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Ultrasound processing of *Chlorella vulgaris* and a novel functional classification of power ultrasound test systems

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Abstract

This study evaluated energy transfer and efficiency in power ultrasound systems applied to processing of Chlorella vulgaris. Power transfer to a series of system combinations was characterized via calorimetry, and energy per cell ruptured was calculated from observed cell disruption. The calorimetric power transferred to solution ranged from 0.028 to 0.348 W/ml. Differentiation of reactor combinations via mixing delay and analysis in the context of non-linear acoustic theory led to a novel approach to reactor classification, allowing inference of cavitation based on streaming and heating behavior. Calorimetric efficiencies of the systems were relatively consistent, and the power transfer of a smooth probe tip was not distinguishable from that of an eroded tip face. The power ultrasound treatment of C. vulgaris required an average ultrasound energy input per cell ruptured ranging from 18 to 76 μJ. This value is 6

orders of magnitude higher than the energy requirement reported for the disruption of a single algae cell with an atomic force microscope. However, the specific energy requirement, estimated as 430 MJ per kg of dry algae cell disrupted, was within the range of values reported in the literature. This difference may be due to power transfer efficiencies inherent in existing algal pretreatment methods.

Keywords:

Power ultrasound | calorimetry | horn erosion | non-linear acoustics | cell rupture

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Disclosure statement

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