Nature-inspired engineering: Exploiting thin film flow processing for chemical and bioprocess intensification

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Abstract

Nature is abound with examples of very efficient processes taking place in extremely well-designed systems based on thin film flow. The human body is a prime example of this where thin film flows of blood take place in large networks of capillaries each of only a few micrometers in diameter, supplying our cells with nutrients and removing waste products. The laminar flow conditions in these blood vessels combined with the very large surface areas of the order of 10,000 m^2/m^3 enable these transfer processes to take place in the most efficient manner possible.

Creating and utilising uniformly thin films in chemical processes have been the focus of much research involving falling film, microreactor and centrifugal field technologies amongst others. Centrifugal technologies are particularly attractive as they provide an additional degree of freedom in the speed of rotation of the device enabling better control of the film hydrodynamics than in gravity falling films. Thin films flowing under high centrifugal forces in a spinning disc reactor have long been recognised to give enhanced heat and mass transfer rates which have been exploited in many industrially important processes such as crystallisation and polymerisation. More recent work has focused on a continuous ortho-lithiation reaction carried out at ambient conditions and on the development of a microalgae biocomposite-integrated spinning disc bioreactor for enhanced CO_2 capture. This presentation will highlight the outcomes of these studies and others to demonstrate the potentials for applying thin film flow technologies generated in spinning disc reactors for chemical and bioprocess intensification.