ELIMINATING ARCHING HANGUPS IN HOPPERS

When an arch develops, it mostly forms at the hopper outlet or the smallest cross-section of the convergence. Arching is evident when nothing flows out of a full bin or hopper outlet after opening a slide gate is opened or starting a feeder.

Cohesive forces within a material cause arching. Some of the factors that increase a material's tendency to arch or bridge are

- A decrease in particle size.
- An increase in moisture or other volatile content.
- An increase in temperatures above freezing.
- Temperature cycling.
- Extended storage time.
- Chemical reactions such as oxidation or acid formation.
- Evaporating volatiles.
- Crystallization.

Arching is less likely in hoppers designed for flow at the walls, but that isn't always the case. It all depends on the material. A solid that is free-flowing, non-fibrous and does not have elastic springback tendencies, doesn't require flow at the walls. On the other hand, cohesive flakes and fibers will work best in hoppers designed with flow at the walls, as will materials that cake with time and are stored in hoppers that are not periodically emptied. Stored, non-moving material may form lumps that can break loose and block the outlet.

The typical method for breaking at arch in to hit the hopper with a hammer, which produces dents that can further impeded flow and make arching problems significantly worse.

Applying vibration can help or hinder. It may be effective with stored materials that cake (agglomerate) with time or with dry, water soluble materials such as salt, sugar and acid with less than 10% minus 100 mesh particles. Vibration is not effective, however, with materials like cake mixes that include shortening, with chopped fiberglass, flaky material or material that tends to be springy or spongy. In addition, vibration and other mechanical flow-aid devices such as air cannons, air lances and air jets consume enormous amounts of energy, can be expensive to maintain mechanically, are excessively noisy and can damage a hopper’s structural components.

If the possibility for arching exists either because the material is stored or because it is cohesive or if there are unavoidable factors, the best anti-arching insurance is an effectively designed hopper that achieves flow at the walls.

This passive force can be propagated in a conical hopper through steep hopper walls, but although conical hoppers with 70- or 80-degree walls (measured from the horizontal) may be economical from a fabrication perspective, they are rarely practical because of the increased headroom requirements. A pyramid-shaped hopper, which also requires steep valley angles and increased headroom requirements to achieve arch-breaking flow at the walls, is even less economical because of the increased wall reinforcement required for safety.

A chisel hopper with a slot across the entire diameter of a circular bin that has a modest 30-degree slope angle will break arches, but this highly effective hopper design will require a large and proportionately more expensive feeder capable of feeding uniformly across the entire slot length. It is critical that this feed draw equally along its entire length.

The Diamondback hopper is a one-dimensional-convergence hopper with a racetrack-shaped cross section and a circular outlet that has the advantage of breaking arches using flatter wall angles, which allows material to converge and discharge through a significantly smaller outlet. This hopper design requires significantly less headroom, but the precision of design means a greater fabrication cost. On the other hand, a smaller outlet means a proportionately smaller gate and feeder, thereby reducing the overall cost.