Pulp extrusion for recycling wastepapers and paper mill sludges

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Application: Low-grade wastepapers and paper mill sludges can be extruded to form composite materials that can be used like fiberboard and hardboard.

THE PULP AND PAPER INDUSTRY NEEDS NEW PROCESSES for converting low-quality recovered papers and paper mill sludges into useful products. However, these materials are not easy to process.

At pulp consistencies of 2%-15%, conventional paper and board manufacture is generally not possible because drainage is too slow. At high consistencies of over 15%, processing is impeded by severe flocculation and non-homogeneous flow. At ultra-high consistencies of over 20%, suspension drainage through a screen is impractical, and another forming method must be found.

Extrusion processing offers a new method by which the pulps from recycled papers and sludges can be processed at ultra-high consistencies to form useful products. This method must surmount two problems. First, the fiber suspension must be made to flow homogeneously to achieve good formation. Second, processing equipment must disperse fiber flocs and transport the highly concentrated suspension.

We can overcome these problems by adding small amounts of a water-soluble polymer such as sodium carboxymethyl cellulose. Then the suspension flows easily and homogeneously at consistencies up to 45%. Furthermore, the rheology of the pulp suspension can be controlled with the polymer additions. As a result, these suspensions can be processed with twin-screw extruders like those used in food processing industries.

New process

In this new process, recovered paper pulps are extruded at ultra-high consistencies to form fiber composite materials with mechanical properties like those of fiberboard and hardboard. This technology utilizes pulps derived from low-grade wastepaper. The pulps do not have to be cleaned or deinked, and they can be combined with paper mill sludges.

This process consists of four steps: (1) pulping and pulp preparation, (2) extrusion (mixing, dispersion, and forming), (3) densification and drying, and (4) post processing. In this study, we focused on the effects of the pulp composition on extrusion variables and on the mechanical properties of the extrudates.

Experimental procedures

The pulps used were mixtures of various furnishes: printed and unprinted old newsprint, old magazine paper, copier paper, bleached softwood, bleached hardwood, and refined softwood kraft. We used two twin-screw extruders, with barrel diameters of 18 mm and 32 mm. Sections of the extruded pulp ribbons were densified and dried in a hydraulic laboratory press. The dried specimens were cut into coupons for testing tensile strength.

Results

Various pulp blends are extrudable. Generally, screw torques and die pressures are larger for pulps with long fibers and low filler content than for short-fibered pulps high in filler.

Pulp type, filler content, polymer concentration, and consistency affect the mechanical properties. Strength and modulus of elasticity increase with increasing fiber length, increasing polymer concentration, decreasing filler content, and decreasing consistency. These extruded fiber composites are usually stiffer than conventionally produced fiber composites of equal strengths.

When the extrudate is exposed to moisture, losses occur in tensile modulus and bending stiffness. Wet-stiffening polymers can be added to the pulp to overcome this problem. These polymers include melamine-formaldehyde (MF) resins, phenol-formaldehyde (PF) resins, and poly(aminoamide)-epichlorohydrin (PAE) resins.

Conclusions

Through this new process, mills can manufacture structural fiber composite materials with consistent, predictable properties. Stiffness losses caused by moisture can be controlled by the addition of cross-linkable resins such as MF, PF, and PAE. **TJ**

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