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## **Cleaning enhancement of solid dirt on plates with water containing fine air bubbles**

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### **Abstract**

Cleaning requires a large amount of water and chemicals which need treatment before emission. Reducing the amount of water and chemicals is the major subject to develop greener processes. The application of fine bubbles, FB, of air to cleaning has been attracting attention because of the potential of realizing chemical free cleaning processes. The advantage of cleaning enhancement was reported by Matsuura et al. [1] and Reuter et al. [2]. Although there is an enhancement of cleaning, the quantitative evaluation is still unclear and the characteristic of fine bubbles is rarely described.

The present study focuses on measuring mass-transfer coefficient of the dirt material in various operating conditions and also to discuss the working mechanism of fine bubbles on the cleaning enhancement. The analysis of fine air bubbles in water helps to elucidate effective bubbles for the enhancement.

Benzoic acid was selected as a model solid dirt on a plate. A glass plate coated with benzoic acid was set in the duct. Water containing fine air bubbles was forced to flow in the duct. The weight reduction of benzoic acid and the change of area were measured to calculate the mass-transfer coefficient of benzoic acid. Distribution of bubble diameter and the number density of bubbles in water were analyzed with a laser diffraction method.

The mass-transfer coefficient for the presence of fine air bubbles was 1.4 times greater than water without fine bubbles. Dependence of the coefficient against flow velocity was compared with the conventional mass-transfer from flat plate and it was found that the presence of FB enhanced 10 % of the dependency against flow velocity.

### **References**

1. K. Matsuura, et al.; Separation and Purification Technology, 142, 242-250, 2015
2. F. Reuter, et al.; Ultrasonics Sonochemistry, 29, 550-562, 2016

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