A Comparison Droplet Formation for the Flexural Curvature Vibration and Flat Surface Vibration by Numerical Simulation

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Abstract

Numerical simulation is carried out to study the phenomena of droplet formation, diameter and size distribution in ultrasonic atomization process as the effect of different vibrating surface. Differ from the ultrasonic common vibrating surface of nozzle spray structure, flexural radial curvature vibration of bending tube model is proposed to generate droplet spray atomization. Various tube lengths are applied to study the effect of different curvature radius. Longitudinal vibration on flat surface vibration of ultrasonic nozzle spray is also investigated for comparison. Volume of Fluid (VOF) of ANSYS FLUENT was applied to perform ultrasonic atomization process in 2D model. In this study, ultrasonic frequency is set to 70 kHz at constant maximum amplitude for all case studies. In this simulation is found that flexural radial curvature vibration could generate nearly equivalent droplet diameter with flat surface vibration and have narrower distribution, whereas the curvature vibration shape affects the droplet size distribution.

Keywords: Ultrasonic atomization, curvature vibration, Volume of Fluid

Introduction

Ultrasonic atomization is the fastest growing atomization technology at present than conventional atomization. Numerous models are designed to fulfill common requirement such as particles size and distribution [1-8]. Ultrasonic atomization process offers more advantages than conventional atomization process. Nevertheless, the whole theory of ultrasonic atomization and design guidelines of new model have not complied yet since the ultrasonic atomization process itself possess a lot of complexity. Only empirical approaches are used to predict mean droplet size and distribution. To overcome this limitation, numerical treatment will be useful for preliminary study to predict atomization process. According to [9], numerical treatment has many facilities for varying geometrical and operational parameter.

In this paper, new mechanism is proposed for ultrasonic atomization process to replace array of nozzles jet ultrasonic atomizer utilization. It consists of piezoelectric transducer to vibrate and to generate flexural radial curvature vibration on a metal tube. Figure 1 and 2 and figure 3 and 4 illustrate the bending tube model and the flat surface model, respectively as comparison. Varying tube lengths are applied to study radius curvature effect in generating droplets.

VOF is used to simulate and to predict the tendency of droplet generation [6], [10]. It is very robust and does not require any additional equation [11-13]. It is also simple and powerful method, more flexible and efficient for treating complicated free boundary configuration and tracking free fluid surface [13] and also very accurate for moving boundary [14], although it requires fine meshing size [15]. Refer to [6], [10], to overcome the use of immense meshing size in computation, 2D domain is applied and the tube surface is used as research object. This treatment refers to [6] and [10], who used the tip of ultrasonic nozzle model as research object.

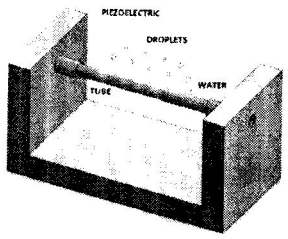

Figure 1 Design structure for bending tube model

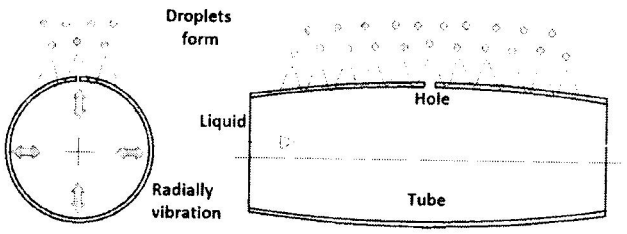

Figure 2 Bending tube with flexural radial curvature vibration