Comparison between squeeze film flow of Newtonian and non-Newtonian fluids with applications to foam-formed papermaking process

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Foam forming technology for manufacturing paper is a novel technique in which the paper sheets are made from a suspension of pulp fibres in foam, rather than a suspension of pulp fibres in water. As well as reducing the water footprint of the papermaking process overall, foam bubbles along with foam rheology are believed to play a significant role in producing a fibre network with improved characteristics compared to water-formed papers, including more uniform pore size distribution, increased strength, lower density, etc.

As a model for foam forming, this work investigates the effect of squeeze film flow of water as a Newtonian fluid versus that of foam as a non-Newtonian fluid between two parallel and non-parallel fibres. The model can help to establish the extent to which foam rheology plays a role in establishing the more uniform pore size distribution of foam-formed papers rather than papers made with water. The hypothesis explored is that the foam might be behaving as a continuum viscoplastic fluid during foam forming, albeit with the viscoelastic fluid properties being related to underlying bubble size. Thus, investigation of squeeze film flow can give an insight into whether non-uniformity of the gap between two fibres being pushed together is reflected in non-uniformity of pore sizes of foam formed paper, and if so, how the non-uniformity of the gap depends on the fluid rheology.

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