be available for other products if another source of fiber could be substituted for part of this material in corrugating medium.

One source of supply is the wood fiber from the paper fraction of municipally collected household trash. This source is plentiful, containing approximately 59% chemical and 41% mechanical fiber (2), but includes a multitude of contaminants.

The problem is to separate the fiber from the household trash and determine if it is technically feasible to convert it into corrugating medium. This report details the separation and preparation of the fiber from household trash and its subsequent conversion into corrugating medium.

RESULTS AND DISCUSSION
Preliminary work involved a corrugating medium made with fiber separated from household trash by the dry process as described by Auchter (3). Results indicated that corrugating medium could be produced but the accumulation of dirt and scum behind the gates of the headbox of the paper machine and buildup of deposits on the dryers were greater than could be tolerated for commercial application. Thus, further research on fiber separation and cleaning was needed.

Separation and Cleaning
To minimize contamination, the system for film plastic removal (4) was adapted (Fig. 1); deinking, screening, and centrifugal cleaning technology were then used (Fig. 2). The result was a reclaimed fiber that could successfully be converted into 26 lb/1000 ft² corrugating medium. The dirt and scum that accumulated behind the gates at the headbox on the preliminary run were materially reduced and the deposits on the first rolls of the dryer section were negligible.

This corrugating medium from 100% reclaimed fiber was satisfactorily bonded, with a pin adhesion of 5.6 pli, to a commercial kraft linerboard at a speed of 400 ft/min and was fluted without fracturing at 900 ft/min.

Once contaminant problems were minimized, the next step was to improve the flat crush resistance of the medium, because the Concora medium test (CMT) of this medium was only 48 lb.

Starch Addition at the Size Press
A corrugating medium made from 100% reclaimed fibers and containing 0.9% starch had a CMT of over 60 lb; it was successfully run on the corrugator at 400 ft/min with satisfactory
bonding (pin adhesion 8.0 pli) to a kraft linerboard. It did not fracture when run at 900 ft./min. Other properties are given in Table 1.

Addition of NSSC

A second approach to improving the flat crush resistance was to blend the pulp in a one-to-one ratio with a commercial neutral sulfite semichemical (NSSC) pulp. The properties of this corrugating medium (Table I) show that a CMT value of over 60 lb can be attained. This medium was successfully single-faced at 40 ft/min and a satisfactory bond attained (pin adhesion 6.8 pli). No fracturing was encountered when this medium was fluted at 900 ft/min.

PROCEDURE

Fiber Separation and Cleaning

The separation of the fiber from the household trash is shown in Fig. 1 and the details of the film plastic removal are described by Laundrie and Klungness (4). The wastepapers recovered by this system were used as the fiber source and further processed, as shown in Fig. 2. The 3.5% NaOH was based on dry fiber weight. The acceptable fiber was recovered from the 1/32-in. tip opening of the centriflicleaners in a reverse cleaner operation (inlet pressure 60 psi, outlet pressure 20 psi); rejected stock was recycled under the same conditions for additional fiber recovery. The stock was dewatered on a sidhill screen and refined in a disk mill to 370 ml CSF. Usable fiber recovered from the wastepaper fraction by this procedure was approximately 60%. The 40% losses included such contaminants as clay, ink, grass, plastic, fines, dirt, and leaves, but a quantitative analysis of these rejects was not included in this study.

Commercial Pulp

An NSSC hardwood pulp was received from a commercial source. The pulp was collected from the presses (used to remove the cooking liquors) and refined in a disk mill to 410 ml.

Table 1. Properties of Corrugating Mediums Made From Household Trash

<table>
<thead>
<tr>
<th>Medium</th>
<th>Even, CMT, lb</th>
<th>Water, wt., %</th>
<th>Burst, pli</th>
<th>Ring, max. g</th>
<th>Moist, MOR, %</th>
<th>Stress, flat crush, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSSC</td>
<td>410</td>
<td>85</td>
<td>12</td>
<td>40</td>
<td>75</td>
<td>53.0</td>
</tr>
<tr>
<td>65% NSSC</td>
<td>78</td>
<td>51</td>
<td>53</td>
<td>2775</td>
<td>250</td>
<td>2.80</td>
</tr>
<tr>
<td>35% NSSC</td>
<td>114</td>
<td>54</td>
<td>2790</td>
<td>580</td>
<td>1.50</td>
<td>3.30</td>
</tr>
<tr>
<td>20% NSSC</td>
<td>122</td>
<td>39</td>
<td>1940</td>
<td>255</td>
<td>2.00</td>
<td>3.30</td>
</tr>
<tr>
<td>10% NSSC</td>
<td>103</td>
<td>53</td>
<td>3800</td>
<td>713</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>100% NSSC</td>
<td>99</td>
<td>41</td>
<td>510</td>
<td>510</td>
<td>5.30</td>
<td>3.30</td>
</tr>
</tbody>
</table>

Fig. 1. Recovery of wastepaper from household trash.

Fig. 2. Processing wastepaper recovered from household trash by dry method.
CSP prior to being converted into corrugating medium.

**Corrugating Medium**

The various pulps were made into nominal 26-lb corrugating medium on a 13-in. wide experimental fourdrinier paper machine. To evaluate the effectiveness of starch for improving resistance to flat crush, an additional quantity of fiber was processed from household trash. This pulp was refined in a disk mill to a freeness of 250 ml CSF. A small quantity of fiber was made into a corrugating medium to obtain initial strength properties before any treatment. The web was then passed through the horizontal size press and a 2% solution of a medium-viscosity ethylated cornstarch applied without changing the other machine conditions. This gave a pickup of 0.9% dry starch based on the weight of dry paper.

To evaluate the effectiveness of Mending the household waste fiber with NSSC, a portion of the NSSC was fiberized in a disk mill and passed through a 6-in. centricleaner to remove shives. This fiber was further refined in a disk mill to a freeness of 345 ml CSF. It was blended in a one-to-one ratio with waste fiber in a stack chest which gave a furnish that had a freeness of 350 ml CSF.

**Testing**

The corrugating mediums were conditioned at 73°F and 50% RH, and evaluated for burst, tear, fold, ring crush, and flat crush according to TAPPI standards. The tensile strength and modulus of elasticity were determined using the procedure described by Setterholm and Kuenzi (5) and modified by Jewett (6). The pin adhesion tests were made using an apparatus fitted with six upper and seven lower pins. Specimen size was 2 in. by 6 in. Tests were run in a compression testing machine at a loading head speed of 1.5 in./min.

**CONCLUSIONS**

Results indicated that a corrugating medium can be made from fiber recovered from household trash. Flat crush resistance can be attained either by addition of starch or mixing the waste fiber with NSSC pulp. Thus, a third alternative to the disposal of household trash by landfill or incineration is dry separation of the fiber fraction and conversion into corrugating medium. This approach also provides a potential source for additional fiber for corrugating medium.

**LITERATURE CITED**


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