While many industries use bins or silos only for storing bulk solids, there are also quite a few that use these types of vessels for processing their materials. The lead article discusses the requirements for reliably operating these systems. An example of a solution we provided is also given.

This issue also introduces the Jenike-Schulze Ring Shear Tester™. If you must conduct your own tests, and you require an automated tester, this is the one for you.

As always, we hope you find this reading interesting as well as informative, and we appreciate your comments and suggestions.

John W. Carson, Ph.D., President, Jenike & Johanson, Inc.
Using silos as processing vessels, and BP Amoco polypropylene purge column case history

Direct injection of gas through inlet pipes should usually be avoided, since this results in highly localized and hence very non-uniform gas distribution. Gas introduction through porous surfaces such as screens helps to minimize this problem, but often results in highly frictional surfaces which can hold up solid particles and thereby prevent mass flow. Cross-beams within vertical cylindrical sections avoid this problem.

Various types of inserts are often used in these vessels, to expand the flow channel as well as to provide a means for gas introduction close to the vessel’s vertical centerline. Inverted cones are sometimes used; however, experience has shown that the size and positioning of such inserts and their supports are critical.

Using a BINSERT® (a cone-in-cone insert) can result in a much more uniform velocity profile than is possible with either a single cone hopper or an inverted cone insert. The outer cone walls can be made less steep than would be required if such an insert were not used, thereby resulting in a significant headroom savings. In addition, this insert’s supports can be located within the vertical (cylindrical) portion of the processing vessel, where they have less detrimental effect on the flow pattern.

Conclusions
With new materials, and newer reactor technologies coming on line, current solids handling systems are being pushed beyond their capabilities. Therefore, these systems are being given new design attention, in regards to both throughput and to their ability to achieve system processing goals. Using a practical, engineering approach, gravity flow processing vessels can be economically designed or retrofitted to provide optimal performance.

Case History - BP Amoco
A new polypropylene (PP) plant was built by BP Amoco Chemical at Geel, Belgium in 1995/96. This project involved construction of a 200,000 tonnes/year PP unit using the BP Amoco gas phase process and BP Amoco’s high-activity supported catalyst. The plant produces random and blocked copolymers, and a wide range of homopolymers. When it came on line in late 1996, it doubled BP Amoco’s European PP capacity.

A purge column was included in the design following the reactors. The purge column provides several important functions in a gas phase process. First, it reduces residual volatiles to an acceptable level using nitrogen as the purge gas. Second, it deactivates the trace catalyst residues, by using a small quantity of steam. Third, it provides surge capacity between the reaction and pelletization sections of the plant.

Engineers at BP Amoco specified the minimum and maximum purge duration (i.e., time of exposure to purge gas). They also specified the required solids and gas flow rates as well as the gas temperature and pressure at the top of the vessel. Based on material flow property data generated during previous projects for BP Amoco, engineers at Jenike & Johanson developed the functional design of this purge column. It consists of a tall, narrow cylinder section, below which is a steep-sided conical hopper. Purge gas is introduced just above the top of the conical hopper section using our patented technology. The design provides a uniform distribution of the purge gas, with no adverse effects on the flowing solids.

The purge column has been in operation now for over two years and has performed very well, meeting the design basis. According to Jim Lee, Research Associate for BP Amoco Chemical, “The performance of the purge column has exceeded our expectations. In fact, it did not require any modification when the rest of the PP unit was debottlenecked by 40% in 1998.” This technology has been incorporated into three other plants which use BP Amoco’s gas phase process: BP Amoco’s Chocolate Bayou No. 4 PP, shown in the photo, and two licenses.

Meet Randall St. Pierre

Title: Senior Lab Technician
Joined J&J: 1976
Job Description: Randy is responsible for conducting flow properties tests, reviewing lab data, and training new technicians.

Of note: With over 23 years of experience conducting flow properties tests on every conceivable bulk solid material, there is not much that Randy has not already seen. In fact, over 6,500 materials have passed through the lab since Randy started. As state troopers are trained to determine just by eye how fast a car is traveling, Randy can predict the arching capabilities of a bulk solid just by compressing some of it in his hands. This of course does not negate the need for testing, but it does provide a double-check of the data.

“I find it interesting that some people feel that a Jenike shear test is difficult to run. Although I disagree, I also don’t apologize. I was taught that there are no shortcuts in life. If you use an alternate ‘simplified’ testing approach, you can usually expect simplistic results. And besides, when a company has a handling problem, they usually need an immediate solution, not a new lab. Why reinvent the wheel? Put our experience to work for you, to provide that solution.”
Is it safe to assume hydrostatic load conditions when performing a structural check on my limestone silo?

No. Bulk solids are significantly different than liquids. Liquid loads are simply a function of density and height. A liquid analysis will predict highest loads at the outlet of a silo. Bulk solids handled in mass flow silos exhibit their highest loads in the region just below the interface between the vertical cylinder and converging hopper. The outlet of a typical mass flow silo has relatively low loads.

Other factors that determine the loads applied by a bulk solid to silo walls are: friction of the solid against the walls, initial fill versus discharge conditions, whether the material is flowing in a mass flow or funnel flow pattern, eccentric loading, and loads caused by collapsing voids.

If you have any bulk solids handling questions, or if you have suggestions for future articles, please contact:

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October 27-28, 1999, Atlanta, GA

Powdex†

Exhibition 1999.

Eric Maynard, project engineer with Jenike & Johanson, will present courses titled “Solve Solids Flow Problems in Bins and Hoppers,” and “Design of Transfer Chutes to Minimize Buildup, Abrasive Wear, and Dust Generation.” Stop by and see us at Booth 632.

November 15-18, 1999, New York, NY

The 99 CHEM SHOW conference & 48th CPI exposition. Eric Maynard, project engineer at Jenike & Johanson, will present a 1-day course titled “How to Ensure Reliable Flow in Bins, Hoppers, and Feeders.”

December 1-2, 1999, Nashville, TN

MPIF: Innovations in powdered metal storage, feed, and transport designs. Brian Pittenger, senior project engineer with Jenike & Johanson, will give a presentation on powdered metal flow behaviors, flow properties, and feed system equipment considerations.

March 21-23, 2000, New York, NY

Interphex†, the International Pharmaceutical Exposition & Conference. James Prescott, senior project engineer with Jenike & Johanson, will present courses titled “Pharmaceutical Powder Handling Part I: Providing Consistent, Reliable Flow,” and “Part II: Maintaining Solid Dosage Form Quality.” Stop by and see us at booth 1370.

April 5-7, 2000, Santiago, Chile

Two in-house courses presented at Jenike & Johanson, Chile S.A.

• Bin and Feeder Design
• An Introduction to Pneumatic Conveying

May 8-11, 2000, Chicago, IL

25th annual Powder and Bulk Solids Conference/Exhibition†

Jenike & Johanson personnel plan to present the following seminars and workshops:

• Solve Solids Flow Problems in Bins and Hoppers
• How to Select or Troubleshoot Volumetric and Gravimetric Feeders to Ensure Reliable Flow
• Fine Powders: Reliably Handling Bulk Solids That Can Behave Like Fluids
• Blending and Segregation and Their Effects on Product Quality
• Flow Aids: What to Use and When to Use Them
• Retrofit Troublesome Solids Handling Equipment to Improve Flow and Product Quality
• Design of Transfer Chutes to Minimize Buildup, Abrasive Wear, and Dust Generation

Stop by and see us at booth 1626.

May 29–June 1, 2000, Israel

The Third Israeli Conference for Conveying and Handling of Particulate Solids. For more information visit the Conference web site at: http://www.bgu.ac.il/me/bsh/

†To register, contact Reed Exposition Companies, (203) 840-5848.