Hydrodynamic cavitation – equipment and uses

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Cavitation is a phenomenon characterised by the formation of bubbles or cavities in a liquid either by exposing it to ultrasonic waves (acoustic cavitation), or by passing the liquid itself through a smaller section (hydrodynamic cavitation), for example a plate with multiple small orifices, usually known as a Venturi section. The bubbles formed alternate through compression and expansion cycles, and if their diameter reaches a specific diameter they implode, leading to the formation of powerful microjets which achieve high local pressures and temperatures.[1]

In the last two decades, acoustic and hydrodynamic cavitation were both studied in terms of their potential for disrupting the biological activity of living cells, Harrison and Pandit obtained the first cavitation reactor which can be used for this purpose, using a choke valve. Recent literature studies followed the applications of ultrasound in the regeneration of adsorbents and the drying / dehydration of food, processes which consist mainly of mass and heat transfer. A common use for cavitation has been the degradation of organic compounds in wastewater treatment, due to the formation of highly oxidative hydroxyl radicals by the dissociation of water molecules under the high temperatures and pressures achieved through cavitation [2, 3]

The goal of this paper is focusing on the potential uses of acoustic and hydrodynamic cavitation in the fuel and biofuel industry, by either improving biodiesel/bioethanol productivity through cavitation assisted processes, or by developing stable fuel – biofuel blends for use in current vehicles. The high temperatures and pressures obtained by cavitation lead to an increase in mass transfer due to the formation of more stable emulsions and a greater dispersion of the two phases which would eliminate the main limiting factor in biodiesel production. The jets formed during the bubble collapse could also improve mass transfer through the cells' membrane in bioprocesses like bioethanol fermentation. For this purpose hydrodynamic cavitation has been obtained using a device which consists of a high speed rotor connected to a set of plates with a specific geometry, and a centrifugal pump for the circulation of the liquid through the space between the moving plates.

A better understanding of the phenomenon of cavitation may allow a better control over its effects and routing them towards carrying out chemical reactions and physical processes with high efficiency and lower power, making possible the development of certain technologies around using cavitation, which are normally limited by long reaction times and high degree of complexity. [4, 5]

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