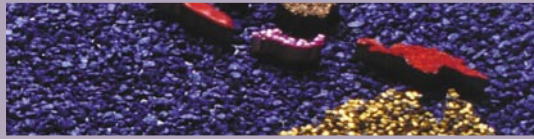
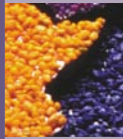


Flow of Solids

Bulk Solids: Science / Engineering / Design

The Newsletter for Jenike & Johanson, Inc.

Fall 2000



The Inside View

Glass Quality Improved with Reduced Segregation

Background

Libbey Glass is the leading producer of high quality, machine made glass tableware in North America, offering a product line that includes over 2,000 distinct types of glassware ranging from beverage glasses to serving and storage containers.

Libbey Glass's City of Industry facility, built in the early 1960s, produces primarily beverage glasses for use in the food service industry.

The soda-lime glass used for these products is primarily composed of silica, limestone, soda, and cullet (crushed, recycled glass). This mixture is referred to as "glass batch." The glass batch ingredients are weighed and blended before they are fed into a storage bin and then melted in a furnace. Molten glass is drawn from the furnace and delivered to molding and forming equipment, where the glass is progressively formed into finished tableware, heat treated, and cooled.



that result in a visual blemish or residual stresses), seeds and blisters (gas bubbles), and composition shifts appeared to be classic examples of batch segregation. On several occasions, the magnitude of the upsets was great enough to cause total production loss." Libbey's investigation of the batch weighing, mixing, and transfer systems did not turn up any significant problems. The mixed batch storage bin, however, showed dramatic signs of segregation, which increased in magnitude when the batching process was suspended for a period of time.

The Solution

Jenike & Johanson, Inc. was contacted to evaluate the problem and recommend a course of action. Two of our engineers, Scott Clement and Tom Troxel, visited the plant where the details of the project were discussed and the process and problems were observed.

After the site visit, a sample of Libbey's glass batch was sent to our testing lab so that the flow properties of the glass batch could be measured. These measurements, along with a review of the existing equipment drawings, confirmed that the geometry of the batch bin was contributing to the quality problems experienced in Libbey's finished products. The measurements also provided the information needed as a design basis for recommending a solution.

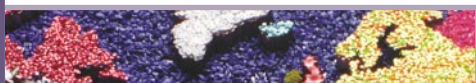
Segregation of the components of a blend by the sifting mechanism is likely if the following conditions are present:

At J&J we recognize the importance of understanding the unique problems, equipment, and terminology of the many industries we serve. That's why we have industry specialists like Jim Prescott, who is featured in this issue. Jim's specialty is the pharmaceutical industry. Other J&J engineers specialize in chemical processing, plastics, metal powders, cement, etc.

To learn more about our background and capabilities in your industry, I ask that you visit our newly revised web site (www.jenike.com). It contains much more information than can be presented in our newsletter.

John W. Carson

John W. Carson, Ph.D.,
President, Jenike & Johanson, Inc.



Glass Quality Improved with Reduced Segregation



- The material is free flowing.
- A sufficient range of particle sizes is present in the blend.
- The material is sufficiently coarse.
- There is inter-particle motion.

When loading material into the batch bin, all of these conditions were met, and sifting segregation occurred. This resulted in a concentration of fine material under the fill point (in this case, the center of the bin), as the fines sifted through a matrix of coarse particles.

Two flow patterns can exist in a bin during discharge. "Funnel flow" is the term used to describe the condition where flowing and stagnant regions of material exist concurrently within a bin. "Mass flow" is achieved when all of the material in the bin is in motion during discharge.

One of the advantages of mass flow is that if a blended material has segregated in a horizontal manner as it is loaded into the bin, it will be recombined at the outlet, since material is withdrawn from along the wall as well as from the center of the bin. When a funnel flow bin with a center fill and center withdrawal is used, and this type of segregation is present, significant variations in the composition of the discharge can be expected as the level in the bin changes.

In order to achieve mass flow, the outlet must be large enough to prevent the formation of an arch, and the hopper walls must be steep and smooth enough to allow the material to flow along them. The hopper wall angle required varies dramatically from bulk solid to bulk solid, and is highly dependent on the wall material and surface finish and, potentially, on such things as moisture content, particle size, and chemical composition. Measuring the actual flow properties of Libbey's glass batch eliminated guesswork and provided a sound design basis for recommending a solution to the segregation problem.

Our tests confirmed that the existing bin was operating with a funnel flow discharge pattern, and, more importantly, provided the information necessary for recommending a solution.



to mass flow and to control the segregation. We developed the BINSERT® system to control and expand flow patterns in bins by using a mass flow hopper-within-a-hopper. The inner hopper is designed to provide mass flow through the central channel and also through the annular space between it and the outer hopper.

After the recommendations were prepared and approved, we provided the equipment necessary for the retrofit. This consisted of a replacement lower hopper with an inner cone, support beams, and a liner for the portion of the upper hopper that was to remain. The retrofit was designed specifically for Libbey's installation and for the material being handled. We also provided assistance to the installation contractor to ensure that the job was completed correctly.

In order to support a previously scheduled shutdown at Christmas, the design work, fabrication, and delivery were completed in just six weeks. Delivery of the equipment was made on December 23, and Libbey's contractors completed the installation in time for the plant to resume production after the New Year.



The Result

As a result of the changes made to the batch storage and delivery systems, the quality problems that had been plaguing the plant since the last rebuild have been eliminated.

"Since the modifications have been implemented, there have been no negative impacts to glass quality on the numerous occasions of batch plant down time," stated Mr. Cetnar.

Another benefit realized after the retrofit was an increased live storage capacity. According to Mr. Cetnar, "Modification of the batch bin and the batch feed system resulted in a dramatic increase in the effective storage capacity, defined as usable, non-segregated batch."

Behind the Scenes: Meet James Prescott

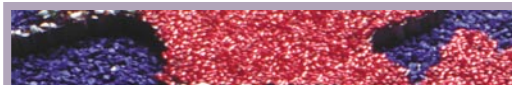
Title: Senior Project Engineer
Joined J&J: 1992
Job Description: Jim consults with

clients on a wide variety of projects. His focus on pharmaceutical applications means he is often addressing segregation problems that lead to blend or tablet non-uniformity. He is participating in the Blend Uniformity Working Group with PQRI

(Product Quality Research Institute), a collaborative process involving industry, academia, and the FDA, to recommend new policies on establishing uniformity of powder blends.

Of note: Jim received his B.S. in aeronautical engineering from Rensselaer Polytechnic Institute, and his M.E. in mechanical engineering from Worcester Polytechnic Institute.

"Clients see my degree in aeronautical engineering and ask whether this helps my understanding of powder flow. Though basic concepts such as continuity and equilibrium apply, the resulting equations that describe powder flow are more complex and harder to apply. Therefore, the understanding of powder flow is not as advanced as that of fluids. Powder flow can be counter-intuitive, frustrating, and surprising, unless every aspect of the powder and equipment is well understood. I enjoy using my experience and engineering background to eliminate this frustration for our clients."



Updated Web Site Has Something for Everyone

Our web site, www.jenike.com, is totally new for 2000. It is packed with case studies, and examples of problems and solutions for all types of bulk solids handling issues. Soon the web site will contain back issues of our newsletters. Whether you would prefer to receive our newsletter electronically, or you still prefer the printed copy, we would like to hear from you. Please indicate your preference in an e-mail addressed to newsletter@jenike.com.



Handling Bulk Solids in a Fluidized Condition (Part 2)

Part 1 of this article, which discussed fluidized bed applications, was presented in our Spring 2000 newsletter. Here is part 2.

Background - Fluidized Handling

The second application for fluidization is purely as a solids handling tool to aid discharge of fine powders from bins and hoppers. Materials can be either partially fluidized (air-assisted discharge) or completely fluidized (fluidized discharge). Even some fine, cohesive powders such as kaolin clay and titanium dioxide can be easily handled by fluidized or air-assisted methods when other discharging equipment just won't work or may be prohibitively expensive. Fluidizing or air-assisted dischargers have the added advantage of being mechanically simple, with no moving parts other than the outlet valve and prime air mover. Fluidization gas, usually air, is introduced into the bulk material through a membrane at the bottom of the bin's cylinder section or cone. Typical membranes are needled polyester, sintered metal, or porous plastic.

With high discharge rate applications, much of the gas introduced through the fluidizing membrane travels down through the outlet, discharging with the material. Low discharge rate applications require that a higher portion of the fluidization gas travel up through the powder and out through the bin vent system. Unlike when using screw and belt feeders, the rate of discharge can influence the type of flow which occurs in a bin when using fluidized or air-assisted discharge. A bin that operates in mass flow at one discharge rate may switch to a funnel flow pattern at a different discharge rate.

Fluidized Handling Capabilities

By testing your material in our discharging test apparatus, we can determine if fluidized or air-assisted discharge is practical for your material. We can determine gas flow rates and outlet sizes needed to achieve the discharge rate your process requires. Depending on the specific application, we can configure our test setup with a fast opening, full throat on/off valve, a positioning type knife gate valve, or a rotary valve. Instrumentation for tests typically measures mass

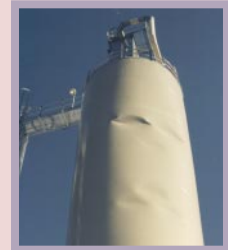


discharge rate, gas flow rate, and gas pressure, allowing a quantitative post test analysis of what does and does not work. Although video is less informative than in the fluidization regime test discussed earlier, tests can be videotaped to help communicate how the material behaved, and show the configuration of the test apparatus. More advanced prototype modeling can be done on our recirculating test setup, using two identical bins equipped for fluidized discharge. Material from the active bin discharges into the recirculation system which fills the second bin. A PLC operates the system, driving the discharge valve to gravimetrically achieve the target discharge rate, monitoring bin fill levels, and switching bins when appropriate, allowing for continuous operation.

Put J&J's experience and abilities to work for you. Prior to making any equipment expenditures, let us determine the most suitable method to handle your material.

Q&A with

Q The sidewall of my silo is starting to wrinkle. Should I be concerned?



A Seemingly minor wrinkles are usually an indication of a serious structural problem, which could lead to a complete failure or collapse, resulting in a stoppage of your process and, worse, worker injuries or death.

While this may seem alarmist, it is always better to take a conservative approach. Discharge from the silo should be stopped immediately and the silo should be inspected for structural integrity. At J&J, we have inspected numerous silo failures to determine their causes, and we have recommended fixes for silos in the early stages of failure. Don't wait until it is too late.

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

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Fax: 978-392-9980
E-mail: newsletter@jenike.com

Did you know?

For over 20 years, experienced engineers from Jenike & Johanson have presented one of AIChE's most successful courses, *Flow of Solids in Bins, Hoppers, Chutes, and Feeders*. We are now pleased to announce that this course will be followed by our one-day *Pneumatic Conveying* course. For dates and locations, please refer to the calendar section on the back page of our newsletter. For more complete course information, please view our web site: www.jenike.com.

Flow-of-Solids Industry Calendar

"You get the benefit of years of experience."
"Instructors were very knowledgeable, well prepared, and professional"
- From course attendee evaluations of recent Jenike & Johanson presentations



**November 29-30, 2000,
Boston, MA**

MPIF: Metal Powder Mixing, Handling, and Segregation Control Seminar. Eric Maynard, project engineer with



Jenike & Johanson, will give a presentation titled *Powder Flow Behavior*. Brian Pittenger, senior project engineer with Jenike & Johanson, will follow with *Blending and Segregation and Their Effects on Quality*. A tour of Jenike & Johanson's facilities will also be available.

January 24-25, 2001, New Orleans, LA

AICHE course, Flow of Solids in Bins, Hoppers, Chutes, and Feeders[†].

January 26, 2001, New Orleans, LA

AICHE course, Pneumatic Conveying of Bulk Solids[†].

March 5-6, 2001, Philadelphia, PA

AICHE course, Flow of Solids in Bins, Hoppers, Chutes, and Feeders[†].

March 7, 2001, Philadelphia, PA

AICHE course, Pneumatic Conveying of Bulk Solids[†].

**March 20-22, 2001,
Philadelphia, PA**



Interphex Confer-

ence/Exhibition. Jenike & Johanson personnel will present the following workshops^{††}:

- Powder Handling I: Utilizing Solids Handling Technology for Providing Consistent, Reliable Flow

- Powder Handling II: Utilizing Solids Handling Technology for Maintaining Solid Dosage Form Quality

April, 2001, Santiago, Chile

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

- Bin and Feeder Design
- An Introduction to Pneumatic Conveying

**May 7-10, 2001,
Chicago, IL**

26th Annual Powder and Bulk Solids Conference/Exhibition.



Jenike & Johanson personnel will present the following seminars and workshops^{††}:

- Solve Solids Flow Problems in Bins & 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
- 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.

July 11-12, 2001, Toronto, Canada

AICHE course, Flow of Solids in Bins, Hoppers, Chutes, and Feeders[†].

July 13, 2001, Toronto, Canada

AICHE course, Pneumatic Conveying of Bulk Solids[†].

[†]To register, contact AIChE, (800) 242-4363, or visit www.aiche.org.

^{††}To register, contact Reed Exposition Companies, (203) 840-5848, or visit www.reedexpo.com.

Hot Off the Press

On Powder Flowability

by J.K. Prescott and R.A. Barnum, *Pharmaceutical Technology*, Oct. 2000

Optimizing Powder Handling in P/M Parts Production

by B.H. Pittenger, T. Geiman, and H. Purutyan, *PM² Tec 2000 Proceedings*

Reducing/Eliminating Segregation Problems in Powdered Metals Processing: Part I, Segregation Mechanisms; Part II, Methods of Controlling Segregation

by B.H. Pittenger, H. Purutyan, and R.A. Barnum, *P/M Science & Technology Briefs*, Mar. 2000, May 2000

Bench-Scale Segregation Tests as a Predictor of Blend Sampling Error

by J.K. Prescott, P. Ramsey *et al.*, presented at AAPS-PDA 2000

Troubleshooting Pneumatic Conveying Problems

by T.G. Troxel and H. Purutyan, *Chemical Processing*, Aug. 2000

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