Computed Tomography characterization of the Green Fiber Bottle

Saxena, Prateek; Bissacco, Giuliano

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Prateek Saxena, Giuliano Bissacco
Department of Mechanical Engineering, Technical University of Denmark,
Kgs. Lyngby, DK-2800, Denmark

Introduction
The work carried out in this research aims at identifying suitable ways for thorough characterization of the quality of paper bottles. Industrial X-ray Computed Tomography (XCT) is particularly advantageous in determining the quality of paper bottles and thus correlating it with the production process. The Green Fiber Bottle (GFB) is a freeform geometry consisting of cellulose fibers. Accurate dimensional measurements such as wall thickness of the GFB is not possible using Coordinate Measuring Machines (CMMs). XCT on one hand provides an effective means of measuring wall thickness and on the other hand it also helps in identifying voids in the order of 110 µm at any location in the bottle geometry.

Manufacturing process
Pulp suspension prepared from recycled newsprint pulp of consistency 0.01 was injected in a forming tool using pump. The tool consists of a wired mesh on the inner surface with uniform distribution of holes on the outer surface. Water is removed from fibers by creating a suction pressure from outside of the tool. Tool geometry is thus replicated onto the pulp fibers. The formed product is then transferred to a heated porous tool, where rest of the water is removed and the product is completely dried.

Process characterization
Porosity analysis
The porosity analysis was helpful in identifying the defects with the resolution of 110µm. A large number of defects in the neck region indicate uneven material distribution in the areas of smooth curvatures. 850µm was the largest defect identified in the bottle geometry. The middle region being cylindrical in shape, experiences uniform material distribution. However presence of a few defects in the bottom region is due to the fact that the bottle is mounted upside down during manufacturing process, thus allowing less pulp material to enter in the bottom section due to gravity.

Wall thickness analysis
The insert used for fiber compaction is unable to compact pulp in the region of smooth curvatures due to which the neck region experiences higher wall thickness and low localized density.

Conclusions and Future work
Wall thickness in neck section of the bottle was relatively higher compared to rest of the sample, which indicate that the tool is unable to compact pulp effectively in the region of smooth curvatures. Porosity analysis reveals large number of voids present in the neck region, which further indicate the non-uniformity in pulp distribution. Thus, industrial XCT provide a good insight in tool design for manufacturing of paper bottles.

Future work involves development of an efficient and robust tool system for the green fiber bottle manufacturing process.

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