Flow of Solids

JENIKE & JOHANSON INCORPORATED

Bulk Solids: Science / Engineering / Design

The Newsletter for Jenike & Johanson, Inc.

Fall 1998

Vol. XVIII

The Inside View

This issue inaugurates a new, updated look for our *Flow of Solids*® newsletter. We hope you will enjoy the new design.

The newsletter's appearance may have changed, but its mission hasn't. It will continue to inform you about the bulk solids industry as well as what Jenike & Johanson can do for you.

To be sure we're giving you the information you want to know, we're introducing a new section -- Q & A with J & J -- in which we answer your questions.

In this issue, you'll learn about a solution to a difficult flow problem and have a choice of free technical papers. You'll also meet another of our outstanding senior engineers, Greg Petro, who has been with us for 11 productive years.

John W. Carson

Case in Point: Achieving high flow rates plus high density with kaolin clay

The Problem

A Jenike & Johanson client company had a tough problem: packaging different grades of kaolin clay uniformly into bulk bags at high rates. The clay's poor handling characteristics made it very difficult to maintain uniform discharge from the existing 100 ton silos to the packaging equipment. Also, discharging from the silos at a high bulk density was critical for efficient packaging.

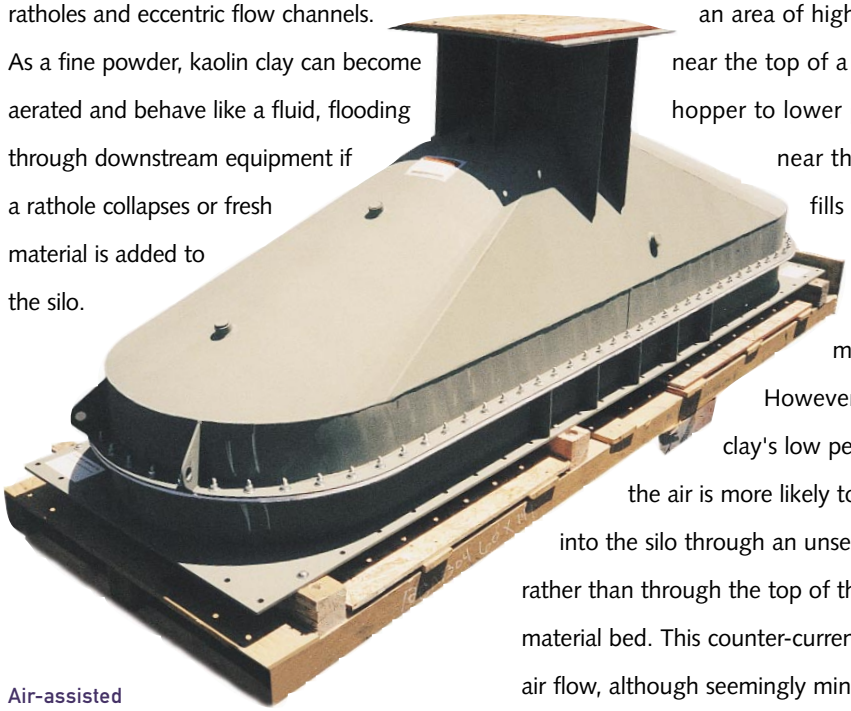
Our testing revealed that the existing silos discharged the material in a funnel flow pattern. With the poor flow characteristics of the material, this can result in stable arches and ratholes. Additional problems with this funnel flow discharge pattern included erratic flow, segregation, reduced live silo

continued on page 2

continued from page 1

Case in Point: Achieving high flow rates plus high density with kaolin clay

capacity, and high loads on both structure and downstream equipment due to collapsing ratholes and eccentric flow channels. As a fine powder, kaolin clay can become aerated and behave like a fluid, flooding through downstream equipment if a rathole collapses or fresh material is added to the silo.



Air-assisted discharger ready for shipment

We determined that while the first-in/first-out sequence of *mass flow* would solve many of these problems, obtaining *mass flow* would be tricky. First, kaolin clay is very frictional and tends to shear on itself rather than slide along a sloping wall surface, which is required for *mass flow*. The hopper wall angle and material would have to be carefully chosen, based on the measured flow properties of the kaolin clay.

Second, because kaolin clay has a low permeability, achieving the client's desired high flow rate would be challenging. Most bulk solids tend to dilate as they flow from an area of higher pressure near the top of a converging hopper to lower pressure near the outlet. Air fills the voids created in the dilating material. However, due to the clay's low permeability, the air is more likely to be drawn into the silo through an unsealed outlet rather than through the top of the material bed. This counter-current air flow, although seemingly minor, severely limits discharge rates.

The Solution

Our design had to meet the client's three primary needs:

- Each silo must be able to store 100 tons of kaolin clay.
- The discharging clay must have as high a bulk density as possible.
- The silos must discharge the clay at a minimum rate of 6 tons per hour.

continued on page 3

Behind the Scenes: Meet Greg Petro

Name	Greg Petro
Title	Senior Structural / Project Engineer
Education	BS in structural engineering.
Joined J&J	April 15, 1987

Job Description: Greg provides structural consulting for bulk solids handling facilities and equipment. In this role, Greg performs calculations and various types of analysis, including finite element, and internal and external loading.

In addition, Greg provides functional design recommendations and also economic analysis for projects and various engineering studies.

Of Note: Since joining the firm, Greg has developed special expertise and methods for analyzing bulk solids handling equipment, such as silos and chutes. Jenike & Johanson's clients have benefited from his knowledge of structural and detailed design, coupled with the principles of bulk solids flow.

Quote: "What I like most about J&J is our highly comprehensive approach to solving problems, and that our company is at the forefront of bulk solids research and development."

New Vice President Named

Jenike & Johanson is pleased to announce the promotion of Tom Troxel from senior project engineer to vice president. Tom has served the company since 1982. Look for more about him in a future issue.

Case in Point:

continued from page 2

Our first step in the solution was to design silos that ensured *mass flow*. To overcome the arching capability and frictional characteristics of the clay, we selected a transition hopper (designed with a long slotted outlet instead of the round outlet of a typical conical hopper). The transition hopper design allowed us to create less steep wall angles than in a cone. It was also easier to mate a feeder to the slotted outlet, which would be sized to prevent arching.

Our next consideration was the feeder itself. The wrong choice of feeder could create funnel flow in an otherwise well-designed *mass flow* silo. In this case, the design challenge was the impermeable material's limiting flow rate. The usual solution for increasing flow rates in fine materials -- aerating them to create a fluid condition -- was not appropriate for this application, which required packaging the material with a high bulk density.

Therefore, we recommended a custom-designed, oval-shaped, air-assisted discharger. Instead of aerating a large volume of material, the air-assisted discharger fluidizes only a thin layer of material near the walls of the discharger. This thin layer of fluidized material greatly reduces friction at the walls of the discharger, allowing material to flow along relatively shallow wall angles. Also, the addition of air overcomes the limiting rate problems and increases the packaged density in comparison to the previous system.

Scale model tests on the conceptual design confirmed the counter-intuitive notion that the addition of air would increase packaging density. We then designed, fabricated, tested, and supplied a full scale discharger.

The Result

Jenike & Johanson's *mass flow* design met -- even exceeded -- our client's original requirements. It is not only an efficient and successful solution to a troublesome flow problem, but also a very cost effective one: our design is one-third the cost of a comparable mechanical feeding technique.

In addition, our design is able to fill a one ton bulk bag in about two minutes - five times faster than the original requirement. Clearly, for a challenge such as the one posed by kaolin clay, creativity and custom design can save the day.

Did you know?

When Jenike & Johanson supplies bulk solids handling equipment, we can offer both a performance as well as a mechanical warranty.

Q&A with J&J

Q Why will my bulk solid behave fine one day, but flow poorly the next?

A Sometimes small differences in moisture content, particle size and shape, storage time, and even temperature can make a big difference in handling ability. You need to keep these variables in mind, and design your bulk solids handling system so it can cope with worst-case conditions.

Q What is the proper way to use the angle of repose to design my storage silo?

A This is a trick question: there is no proper way because there is no correlation between the two. The angle of repose should only be used to determine the capacity of your bin or silo.

If you have any bulk solids handling questions you'd like answered, or if you have suggestions for future articles, please send them to:

Flow of Solids Newsletter
Jenike & Johanson, Inc.
One Technology Park Drive
Westford, MA 01886-3189
voice: 978-392-0300
fax: 978-392-9980

We will include as many questions as space allows.

Flow-of-Solids Industry Calendar

September 28-30, 1998, The University of Wolongong, N.S.W., Australia

Sixth International Conference on Bulk Materials Storage, Handling, and Transportation. David Craig, Ph.D., project engineer/R&D engineer at Jenike & Johanson, will present a paper on the blending of highly segregating bulk solids.

October 21-22, 1998, Secaucus, NJ

POWDEX†† Exhibition 1998. John Carson, Ph.D., president of Jenike & Johanson, will present a luncheon talk on "The Perils of Assuming that Bulk Solids Behave Like Liquids." Stop by and see us at Booth 607.

November 10-11, 1998, Miami, FL

AIChE Continuing Education Series†: "Flow of Solids in Bins, Hoppers and Feeders" course presented by Jenike & Johanson engineers.

November 15-19, 1998, San Francisco, CA

Annual AAPS Meeting and Exposition. James Prescott, senior project engineer with Jenike & Johanson, will be a speaker in the "Blending, Sampling, and Content Uniformity Issues" roundtable.

November 15-20, 1998, Miami Beach, FL

AIChE/Particle Technology Forum. John Carson, Ph.D., president of Jenike & Johanson, will co-chair a technical session on Powder Mechanics and Material Storage.

March 10-11, 1999, Houston, TX

AIChE Continuing Education Series†: "Flow of Solids in Bins, Hoppers and Feeders" course presented by Jenike & Johanson engineers.

March 18-19, 1999, Philadelphia, PA

AIChE Continuing Education Series†: "Flow of Solids in Bins, Hoppers and Feeders" course presented by Jenike & Johanson engineers.

† Offered through AIChE's continuing education program. To register, call AIChE at (800) 242-4363. The fee is $845 for members and $945 for non-members.

††To register, call Reed Exhibition Companies at (203) 840-5666.

Hot Off the Press

Uniform Conditioning of Bulk Solids in Processing Vessels
by John W. Carson, Ph.D., James K. Prescott, Herman Purutyan & T. Anthony Royal (Powder Handling & Processing, February 1998)

Retrofitting Troublesome Solids Handling Equipment
by Herman Purutyan, Brian H. Pittenger, & John W. Carson, Ph.D. (Chemical Engineering Progress, April 1998)

Bin Selection Guidelines
by John W. Carson, Ph.D. (Chemical Processing, 1998 Powder and Solids Annual)

Feeder Selection Tips
by John W. Carson, Ph.D., & Greg Petro (Chemical Processing, 1998 Powder and Solids Annual)

To order any of these free papers, or for a full list of papers, write on your company letterhead to:
Librarian, Jenike & Johanson, Inc.,
One Technology Park Drive,
Westford, MA 01886-3189 USA
or fax us at (978) 392-9980.

Web Site: http://www.jenike.com Email: newsletter@jenike.com

East Coast, USA
Jenike & Johanson, Inc.
One Technology Park Drive
Westford, MA
01886-3189 USA
voice: (978) 392-0300
fax: (978) 392-9980

West Coast, USA
Jenike & Johanson, Inc.
3485 Empresa Drive
San Luis Obispo, CA
93401-7328 USA
voice: (805) 541-0901
fax: (805) 541-4680

Canada
Jenike & Johanson, Ltd.
400 Carlingview Drive
Etobicoke, Ontario
M9W 5X9 Canada
voice: (416) 674-8595
fax: (416) 674-8520

South America
Jenike & Johanson, Chile Ltda.
Edificio Arcadia
Arlegui 440 Of. 613
Viña del Mar, Chile
voice & fax: (+56) 32 690 596

Flow of Solids® Newsletter is published periodically by Jenike & Johanson, Inc., the leading authority on the flow of solids, at its international corporate headquarters, One Technology Park Drive, Westford, MA 01886-3189 USA. Subscriptions to qualified flow of solids industry representatives are available free of charge by contacting Jenike & Johanson. Information contained in Flow of Solids® Newsletter is selected to assist and inform readers.