



The influence of gas velocity, salt type and concentration on transition concentration for bubble coalescence inhibition and gas holdup

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A B S T R A C T

The influence of gas velocity (3.5, 10, and 18 mm/s), salt type (NaCl, NaF, NaBr, NaI and CsCl) and salt concentration (0.001–3 M) on bubble coalescence in a small bubble column were studied. The bubble coalescence was determined by the relative change in the measured light intensities passing through the salt solutions and clean deionised water. It was shown that the transition salt concentration for bubble coalescence inhibition (determined at 50% of bubble coalescence) of all investigated salts decreases with increasing superficial gas velocity. The difference in the transition concentration between NaCl, NaF, NaBr and CsCl does not significantly change with the gas velocity. However that difference between NaI and the other salts significantly decreases with increasing the gas velocity. The gas holdup significantly increases with NaCl, NaF, NaBr and CsCl concentrations but does not significantly change with NaI concentration. These new results imply that the transition salt concentration for bubble coalescence and gas holdup depend not only on the salt properties (i.e. the ion type and their combination) as previously reported, but also on the hydrodynamic conditions.

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Keywords: Bubble; Coalescence; Gas holdup; Salt; Ion specificity

1. Introduction

Air bubbles are used in industrial applications to provide high specific surface areas for mass and/or heat transfer in bubble columns and chemical reactors or for flotation separation in mineral processing, wastewater treatment and water desalination. Salts have been found to significantly affect the size and the coalescence of bubbles, and hence the performance of these applications (Harvey et al., 2002; Klassen and Mokrousov, 1963; Paulson and Pugh, 1996).

Numerous studies have been carried out to investigate the effects of salts on bubble coalescence and the underlying mechanisms (Chesters and Hofman, 1982; Craig et al., 1993; Hofmeier et al., 1995; Marrucci, 1969; Marrucci and Nicodemo, 1967; Prince and Blanch, 1990a). Many studies have focused on explaining the ion effects specific to the ion types and combinations. Some salts have been found to inhibit coalescence, whereas many other salts do not. C_{trans} is defined as the concentration at which bubble coalescence is 50%, where 100%

is for pure water. Bubble coalescence has been found to be ion-specific, i.e., C_{trans} strongly depends on ion types and their combination (Christenson et al., 2008; Craig et al., 1993). In some of the studies, C_{trans} was identified as a unique parameter for each of the salts examined. Some researchers (Chan and Tsang, 2005; Marrucci and Nicodemo, 1967; Prince and Blanch, 1990b) developed models to predict C_{trans} as a function of surface tension, bubble size, and van der Waals forces. It is noted that these theories were developed for the immobile air–water interface, which are expected to be different to the mobile air–salt solution interfaces. The mobility of air–salt solution interface is hypothesised to be a function of ion partition at the interface. Researchers (Zahradnik et al., 1995) have used the proposed model equations and compared the theories with various experimental data (Lessard and Zieminski, 1971), but have not realised that the models developed for bubbles with the immobile surface might not be physically consistent with the data obtained with bubbles having a mobile surface (Zahradnik et al., 1995). Tsang et al. (2004) reported the first

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Received 8 March 2011; Received in revised form 5 August 2011; Accepted 8 August 2011