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Dimensionless Numbers on Cavitation in a Nozzle of a Plain Orifice Atomizer

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Abstract

Although it is known that the development of cavitation (super cavitation) in a nozzle of pressure atomizers promotes liquid jet atomization (**Fig. 1**), our knowledge on various dimensionless numbers, such as the cavitation number σ and the Reynolds number *Re*, on cavitation and jets is still rudimentary. At present we do not know which dimensionless number can be used to quantitatively predict the formation of super cavitation in various nozzles. In this study, effects of various dimensionless numbers on cavitation in plain orifice atomizers and liquid jets are investigated. To examine the effects of σ and *Re* on cavitation and jets, water temperature and flow rates are varied to adjust σ and *Re* to desired values. Nozzles of different upstream widths and length-to-diameter ratios *L*/*D* are used to examine the effects of flow contraction on cavitation and whether or not various dimensionless numbers can be used to predict the formation of super cavitation. As a result, we confirm that (1) cavitation length L_{cav}/L and associated jet are not strongly affected by *Re* but by σ (**Figs. 2 and 3**), (2) the thickness of the cavitation zone increases with the ratio C_u of the cross-sectional area upstream of the nozzle to that of the nozzle due to the decrease in contraction coefficient C_c, (3) the formation of super cavitation in nozzles with different C_u and *L*/*D* is predicted not by the conventional cavitation numbers, such as σ, σ_2 and σ_3, but by the modified cavitation number σ_c ($= C_c^2[2(P_b-P_v)/\rho V^2+\lambda L/D_H+1]$) in which effects of the flow contraction and the frictional pressure drop in a nozzle are taken into account (**Figs. 4 and 5**).

Key words: Cavitation, Nozzle, Cavitation number, Reynolds number, Flow contraction

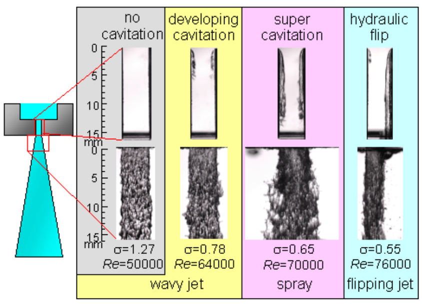

Fig. 1 Cavitation and liquid jet

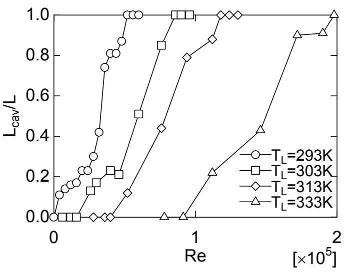

Fig. 2 *Re* vs. L_{cav}/L

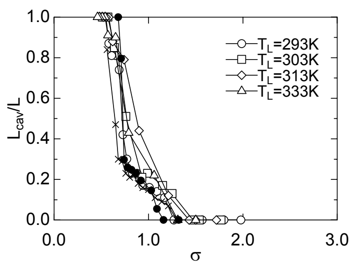

Fig. 3 σ vs. L_{cav}/L

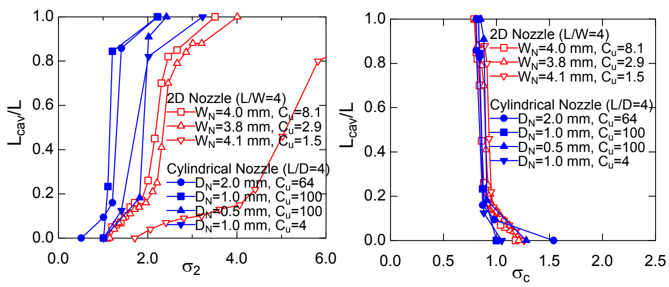

Fig. 4 σ_2 and σ_c vs. L_{cav}/L for different C_u (*L*/*D*=4)

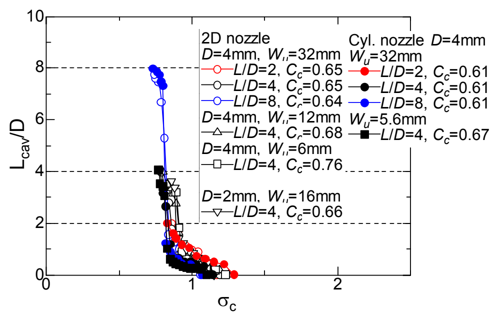

Fig. 5 σ_c vs. L_{cav}/D for different *L*/*D*

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