Solids Suspension in Tall Tanks

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Abstract

Uniformly suspending slurry solids in process vessels (reactors, crystallizers, storage tanks, etc.) of various sizes and shapes is a significant challenge in the chemical industry. This may be a bigger issue in manufacturing processes using glass-lined vessels, such as suspension polymerization, where large capacity vessels are disproportionately tall due to size constraints on the vessel manufacturer's glass-firing furnace. While tall tanks offer the enticement of higher capacity with a lesser foot print, uniformly suspending solids within such vessels is still a very daunting challenge.

The extensive work in solids-liquid systems is well represented in Paul et al. (2004) and such recent studies as (Brown et al., 2007; Himmelsbach et al., 2007; Spogis and Nunhez, 2007; Khazam and Kresta, 2006; Ditl and Rieger, 2006; Bao et al., 2005). These works involve experimentation and/or computer modelling to examine a variety of floating or settling solids, and traditional and/or new impeller types operating at various conditions of agitation speed and flow direction. The research described in this document seeks to understand the performance of a multi-tier agitation system consisting of either axial flow hydrofoils or mixed flow pitched blade turbines in uniformly suspending a specific settling solid in water throughout a "tall" laboratory vessel.

This study determined how the solids distribution changes as a function of solids loading (10, 20, 30, and 40 wt%), mixing rate (100, 150, 200, 250 RPM), and impeller type (pitched blade turbine (PBT) or wide-blade hydrofoil (Lightnin A320 or A340)). All work was conducted in a 17.5 in. ID Plexiglas® tank, with a slurry height of 35 in. At fixed operating conditions, the solids concentrations were obtained at four different axial tank locations. The results indicate that both impeller types produced a uniform solids suspension when the rotation rate produced an energy input of at least 6 HP/1000 gallons for the hydrofoils, and 7 HP/1000 gallons for the PBTs. Significantly higher energy or rotation rates improved the solids distribution only slightly because, at some point, flow within the vessel appeared to become choked.