Atomization Enhancement of Four-Fluid Spray by Electric Field

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Abstract

The technology which atomizes the liquid in the particles of a few microns can be effectively applied not only to the high-efficient, low-pollutive spray combustor but also to the high-efficient manufacturing methods for such as drugs absorbed better in human body, cosmetic powders, electrode materials of new-model batteries, new catalysers and raw materials for new semiconductors by using it as "spray drier".

A new spray drying nozzle[1] (special quadruplet fluid spray nozzle) has been developed by us for drug manufacturing and we have succeeded in producing fine particles of 2 μm diameter of 1/15 ratios to those currently in use.

There are three types of nozzle, namely, circle one(radial flow), flat one(straight flow) and pencil one(coaxial flow). The former two have the same wedge-shaped edges on their nozzle tips. The latter has the additional center air jet.

A developmental study of these supersonic air-assist four-fluid spray nozzles was reported on the 17th Annual Conference on Liquid Atomization & Spray Systems in Zurich[2]. We have succeeded in manufacturing a large quantity of several microns particles (SMD) with these spray drying nozzles. Using the optical visualization techniques, the atomization mechanisms of these nozzles were made clear and their basic characteristics were investigated by measuring the droplet size distributions applying the laser light scattering method.

In case of these nozzles, the two air jets become under-expanded on both edge sides of the nozzle, generate shock and expansion waves alternately on each side and reach the edge tip, where they collide, unite, and spout out while shock and expansion waves are again formed in the mixed jet. When the edge surfaces are supplied with water, the water is extended into thin film by the air jet and intensely disturbed. At the nozzle tip, it is torn into ligaments, which are further atomized afterwards in shock waves. At the spray tip, the friction with ambient air shears the droplets furthermore, and they seem to decrease further in size.

The further experimental works were carried out to enhance the liquid atomization by applying the electric field to the same nozzle sprays. A circular plate electrode with a circular hole in the center for jet to penetrate and also a ring electrode were set in front of the nozzle exit. In this study, the measurements of the droplet diameter and the atomization angle from the spray photographs were made with applied voltage and air pressure as parameter. Either positive or negative potential was applied to above electrodes, and the nozzle was grounded. We show mainly the results of pencil type nozzle for laboratory use.

Experimental results have shown that the atomization angle decreases as the air pressure of the nozzle increases up to about 0.4 MPa and that the average diameter of the droplets decreases as the electrical potential increases. As the air pressure grows larger, the atomization effect of the electric field on the droplet size diminishes accordingly. We assume that the effect of electric field on atomization becomes smaller as the speed of air flow increases

. The characteristics of atomization by this superimposed electric field and the further prospects are described in this contribution.

References

[1] Japanese patent No. 2797080, 1998, etc.
[2] S. Miyashiro, H. Mori and H. Takechi, DEVELOPMENTAL STUDY OF SUPERSONIC AIR ASSIST FOUR-FLUID SPRAY NOZZLES, Proceedings of the 17th Annual Conference on Liquid Atomization & Spray Systems, 2001, Zurich.

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