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Dimensional stability of composites from plastics and cornstalk fibers

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Abstract

Thermoplastic composites using corn crop residues were developed and their dimensional stability was evaluated in this study. The fibers were obtained from cornstalks or cornstems collected from farms in Central Illinois. They were blended with both virgin and recycled high-density polyethylene (HDPE) to make 1/2-inch-thick composite panels; and both virgin and recycled polypropylene to produce 1/4-inch-thick composite panels. The 1/2-inch-thick melt-blended composite panels were made using 60 percent low-density polyethylene (LDPE) compounded with 40

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percent cornstalk fibers at two density levels. They were blended in a corotating, intermeshing segmented twin-screw extruder with a length-to-diameter ratio of 32:1. The cooled strands were pelletized. The compounded pellets were placed in a mold and compressed into panels using 1/2-inch stops.

Steam-pressurized cornstalk fibers (10% and 20% levels) were blended with both virgin HDPE and recycled HDPE (90% and 80% levels) for the production of resin blending-HDPE panels. The well-mixed material was then formed into a mat in a deckle box that had been placed on a caul plate. The mats were pressed in the steam-heated platen press to 1/2-inch-thick experimental composite panels. Water absorption and thickness swell properties (after a 24-hour water soak and 2-hour water-boil), and linear expansion of all panels exposed from 50 to 90 percent relative humidity were determined according to ASTM D 1037 standards. The ASTM D 955 standard was used to measure the dimensional shrinkage from mold dimensions of molded cornstalk-polypropylene composite samples in the shape of the standard ASTM injection-molded specimen obtained from a 33-ton Cincinnati Milacron injection-molder. The results showed that most of the cornstalk-polypropylene composite specimens obtained an average thickness shrinkage of about 5 percent. Width shrinkage was no more than 1.5 percent. Length shrinkage averaged about 0.5 percent. In terms of water resistance, the melt-blended LDPE panels were superior to the melt-blended HDPE and polypropylene panels. It was found that the composite made with 10 percent recycled polypropylene and 90 percent cornstalks was the least water resistant. The polypropylene composite panel obtained overall lower average water absorption, thickness swell, and linear expansion values than those of the HDPE composite panels in three tests (24-hour water-soak, 2-hour water-boil, and the 90% high humidity exposure tests). All resin-blended composite panels exhibited relatively low water resistance and dimensional stability in both 24-hour water-soak and 2-hour water-boil tests. The 10 percent virgin HDPE composite panels did not survive the 2-hour water-boil test. The 20 percent HDPE and polypropylene composite panels did show the slightly lower values in thickness swell in the water soaking test. The thermal expansion of the melt-blended cornstalk-LDPE composite panels appeared to be a problem in determining the cause (whether or not it was due to heat or moisture) of the dimensional expansion in the 2-hour water-boil evaluation.

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