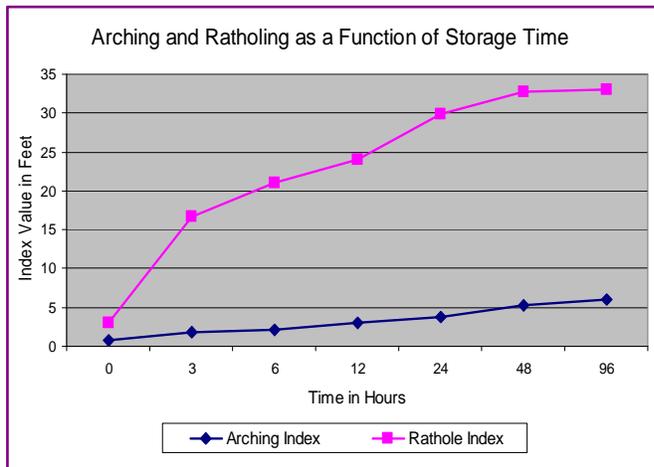


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## Addressing the Effect of Storage over Time on Process Design

### Material Flow Solutions, Inc.

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When bulk materials contain moisture, and/or are exposed to humid environments, caking (clumping) can occur. The effects of this caking generally increase with storage over time – sometimes in an exponential fashion. Moreover, fluctuating temperature resulting from day/night storage conditions in many production facilities causes changes in the local moisture content due to thermal moisture migration which leads to dissolution of soluble salts within the particles and re-crystallization between particles during each temperature cycle. Generally, if caking due to crystallization is

a potential problem, then temperature cycling produces a significant increase in strength with each temperature cycle. Optimal process design and operation parameters can eliminate, or at least mitigate, this production issue.

Good design protocol begins with characterization of the material that will be used in the final system design. Bulk strength is the primary property used to predict hang-ups in process equipment and is the primary variable describing the development of a strong cake in bulk materials. Therefore, unconfined yield strength must be measured at various consolidation pressures and over a range of storage times expected in the system. Since strength increase with time can be the result of de-aeration effects – particles come in closer contact as material loses entrained air and compacts during storage – it is also important to measure the material's density and permeability values. At Material Flow Solutions, we also measure wall friction angles and particle size distribution – which give data necessary to choose proper bin, hopper and feeder angles to maximize material flow through the system free of erratic flow effects.

**PRACTICAL APPLICATIONS** for information regarding how *storage over time* affects bulk solids include, but are not limited to:

- Design to eliminate the potential for material hang-up (arching) and ratholing that can otherwise shut down a running production plant
- Design custom processes to prevent lump formation
- Achieve consumer acceptability by maintaining consistent quality of end-product through controlled humidity migration