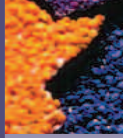


# Flow of Solids

Bulk Solids: Science / Engineering / Design

The Newsletter of Jenike & Johanson, Inc.

Spring 2004



## The Inside View

Many of our clients are experiencing significant reductions in engineering staff. Those who remain (often the least experienced) are stretched thin, so only the most urgent projects can receive attention. Staff is often switched from one project to another, making continuity difficult.

We at J&J can assist in solving this dilemma. Our experienced engineers are accustomed to rapid execution of complex solids handling projects, and can be available on short notice. We offer a wide range of services – from on-site consultation to testing, modeling, functional design, detail design, and even supply of custom equipment. Give us a call to discuss how we can be of service to you.

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

## Engineered solution for cement plant coal delivery problem

### Background

Lone Star Industries produces 1.4 million tons of cement annually, in Cape Girardeau, Missouri. Limestone, a primary ingredient, arrives from an open pit mine adjacent to the plant, then it is crushed for processing. Additives are mixed with the limestone, then ground in a roller mill to create "raw meal." The raw meal goes through a preheater tower then a precalciner, which rapidly elevates the raw meal's temperature to 1,600°F. The raw meal then passes through a rotary kiln where it is completely transformed into clinker. The clinker is then ground with gypsum in a ball mill to produce cement.

### Coal Handling System

The precalciner and the rotary kiln each have their own heating systems. Coal is transferred from outdoor stockpiles to one of two bins, then via belt feeder to pulverizing roller mills. The mills supply coal fines via downstream baghouse dust collectors to the precalciner and rotary kiln.

A reliable coal supply is crucial for keeping the entire clinker production process on-line. The precalciner requires up to 25 t/h of coal, while the rotary kiln requires up to 15 t/h of coal. If the coal supply is interrupted, plant personnel have about 15 minutes to restore feed before the precalciner and rotary kiln shut down.

The interface between each belt feeder and pulverizing roller mill is critical to providing reliable coal flow. In each line, the mill operates under a vacuum of 10-12 inches water, so an air seal must be maintained at the mill's feed inlet. For 18 years the company used a triple-flap gate to provide the air seal. The company had

rejected a more conventional rotary airlock feeder because it would have been subject to excessive wear, leakage, and material buildup.

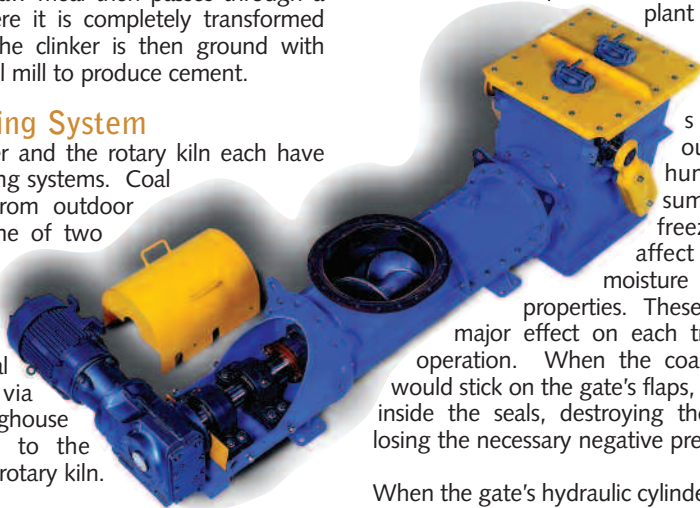
### Problem

Since the triple-flap gates were installed in 1982, Lone Star Industries consistently experienced the problems they were trying to avoid by not using rotary valves. The results were equipment downtime, increased labor costs due to maintenance requirements, and unscheduled plant shutdowns.

Because the coal is stockpiled outside, the humid Missouri summers and freezing winters affect the coal's moisture level and flow properties. These changes had a major effect on each triple-flap gate's operation. When the coal was moist, it would stick on the gate's flaps, causing buildup inside the seals, destroying the air seal, and losing the necessary negative pressure.

When the gate's hydraulic cylinders and bearings started to wear, the linkage became loose. This caused the gate to become misaligned so it was unable to create a tight seal. This eventually caused airflow problems, and the gate started to bind up. The gate could also be held open and bent by foreign material, such as tramp metal, and it was prone to material buildup when coal impacted it after falling from the belt feeder. According to Gunder Woldtvedt, mechanical engineer at Lone Star, this coal impact was "similar to taking a mud ball and throwing it on a plate. If you tip the plate over, the mud doesn't move." Because the triple-flap gate had so many pivot points to wear out, as well as high-maintenance hydraulic components, upkeep was extremely costly.

These problems were destroying the air seal and  
continued on page 2



## Engineered solution for cement plant coal delivery problem



causing air to leak into the mill. As a result, the pulverized coal wasn't conveyed away from the mill's rolls. Instead, it accumulated in the mill until the mill began to reject the coal onto the ground. The coal feed to the pulverizing roller mill had to be stopped until the triple-flap gate could be repaired, which could take anywhere from 30 minutes to 2 hours. Annually, this cost the company 48 hours in downtime, and clinker production was lost at a rate of 543 t/h.

The constant recurrence of the triple-flap gate problems forced the company to look for a new feed method. The engineering staff at Lone Star Industries needed to consider many factors. The feed method had to be robust; it had to efficiently handle the abrasive coal; and it had to run continuously – 24 hours a day, 365 days a year – without having to stop between scheduled plant maintenance shutdowns.

### Solution

Lone Star learned of another cement plant that had replaced a rotary valve in a similar application and had a positive result. The staff decided to investigate further. For that application, Jenike & Johanson engineered a custom Solids Pump™ pressure-sealing feeder to properly convey the dry bulk solid between spaces at different gas pressures with minimal gas leakage.

The Solids Pump has a feed section, a sealing section, and a weighted discharge gate. The feed section has a low-speed auger within a tubular steel trough. Material progresses through the feed section into the sealing section, where it's consolidated to form a low-permeability plug, which is then pushed out of the feeder through the weighted discharge gate. This gate helps the plug develop during startup and minimizes air leakage when the feeder is empty.

The Solids Pump has been built with throughputs ranging from 2 to 50 t/h. The unit's gas pressure capability depends on a material's properties, but 1 psi co-current (in the direction of material flow) and 5 psi counter-current (opposite the direction of material flow) is common.

Lone Star decided that they wanted to use a Solids Pump in their precalciner line's mill, so engineers from Jenike & Johanson traveled to the Cape Girardeau plant to make sure the feeder was appropriate for the application, discuss installation requirements, and take measurements. They found limited headroom for the feeder, and that the feeder had to fit a fixed horizontal length because of electrical conduit racks in the area. Ultimately, our engineers customized the feeder's drive arrangement to work around the racks, which would have been impractical and costly to move.

Back at our lab, technicians tested the coal. A compressibility test measured the coal's bulk density and a permeability test measured the air pressure drop, both at different consolidating pressures. Using this data, our engineers calculated an air leakage rate for the application, determined that a Solids Pump was suitable, and proceeded with the functional design and fabrication.

### Result

In spring 1998 a 3-week time span was allotted for the Solids Pump installation during Lone Star's annual 4-week plant shutdown, making a short lead time for the feeder's fabrication and delivery. Six weeks after Lone Star approved the drawings, the 16-inch Solids Pump arrived for the plant's scheduled installation window.

Lone Star installed the Solids Pump during the plant shutdown without any problems. This didn't surprise Lone Star, which was confident that our measurements and design would ensure that the feeder fit properly into the precalciner line.

Now the coal flows from the belt feeder into the mill through the Solids Pump without problems. The feeder has no linkage to wear, no damage from tramp metal, and no gates that can be held open by foreign material. More importantly, material can't build up and create air seal problems that could halt coal flow.

Savings in reduced maintenance costs alone paid for the installation of the Solids Pump within 8 months. More specifically, return on the investment was 115% for that time period. Woldtvedt states, "It's been out of sight, out of mind. Depending on the type of coal that comes in, we might get a little bit of buildup in the inlet chute that feeds the Solids Pump, but we pretty much know about it and go down and blow it out. We check it once a shift and that's about it."

The Solids Pump is virtually maintenance-free. During Lone Star's once-a-year plant shutdown, the feeder's bearings and auger are changed by Lone Star's workers. The feeder barrel is also inspected then to make sure its wear plates are still in good shape.

After one year of improved operation, plant personnel were so pleased that they installed a second Solids Pump to supply coal to the mill for the rotary kiln. Once again the equipment quickly paid for itself, and Lone Star continues to experience cost savings in reduced downtime and uninterrupted production.

## Behind the Scenes: Meet Eric Maynard

Title: Project Engineer  
Joined J&J: 1996

Job Description: Eric's industry focus is cement and minerals, though he continues to engineer bulk solids solutions for other industries including chemicals, foods, power, and environmental. Eric devotes a significant

portion of his time delivering seminars on effective practices in bulk solids handling. These educational offerings are presented at industry conferences and numerous companies worldwide.

Of note: Eric received his BS

in Mechanical Engineering ('93) from Villanova University and an MS in Mechanical Engineering ('96) from Worcester Polytechnic Institute. Eric is a member of ASME and AIChE.

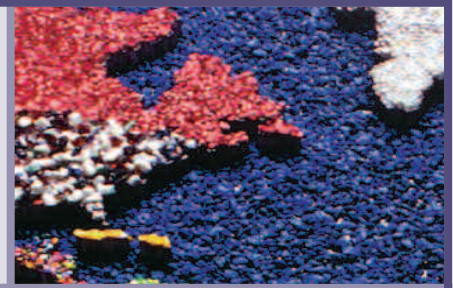


**"Teaching Dr. Jenike's theory on bulk solids flow to our clients or conference attendees is personally rewarding in several ways. It is rewarding when the knowledge gained at one of our courses is used to implement cost-effective and practical solutions to bulk solids flow problems at a manufacturing plant. It is rewarding to witness course attendees learning a critical job skill that is not regularly taught at the university level. It is also rewarding to discover the many ways our course attendees create, process, and handle bulk solids in all kinds of industries."**



## Jenike & Johanson abre sitio web en Español

Nos complace informar que acaba de ser puesta en funcionamiento una versión en Español (Castellano) de nuestro sitio web [www.jenike.com](http://www.jenike.com). En él nuestros numerosos clientes de Latinoamérica y España podrán encontrar una completa información acerca de nuestra experiencia y capacidades, así como de la ayuda que podemos brindarles en el área del manejo de materiales a granel (diseño de silos, chutes, pilas de almacenamiento, transporte neumático, manejo de polvo, etc.).



## A system assessment can improve your competitive edge

In today's highly competitive global marketplace, it is more important than ever for companies to produce higher quality products more efficiently. In most operations, the "low-hanging fruit" has already been picked. To remain competitive, companies are being forced to reconsider the larger effort required to reap the more difficult-to-obtain improvements. While these efforts, which provide a proportionally smaller return on investment, are more frequently becoming necessary, there may still be areas for large improvements that are being overlooked. Reliable solids handling is often one of these areas. The cost of solids handling and processing is tremendous, so even incremental improvements can result in significant savings, through improved quality and increased production. (A good example of this can be seen in the article on page 1.)

**It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change.**

**- Charles Darwin**

Solids handling has often been characterized as the "forgotten stepchild." Typical engineering curriculum includes fundamentals of fluid behavior, but engineers are almost never exposed to solids handling until they get out into the workforce. Even then, exposure is typically limited to what has been standard practice for the company or industry. This generally consists of rules of thumb and avoiding what has not worked. Combine a reduction in human resources with this lack of expertise, and it becomes even more challenging to take an integrated global approach to improving solids handling processes and identifying hidden costs. With plant engineers stretched thin, obvious and immediate problems take precedence over benchmarking a process that appears to be working.

Having established that improving process efficiencies are important to the success of a company, that improving the reliability of bulk

solids handling can often be an effective way to improve process efficiencies, and that most companies are not equipped to solve solids handling problems, how do companies conduct their own benchmarking or system assessment to improve process efficiencies? The answer is that they are not supposed to. A chief benchmarking concept is to use an external perspective to help improve performance. We have repeatedly learned from many past clients that closed design and procurement systems tend to focus only on what's been done internally, which limits the opportunities for high performance. That's where we come in, to provide the external, expert solids handling perspective. This service

provides enormous strategic advantages when approaching new process development and the debottlenecking of existing processes. We provide a single source to the broadest base of expertise in industrial solids handling. We also provide a concentrated but global perspective, which can yield even greater results. As an example, by focusing on acceptable variations in received raw materials, or variations in upstream processes, inefficiencies in downstream processing can be detected and resolved rather than relying on the narrow focus of each operation or department.

**Benchmarking - A standard of excellence against which other similar things are measured or judged.**

the expertise and experience to properly assess your process from end to end, and determine how it compares to industry best practices, while at the same time, identifying areas where savings can be had by applying the appropriate technology. Could your solids processing systems use an independent, unbiased, and expert review? For more information, contact the nearest Jenike & Johanson office, or email your inquiry to [mail@jenike.com](mailto:mail@jenike.com).

We at Jenike & Johanson, as the leading technologists in solids handling and processing, have

## Q&A with

**Q** Segregation is a major concern with most pharmaceutical powder mixes. What can I do to prevent it?



**A** For an existing problematic application, the first step is to learn why the segregation is occurring. Testing can determine whether the mix tends to segregate due to a particular mechanism (typically sifting or fluidization). Then one must consider whether the process promotes the prevalent mechanism of segregation. If so, the mix or process must be modified, as allowed, to minimize segregation.

In the case of a new product or process, up-front testing can determine the segregation potential and handling requirements of a mix, dictating the initial process design - eliminating the expense of later modifications.

Our engineers have analyzed, prevented, and solved hundreds of segregation-related pharmaceutical processing problems. Put our knowledge to work for you.

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

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## Jenike & Johanson com novos empreendimentos no Brasil

Seguindo a decisão da Jenike & Johanson de implantar uma presença local no Brasil, e a colocação do Gregory Hoyl na posição de direção e expansão de esforços locais, J&J está fazendo vários estudos para diversos clientes nos setores de mineração e metalurgia. Esforços estão sendo expandidos, visando à inclusão de outros setores, como o Farmacêutico, Químico, Plástico, e Alimentício; setores nos quais J&J já é reconhecido internacionalmente por suas soluções seguras, e com o melhor custo-benefício, para problemas de manuseio de produtos a granel.  
Phone: +55 (11) 4154-5691, email: [gregory.h.hoyl@attglobal.net](mailto:gregory.h.hoyl@attglobal.net)

# 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



## May 3-6, 2004, Chicago, IL

International Powder and Bulk Solids Conference and

Exposition. Presentations by Jenike & Johanson personnel will include the following<sup>†</sup>:

- How to Ensure Reliable Solids Flow in Bins and Hoppers
- Design of Transfer Chutes to Minimize Buildup, Abrasive Wear, and Dust Generation
- How to Prevent Caking of Bulk Solids
- How to Select or Troubleshoot Volumetric and Gravimetric Feeders to Ensure Reliable Flow
- How to Prevent Silo Failures
- Blending and Segregation and their Effects on Product Quality
- How to Prevent Attrition of Bulk Solids

## May 17-19, Las Vegas, NV

Advanced Practices in Pharmaceutical Tablet and Capsule Technology - University of Wisconsin, Engineering Professional Development course. Jim Prescott, Jenike & Johanson senior consultant, will be presenting the paper, *How Powders are Affected by Interstitial Air*

## May 24-25, Philadelphia, PA

Blend and Dose Uniformity Conference. Roger Barnum, Jenike & Johanson project engineer, will be giving a presentation, titled, *Identifying and Solving Dose Uniformity Problems*



## May 26-28, Viña del Mar, Chile

*Silo Design & Pneumatic Conveying* courses will be presented by Jenike & Johanson, Chile S.A.

## July 19, Westford, MA

*Solids Handling Introduction* course, presented at Jenike & Johanson, with a lab tour and demonstrations. More details will be provided on our web site as they become available.

## September 20-22, Houston, TX

Jenike & Johanson engineers will present the following AIChE/ASME courses<sup>††</sup>

- Flow of Solids in Bins, Hoppers, Chutes, and Feeders
- Pneumatic Conveying of Bulk Solids.

## September 29-October 1, Belo Horizonte, Brazil

*Silo Design & Pneumatic Conveying* courses will be presented by Jenike & Johanson<sup>†††</sup>

<sup>†</sup>To register, contact Reed Exposition Companies, (203) 840-5848, or visit [www.reedexpo.com](http://www.reedexpo.com).

<sup>††</sup>For more information, please refer to the following article, and visit [www.asme.org](http://www.asme.org).

<sup>†††</sup>To register, please contact Gregory Hoyle, (55-11) 41545691, or by e-mail to [gregory.h.oyl@attglobal.net](mailto:gregory.h.oyl@attglobal.net)

More complete course information is available at [www.jenike.com/pages/education/dates.html](http://www.jenike.com/pages/education/dates.html)

## Hot Off the Press

### Advances in Storage Vessel Technology Over the Last Twenty Years

by J.W. Carson

### New Technology Restores Waste Coal Feed To Boiler

by R.J. Hossfeld, D.A. Craig and R.A. Barnum

### Pneumatic conveying problems? Practical Solutions for the Cement Industry

by E.P. Maynard

### Practical Solutions for Solving Bulk Solids Flow Problems

by E.P. Maynard

### Preventing Particle Segregation

by J.W. Carson

## Did you know?

The American Institute of Chemical Engineers (AIChE) and the American Society of Mechanical Engineers (ASME) have

recently reached an agreement for ASME to deliver AIChE's continuing education public seminars, on-site courses, and e-learning CD-ROMS. ASME will release a schedule shortly, and plans to begin offering these courses in August of this year. J&J is pleased to announce that we will continue to provide our popular two-day course, "Flow of Solids in Bins, Hoppers, Feeders, and Chutes" and our one-day course, "Pneumatic Conveying of Bulk Solids," through ASME.

To order any of these free 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>

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