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Mixing of high-consistency fiber-foam suspensions

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Foam-forming has been gaining attention recently to manufacture sustainable packaging and cushioning products in various sectors, including food, automobile and construction [1]. Conventionally, foam suspension is made in a mixing tank at a lower fibre consistency, ≤ 2% resulting in large volumes of water consumption. Besides, the excess moisture from the final foam-formed product needs to be removed by drying. Replacing the current foaming methods with High-consistency foam (HCF) can reduce water consumption, drying energy and equipment footprint. However, increasing the fibre consistency makes the rheology of fibre-foam suspension complex [2], posing challenges in mixing. The present work focuses on mixing this complex suspension to generate a homogeneous HCF by selecting proper impeller geometry, mixing time and surfactant dosage. The lab-scale testing facility consisted of a 0.43 m tall and 0.16 m wide transparent acrylic tank equipped with a top-mount impeller assembly. Three impeller geometries, namely bend-disc, Bakker turbine and high solidity pitched blade turbine, and four impeller combinations were used. Chemi-thermomechanical pulp (CTMP) with a mean fibre length of 2.0 mm, a width of 39 μm and Canadian standard freeness (CSF) of 600 ml was used as the fibre material. The consistency varied from 5% to 15%. An 80/20 mol% mixture of sodium dodecyl sulphate (SDS) and Tween 20 (T 20) was used as the surfactant. The surfactant dosage was varied from 0.5 g/l to 2.0 g/l based on fibre consistency. The quality of the HCF was assessed in terms of air content, foaming time and X-ray microtomography. Preliminary results indicated that the used impeller combination should be selected on the base of fibre consistency. No improvement in the air content was noticed beyond 1.2 g/l surfactant dosage. However, increasing the surfactant dosage reduced foaming time at higher consistencies. Currently, experiments are carried out to understand the role of fibre length and the addition of binders such as guar gum in the mixing. In summary, this work provides an understanding of the mixing geometry and foam chemistry that enables the manufacturing of sustainable packaging products at a much lower water consumption.

Reference

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