2015 Taiwan/Korea/Japan Joint Meeting on Chemical Engineering, November 5-7, 2015,
E-DA Royal Hotel, Kaohsiung, Taiwan

Effects of gas properties on bubble behaviors in fluidized catalyst beds

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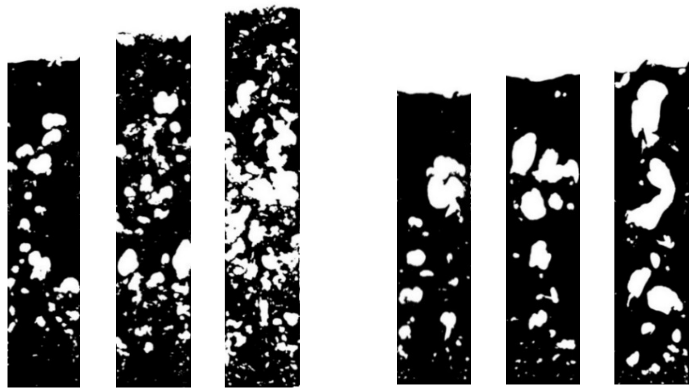
Abstract

Bubble size is an important parameter for the reactor model of fluidized beds. Therefore, many researchers have measured bubble size and proposed the equations to predict bubble size (Karimipour and Pugsley, 2011). However, almost all the measurements were carried out using air at ambient temperature, and so the proposed equations ignore the influence of the gas properties such as density and viscosity. As the results, these equations cannot correctly predict the bubble size in fluidized catalyst beds. It has been reported that bubble size is affected by the apparent viscosity of the emulsion phase (Kai *et al*., 1987b). In addition, the emulsion phase voidage is greater than that at minimum fluidization for the fluidized bed with fine particles, and the apparent viscosity decreased with an increase of the voidage (Kai *et al*., 1991). Furthermore, because the emulsion phase voidage is affected by the gas properties (Kai *et al*., 1987a), hence the gas properties affect the bubble size in the fluidized catalyst beds. In this study, the expansion ratio of the emulsion phase and bubble size were measured in a two-dimensional fluidized bed. Five types of gases were used as the fluidizing gas; argon, helium, carbon dioxide, nitrogen and hydrogen. The measurement was carried out using two optical probes, and the bubble size was calculated from the signals from these probes.

The emulsion phase voidage was strongly affected by gas viscosity. The voidage was high for high viscosity gas. The bubble size was small for high viscosity gas, while was large for low viscosity gas such as hydrogen. The binarized images of the beds fluidized by argon gas and hydrogen gas are shown in Figure 1. This figure indicates that the bubble size were affected by the type of fluidizing gas. The relationship between the apparent viscosity of the emulsion phase and bubble size was obtained using the correlation of the apparent viscosity considering the emulsion phase voidage. The relationship agreed with the theoretical formula introduced by Kurooka *et al.* (2008).



(a) Ar (U_G=3.16, 6.95, 10.5 cm s^{-1}) (b) H_2 (U_G=2.97, 6.67, 9.71 cm s^{-1})

Fig. 1 Binarized images of 2D bed fluidized by (a) Ar and (b) H_2.

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