
“Know Floe’s Korner”



Top Ten Tips for Dense Phase Pneumatic Conveying

Shrikant Dhodapkar (The Dow Chemical Company, USA)

George Klinzing (University of Pittsburgh, PA, USA)

Lyn Bates (Ajax Equipment, UK)

Peter Wypych (University of Wollongong, Australia)

1. The term “dense phase” is often misused in practice. For example, many so-called “dense-phase” systems are found to be operating in dilute-phase (or suspension flow). Also, many researchers and designers define “dense-phase” as a flow mode with solids loading greater than 10 or 15. Many different types of dense-phase have been developed over the past few decades to take advantage of certain product properties (e.g. air retention, deaeration, permeability, cohesion, particle size distribution). In most cases, “dense-phase” can simply be considered as some form of non-suspension flow that occurs at some time at any section along the pipeline. Using solids loading as an indicator of flow mode can be misleading (e.g. solids loading is a mass concentration parameter that depends on the mass or density of the particles; some dilute phase systems are operating at a solid loading greater than 40 and some dense phase systems less than 10). ***Ensure that the choice of a flow mode (and system) is based on the product properties (rather than an imprecise definition or misleading solids loading), and that the selected or supplied flow mode is confirmed during commissioning.***
2. Coarse/granular materials that can be conveyed in dense phase (viz. low-velocity slug-flow) exhibit an unstable operating zone in between (high-velocity) dilute phase and (low velocity) dense phase conveying. The dense phase regime is bound by a high-velocity (unstable zone) boundary and a low-velocity (blockage) boundary. ***Make sure the operating point (gas flow rate, solids flow rate) falls well within these bounds at all locations in the system and for all pipeline configurations (if applicable).***
3. ***The minimum and maximum conveying rates in a process must be defined upfront.*** Compared with dilute phase, the dense phase regime can be more limiting and sensitive to variations in air flow and/or conveying rate. For some materials, a reduction in solids flow rate can shift the operating point into the unstable zone, thereby causing severe instability (line vibrations and pressure spikes).
4. Bench top characterization tests (wall friction, permeability, deaeration, etc.) are helpful for preliminary screening of a material’s suitability for dense phase conveying. Dense phase conveying performance can be quite sensitive to variations in material property (particle size, size distribution, shape, density, moisture, cohesion, etc.). ***It is highly***

recommended that pilot scale or full scale testing be conducted on representative material, especially for new or different products where no prior experience is available.

5. Using a conventional or “off-the-shelf” pipeline, not all materials can be conveyed reliably in dense phase. Some materials can be conveyed in single or multi slug/plug mode, some in fluidized moving bed type flow, while others can **only** be conveyed in dilute phase. Not selecting the right flow mode for a particular material or the right operating condition for a given flow mode can result in excessive pressure spikes, system shutdown, unstable vibrations and/or pipeline blockages. *For materials that do not have a natural tendency for conventional dense phase conveying, consider specialized systems with controlled and regulated gas injection or bypass pipeline technology. Also, ensure proper dense phase flow actually is achieved during commissioning.*
6. Feeder gas leakage can be a significant fraction (up to 50%) of total gas consumption. *The gas leakage at the feeder (esp. rotary valves) must be considered in design calculations and compensated appropriately. Ensure proper venting at the feeder to avoid feeding problems that may result from the gas blowback.*
7. *Use a gas flow control system for multi-product and multi-destination systems to ensure that the operating point is maintained within the stable operating zone.* Also, ensure that the gas flow control system provides a constant gas mass flow rate for the full range of operating pressures and pressure fluctuations. Numerous control logic schemes are available from various vendors or can be designed by reputable consultants.
8. In dense phase systems, gas expansion can be significant between feed point and destination. This will result in a corresponding increase in gas velocity, and a possible transition from dense to dilute phase flow along the conveying pipeline. *For high pressure drop systems (7 psi or 50 kPa and higher), consider stepping the line diameter to reduce the velocity and maintain dense phase conditions.*
9. The motion of slugs and stresses generated within the conveying line during directional changes (bends or diverter valves) results in significantly higher stresses on pipe supports as compared to dilute phase systems. *It is essential to work closely with an experienced vendor to design and install proper pipeline supports to prevent excessive deflection and line movement, and reduce the prospect of fatigue failure.*
10. To purge a dense phase line clean, a controlled increase in gas velocity may be required. *A proper purge control sequence may need to be designed and tested to avoid unnecessary product degradation and/or pipeline blockage. The dust collector must be designed to handle the peak gas flow rates.*

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