413b Bubble Sizes in Agitated Solvent/Reactant Mixtures Used in Heterogeneous Catalytic Hydrogenation

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Catalytic hydrogenations reactions are frequently conducted in ‘dead-end' multiphase stirred reactors with the reactant dissolved in either an alcohol, water or a mixture of the two. In such systems, the rate of gas–liquid mass transfer which depends on bubble size may well be the overall rate-limiting step. However, a study of bubble sizes across the whole range of solvent compositions from entirely water to entirely organic has not been reported. Here, for the first time, a systematic investigation has been made in a 3L, “dead-end” vessel containing 1% by volume of air dispersed by a Rushton turbine in water, isopropanol (IPA) and mixtures of the two, with and without 2-butyne-1, 4-diol simulating a reactant. In the single component solvents (water s = ~ 72 mNm-1, isopropanol s = ~ 21 mNm-1) though the interfacial tensions are very different, irregular, relatively large bubbles of similar sizes were observed (d32 ~ 300 mm in IPA, and ~ 400 mm in water,) with a wide size distribution. In the mixed aqueous/organic solvents, and especially at the lower concentrations of IPA (1%, 5%, 10%), the bubbles were spherical, much smaller (d32 from 50 to 70 mm) with a narrow size distribution. The addition of the reactant to the mixed solvents had little effect on the mean size, shape or distribution. However, addition to water (thus producing a mixed liquid phase) led to small (50 mm diameter) spherical bubbles of narrow size distribution. Neither Weber number nor surface tension were suitable for correlating bubble sizes since s decreases steadily from pure water to IPA whilst bubble size passes through a minimum at around 5% IPA. For any particular fluid composition, the functionality between d32 and is similar, i.e. . The above observations are explained in terms of the polarisation of bubble surfaces in miscible mixed aqueous/organic liquids caused by preferential directional adsorption at low concentrations of the organic component with it's OH groups at the gas/liquid interface. As a result, coalescence is heavily suppressed in the low concentration miscible alcohol (or diol)/aqueous systems whilst strong coalescence dominates bubble sizes in water and the alcohol and at high concentrations of the latter.