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Principles and Application of CPT Cavitation Sparging System in Flotation

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Application of CPT Cavitation Sparging System

CPT has applied external hydro-dynamic (cavitation) sparging systems for a variety of industrial column flotation applications ranging from iron ore, phosphate, fluorite, niobium, feldspar, mica to molybdenum.

The CPT Cavitation Tube

A model of the CPT Cavitation Tube (CavTube) is shown in Figure 1. The combined slurry/gas mixture exiting the throat of the CavTube is lower in pressure and higher in velocity than the combined slurry/gas mixture entering the CavTube. The resulting hydrodynamic cavitation produces bubbles so fine that they resemble 'smoke'. Additionally, the presence of tiny pockets of un-dissolved gas in crevices on mineral particles assists cavitation, through the expansion of those 'gas pockets' under the negative pressure. As well, smaller and more numerous cavities are produced by the addition of organic chemicals such as frothers, acting to stabilize the cavities preventing cavity collapse and coalescence.

Figure 1 CPT Cavitation Tube

How Hydrodynamic Cavitation improves Froth Flotation

Hydrodynamic cavitation is a process of creation and growth of very small gas and/or vapor filled bubbles (pico-bubbles) in a liquid due to the rupture of a liquid–liquid or a liquid–solid interface under the influence of external forces. Adhesion

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work, $W_a = \gamma_l(1 + cos\theta)$ between a solid particle and water is always smaller than that of cohesion, $W_c = 2\gamma_l$ thus pico-bubbles preferentially nucleate onto the surface of particles and may eliminate the rate-determining steps for fine particle flotation: collision and attachment. Particles are less likely to detach from smaller bubbles due to their lower upward velocity and the centrifugal force associated with the detachment process, reducing the probability of detachment.

Pico-bubbles also act to substantially improve the flotation recovery and capacity of poorly floating fine particles, i.e. particles of insufficient size or density to penetrate flotation streamlines, thereby increasing the probability of particle-bubble collision. As well, W_a decreases with the contact angle θ or solid surface hydrophobicity thus pico-bubbles are more readily formed on the surface of hydrophobic particles than on hydrophilic particles. This acts to improve and increase flotation selectivity critical in the application of fine or ultrafine particle separation.

Finally pico-bubbles attached to a particle's surface also serve as a secondary collector leading to a reduction of reagent costs. The cost of reagents is often the largest single operating cost in industrial mineral flotation plants.

Typical Installation

A Cavitation tube sparging system installation, figure 2, comprises; a slurry re-circulation pump, slurry and air manifolds and cavitation tube spargers. In operation, slurry is pumped from the bottom of the CPT flotation column into the slurry manifold and back into the column through the cavitation tube spargers. Sparger air is injected into the slurry just ahead of the spargers. Hydro-dynamic cavitation acting on the slurry-air mixture as it moves through the sparger causes the formation of pico-bubbles greatly improving flotation performance. An example of the resulting concentrate froth is shown, figure 3.

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Figure 2 CPT Flotation Column fitted with Cavitation tube sparging system

Figure 3 CavTube generated froth

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CPT cavitation sparging systems operating at several Brazilian igneous phosphate flotation plants have demonstrated impressive results. On average, a 2% - 3% increase in overall flotation plant recovery and up to 15 % increase in ultra-fines (-20 µm) recovery at the specified product grade. CPT cavitation systems have also been successfully used to recover niobium slimes (-5 µm) from a waste stream and upgraded it to final concentrate specifications.