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Cavitation and acoustic streaming generated by different sonotrode tips

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Abstract

Aiming at improving the efficiency of cavitation treatment, this work investigates characteristics of acoustic streaming and cavitation generated in water by dumbbell-shaped sonotrodes with plane, truncated and conical tips. The main emphasis was placed on elucidating the effects of tip shape and vibration amplitude ranged from 40 to 60 μm. The PIV technique and Weissler reaction were used to measure flow pattern and velocity of acoustic streaming, and cavitation efficiency, respectively. To provide a theoretical explanation to the experimental results, a self-developed mathematical model was used to simulate the acoustic streaming and predict the size of cavitation zone numerically.

Both the experimental and numerical results revealed that the sonotrode tip shape affects the acoustic streaming significantly, altering the flow magnitude and direction from fast and downward under the plane and truncated tips to relatively slow and upward near the conical tip. Besides, the conical tip provides a more efficient cavitation treatment in comparison with the plane and truncated tips. The simulation results showed that widening of cavitation zone and altering of acoustic streaming velocity and direction near the sonotrode tip are responsible for the enhancement of cavitation treatment efficiency.

1. Introduction

It has been long recognized that most of the effects of ultrasonic radiation in liquids is related to two phenomena: acoustic cavitation and acoustic streaming. There is a vast number of studies that has investigated acoustic cavitation both experimentally and theoretically. Examples include but not limited to such fields as sonochemistry, cleaning, wastewater