Slurries

Pumping slurries and keeping slurries agitated in tanks are two of the most difficult transport operations in chemical engineering. Provisions must be made in the design to keep all slurries moving so as to not have them plug lines or plug the bottoms of agitated tanks.

Many times engineers designing system do not take into consideration all the transient and failure modes that may affect the slurry handling systems design. For example, slurry tanks should have provisions to allow the re-start of the agitator in a tank bottom where the solids have settled into a cake in around the impeller. System design methods could include high torque agitator drives, shafts and couplings, back up electrical power, or decoupling and mechanical torque multipliers to assist in the restart. Methods to get the slurry moving in the bottom of a settled tank could include installing access for air lances to be placed into the caked up tank to begin to move the material using air then allowing the agitator start up to finish the re-suspension of material.

This could include the use of flush fluids to dilute the slurry so to a concentration where it will no longer sand up. This could also include placing critical agitators on back up power in the event of a power failure to the drive. The back up power method has to then have a secondary way to get the slurry to re-suspend as the failure may be in the agitator itself and not necessarily the lost of primary power.

All slurry inlet and discharge lines must be designed with the ability to have a continual re-circulation and to have the provisions for flushing the lines back to tank or forward to tanks only allowing thin fluids to remain in dead legs. Operational lines where there is no flow at some point in the normal operational cycle must be equipped with automated flushes.

Operational lines that will only have slurries during abnormal operation, like the use of a blocked out redundant pump, or lines that will contain slurries only during the clean out of a line for maintenance preparation, can be equipped with manual flush connections.

The cone bottoms of any slurry containing vessel shall have provisions to be able to move the slurry out of the cone and back up into the vessel, or these vessels shall have a provision to keep the material moving in the discharge cone at all times. Methods for this provision could include tickler impellers at the bottom discharge on the end of the agitator shaft, flush lines that will push material back up into the tank, and air blow lines that will break any sand bridge in the cone of the discharge.

Similar to pumps in slurry service, but to a much different scale, particle velocities should be kept to a minimum to prevent high velocity particle erosion areas. It is better to have a larger diameter impeller that moves at a slower rate in order to add missing energy to the system versus a small diameter high speed impeller.

Particle shear is critical in forming some of the precipitated products. Shear rate and particle velocity fields must be considered and presented as justification for a certain proposed agitator designs.

Slurry System Design Guidelines

- Keep slurries moving at all times whether in tanks with agitators or in pipelines with pumps.
- Loop feed systems are more successful than one way feed systems.
- Do not install dead legs in slurry transfer piping.
- Flush ports, pad flanges, flush diaphragms, and flow through diaphragms should be used for valve nipples and instrument tees.
- Insure that the fluid velocity in slurry piping is above the critical carrying velocity of the slurry.
- Insure that the agitator upflow pumping rate is greater than the settling velocity of the slurry.
- Throttle volumetric flow rates of slurry lines using pump speed controllers or line size changes versus control valves. Pinch valves can be used if the elastomer in the pinch bladder is soft enough and tough enough to have the slurry solid particles impregnate in the bladder and create its own wear surface against the particles themselves
- All slurry tanks shall have provisions to allow the re-start of the agitator in the case where the solids could settle and bind up tank agitator in settled bottom solids mass. Methods might include:
    1. High torque agitator drives, shafts and couplings.
    2. Access for air lances to be placed into the sanded up tank to begin to move the material to then let the agitator start up and finish the re-suspension of material.
    3. The use of flush fluids to dilute the slurry so to a concentration where it will no longer sand up.
    4. Place critical agitators on back up power in the event of a power failure to the drive.

The cone bottoms of any slurry containing vessel shall have provisions to be able to move the slurry out of the cone and back up into the vessel, or these vessels shall have a provision to keep the material moving in the discharge cone at all times. Methods for this provision could include tickler impellers at the bottom discharge on the end of the agitator shaft, flush lines that will push material back up into the tank, and air blow lines that will break any sand bridge in the cone of the discharge.

Particle velocities should be kept to a minimum to prevent high velocity particle erosion areas, however, the velocity must be kept above the critical settling velocities to prevent plugged lines. It is better to have a larger diameter impeller that moves at a slower rate in order to add missing energy to the system versus a small diameter high speed impeller.