Hydrodynamically Generated Cavitation as an Alternative to Sonochemical Processing

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Abstract:

Hydrodynamic Cavitation, which was and is still looked upon as an unavoidable nuisance in flow systems, is now a serious contender as an alternative to acoustic cavitation for harnessing the spectacular effects of cavitation in physical and chemical processing. The complex scale up procedures and the limitations of the equipments associated with acoustic cavitation based transformations has restricted the growth and adaptation of the same in industrial applications. Hydrodynamic cavitation on the other hand has shown a considerable scale up potential and applications (initially physical in nature) are envisaged at a scale of 1000 m³/hr.

The present lecture will cover the basics of hydrodynamic cavitation including the reactor designs and the bubble dynamics studies for optimization of the operating parameters. The difference in the bubble dynamics approach in the two modes of cavity generation will be highlighted. It is expected that an ensemble of driving frequencies (as in the case of hydrodynamic cavitation) will drive the cavitation nuclei (which exists with a size distribution rather than a fixed size) more optimally rather than a fixed driving frequency (as in the case of acoustic cavitation).

An overview of applications in different areas of physical, chemical and biological processing on scales ranging from few grams to several hundred kilograms will also be presented. Since hydrodynamic cavitation was initially proposed as an alternative to acoustic cavitation, it is necessary to compare the efficacy of both these modes of cavitations for a variety of applications. Such comparisons either on the basis of energy efficiency or based on the scale of operation will also be an important feature of the lecture. Some ways for intensification of cavitation intensity in the hydrodynamic cavitation reactors will also be discussed.

Cavity dynamics simulator software package will also be demonstrated as a ready tool to predict the cavitation intensity as a function of the operating parameters and the liquid physicochemical properties in both acoustic and hydrodynamic cavitation reactors. The software will also provide a ready comparison methodology for the understanding of the cavity behavior in hydrodynamic and acoustic cavitation.

Keywords: Hydrodynamic Cavitation, Sonochemistry, Bubble Dynamics, Chemical Processing, Biological Processing