Suspension of Solid Mixtures by Mechanical Agitation

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Introduction
Just-suspended condition, which is the most commonly encountered level of liquid-solid agitation, occurs when no solid particles rest on the tank base for longer than one to two seconds such that all solids are suspended in liquid phase and the maximum surface area is accessible for desired process requirement with the minimum power consumption.

Motivation and Objective
• Just-suspended speed ($N_{js}$) of uniform solids has been extensively studied and can be reasonably predicted by empirical correlations
• There has been very little work on just-suspended behavior of solid mixtures
• Is the mixture suspension power equal to the sum of powers required to suspend the individual solids in a binary system ($P_{mixture} = P_{solid1} + P_{solid2}$)
• Design rule: $N_{js,m} = (N_{js,1}^3 + N_{js,2}^3)^{1/3}$

System Geometry
• 11.5-inch diameter flat-bottom tank
• Four 1-inch width straight baffles
• 4-inch diameter 45° pitch-blade turbine
• 2.875-inch off-bottom clearance
• Liquid level equal to tank diameter
• Water used as liquid phase

Experimental Procedure
• A fixed mass of solid 1 was first added in test tank
• The various amounts of solid 2 masses were progressively added in the test tank
• The sum of powers approach (design rule) was applied to estimate the solids mixture just-suspended speed ($N_{js,pre}$)
• With the fixed mass of solid 1, mixture speeds ($N_{js,mea}$) were measured with progressively increasing mass of solid 2

Results
• High-density systems: the combination of two solids of density above 2.4 g/cm$^3$
• Low-density systems: the combination of two solids of density below 1.5 g/cm$^3$

Conclusion
The sum of powers approach can reasonably predict the just-suspended speed of both high-density and mixed-density systems except those involving olivine sand while the predicted speeds from the sum of powers approach are typically ten to twenty percent greater than the measured speeds of low-density systems. For those systems with olivine sand, the sum of powers approach always significantly over predicts the measured mixture suspension speeds.