
Process Design with the Judicious Use of Air/Gas Flow

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Use of air/gas vents and injection ports to facilitate flow of material through a system can help – or hurt – overall process performance. Erratic flow rates caused by improperly positioned air/gas flow can cause hang-ups that are not limited to the region near hopper outlets. Gas pressure gradients can also influence stress levels in bins, making hang-up possible through the entire equipment, depending on the flow of gas.

Erratic flow rates and other flow rate related problems depend on two properties of the bulk material. Compressibility of the material dictates the amount of gas that can be stored in the solids pore structure. Permeability, or resistance to gas flow, determines the rate at which gas will pass through (or leave) a bulk material. As compressible material is placed into a piece of process equipment and passed through the equipment relatively slowly, the material compresses as more bulk solids pile on top,

squeezing the gas in the bulk solid out and resulting in limiting flow rate problems. Designing for conditions that could have gas pressure gradients is more complex than standard process design. One must measure the cohesive flow properties, compressibility, and gas permeability and then compute the expected gas pressures in process equipment. When these pressure profiles are computed, the pressure gradients can be used to determine the flow rates, expected arching, potential rathole, and possible mass flow effects in the material.

Limiting rates are handled by injecting the right amount of gas in the right location to replace gas that was pressed out of the material during normal compaction of the bulk material during flow. However, injecting too much gas can cause erratic flow problems. Therefore, it is of primary importance to consider the air flow through the entire system, in conjunction with the flow characteristics of the bulk material, to achieve successful (get it right the first time) process design.

PRACTICAL APPLICATIONS of *air/gas flow* information include, but are not limited to:

- Design to eliminate the potential for material hang-up (arching) due to gas injection
- Design custom processes to control velocity profiles by gas injection
- Achieve consumer acceptability by maintaining consistent flow rates in packing equipment