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A Theoretical Analysis of Fluid Flow and Heat Transfer in a Scraped-Surface Heat Exchanger

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Scraped-surface heat exchangers (SSHEs) are widely used in the food industry to transfer heat into and out of foodstuffs in a quick and efficient manner without causing unwanted changes to the texture and appearance of the final product.

Despite their widespread use there is at present only a very limited understanding of the fundamental mechanisms at work in a SSHE.

The purpose of the present work is to construct and analyse paradigm mathematical models for the fluid flow and heat transfer within a SSHE, with the aim of elucidating the basic mechanisms at work, and hence ultimately to optimise the efficiency of the process.

The initial theoretical work used a lubrication approximation to analyse the behaviour of a freely pivoted scraper blade (or one freely pivoted scraper blade in a periodic array of blades) and the possible flow patterns that can occur around it. The main conclusion of this work is that in practice the blades will usually be in close contact with the wall, and so subsequent work focused on analysing the consequences of non-Newtonian fluid behaviour and slip boundary conditions on the flow in this situation. Recent work has concentrated on incorporating thermal effects (which can manifest themselves in temperature-dependent-viscosity and/or significant viscous-dissipation effects) into the model.

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