Flow of Solids

JENIKE & JOHANSON INCORPORATED

Bulk Solids: Science / Engineering / Design

The Newsletter for Jenike & Johanson, Inc.

Spring 2000

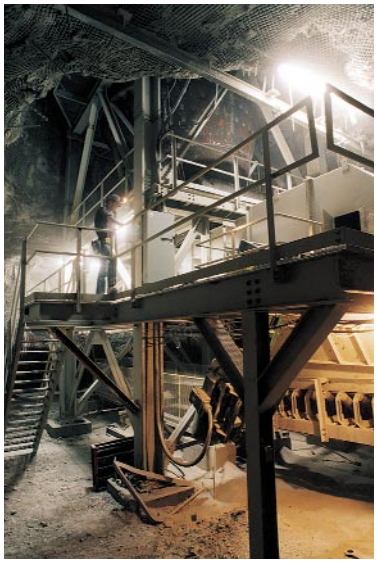
Engineering Solutions for FMC Wyoming Improve Quality and Reliability in Handling Trona Ore

Background

The world's largest known source of natural sodium carbonate (trona) lies in the Green River formation in southwest Wyoming. FMC Wyoming is the largest of four companies operating in the region, which together mine roughly 15,000,000 metric tons of trona each year and produce over 8,000,000 metric tons of soda ash, which is roughly 80% of the soda ash produced worldwide from natural sodium carbonate.

The Problem

The primary deposits in the Green River formation are found at depths of 400 to 3,500 feet in beds that range from 4 to 12 feet in thickness. Approximately 500 square miles of deposits contain high quality ore, but occasional pockets of insoluble impurities are common even in high quality ore deposits. When these unpredictably high levels of insoluble materials enter the process stream they reduce yields and drive up production costs. To smooth out these variations in the ore, FMC engineers wanted to detect the troublesome ore and divert it from the process stream, then meter it back into the process in a controlled way.



The Solution

FMC found they could use an on-line analyzer to detect the level of insolubles in the ore as it moves on a conveyor belt from the mine face to the hoist. In order to segregate the high-insol ore and control its delivery, a large underground storage and handling system was needed. Another benefit of underground storage was that it would allow operators to better control the flow of ore to the surface. With limited underground storage and miles of conveyors, matching the mine output to the hoisting capacity was a challenge. The additional storage would give the system a greater ability to adjust to surges from the mine face and maintain a constant flow of ore to the surface.

Jenike & Johanson (J&J) was enlisted to evaluate the feasibility of reliably handling the trona ore in two 1,300 ton silos to be constructed underground. Flow properties tests on the trona confirmed what most operators know: when stored at rest, trona crystals grow together and form a hard, solid mass. Surface moisture accelerates the process and results in higher strength. The tests provided the information necessary to design the silos for mass flow, which prevents stagnant, non-flowing regions where the trona could cake together.

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The Inside View

We strive to make each issue of our newsletter useful to our readers, while also outlining our services and capabilities. This issue includes a case study of a challenging application requiring two large silos 1,800 ft. underground. It also includes a followup article on a processing vessel project with Dow Chemical. A prior article discussed our work on the pilot plant design. And finally, many of you may be unaware of our capabilities in fluidized handling of bulk solids, so some background on this is presented. We hope you find this reading interesting as well as informative, and that you will contact us whenever you have a project which involves handling or processing of bulk solids.

John W. Carson

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

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Once the functional design of the system was determined, we enlisted the help of our affiliate H. G. Engineering (HGE). HGE provided the experience in engineering and construction management of large mining projects needed to meet the many challenges of this unique project. We worked closely with HGE throughout the design process to ensure that the functional requirements were met as the design evolved through various stages of engineering the enormous handling system.

"The bins are performing very well. When we inspected the material through the bin blaster nozzles in the hopper, the material could be seen moving along the hopper walls, which is a clear indication of mass flow. The insolubles are being detected, separated, and fed back into the stream at an acceptable level, and the overall system is working as planned." - Dan Moulden, senior engineer, FMC Wyoming.

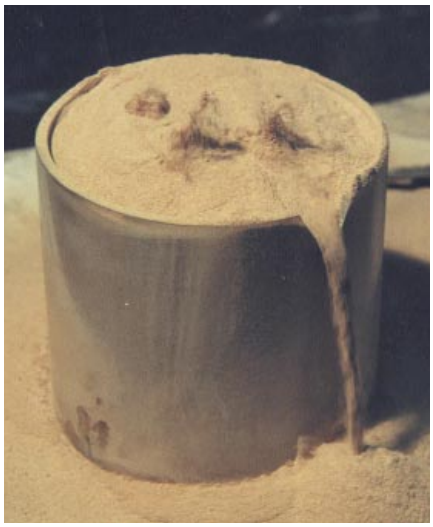
The Result

Building two 25-foot diameter silos and a 200-foot conveyor system at a depth of 1,800 feet below the surface provided many challenges! We worked closely with FMC and HGE to evaluate materials of construction for abrasive wear, calculate loads on the structure and feeder, and design a unique diverter for the in-feed conveyor system. Since startup in early 1998, the system has been operating reliably and has allowed the mine and processing plant to work together more efficiently, thereby reducing production costs.

Handling Bulk Solids in a Fluidized Condition

Background - Fluidized Bed

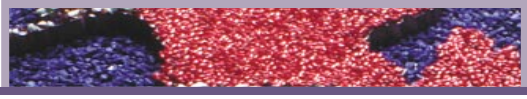
Fluidization is an excellent way to change the way a bulk solid behaves, and generally has two very different applications. The first, fluid bed processing, utilizes a fixed or recirculating bed of material to achieve a reaction goal. Fluidizing a material can provide uniform reaction temperatures, excellent mixing, high reaction rates, and efficient heat transfer. Two common examples are the fluid bed reactors used in plastics production, and burning coal in power plants. Fluid bed reactors are usually operated well above the minimum fluidization velocity of the material. When introducing a new material to a fluid bed reactor, or designing a new system, it is important to understand the fluidization characteristics of the material.



Fluidized Bed Capabilities

We can measure the fluidization characteristics of your material over a range of gas velocities. Our instrumented test apparatus captures gas velocity, total pressure drop through the bed, pressure drop across a known distance, and product density. We typically videotape tests so that you can see the fluidization behavior for yourself and easily share the information with others in your company. Data from our test can provide the information needed to size and design a gas supply system which will create the proper fluidization regime for your application.

In the next newsletter, we will address the second application for fluidization, which is purely as a solids handling tool to aid discharge of a fine powder from bins and hoppers.



Behind the Scenes: Meet Herman Purutyan

Title: Senior Project Engineer
Joined J&J: 1991
Job Description: One of Herman's main responsibilities is to provide consulting services to clients. This includes making site visits to fully understand the requirements of a project, as well as providing complete engineered solutions to difficult bulk solids handling and processing problems. Herman has worked with well over 200 clients, solving problems ranging from excessive vibrations in large outdoor silos to variations in individual drink mix packages.

Of note: Herman received his B.S. and M.S. in Mechanical Engineering from Worcester Polytechnic Institute, and an MBA degree from Babson College, graduating summa cum laude. In addition to his technical responsibilities at J&J, he also has managerial duties, and was recently voted to the company's Board of Directors.

"The blending of science and experience to confront real life problems is what sustains my excitement at J&J. Part of this equation is continuous innovation, like the PharmaSok™."

(PharmaSok was recently chosen as the most innovative material handling product of 1999 by readers of Powder/Bulk Solids magazine and a panel of industry experts.)

Upcoming AIChE Course Dates

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. Upcoming dates and locations are as follows: **July 27-28, 2000 in New York, NY; Nov. 8-9, 2000 in Los Angeles, CA**.

This course is offered through AIChE's continuing education program. To register, call AIChE at (800) 242-4363. The fee is $895 for members and $1,095 for non-members.

Project at Dow Chemical Receives Award

A project in which Jenike & Johanson (J&J) engineers were heavily involved recently received a Dow Technology Center Award. Dow has about 25 Technology Centers, and each year one or more projects are recognized within each Technology Center. In order for a project to be considered for recognition, it must involve significant new technology and meet certain economic criteria. The best projects proposed within each Center are recognized with the award.

Background

This project was at one of Dow's North American facilities which produces a flaked material. During part of the manufacturing process, excess moisture is present in the product. To enable further processing, most of this water must be removed. Dow's engineers decided to investigate whether two unused blending silos could be modified to dry the product by forcing hot, dry gas counter-current to the flowing material. The approach, if successful, would be much less costly than purchasing new commercially available dryers and the retrofits could be installed in much less time than it would take for delivery of a commercial dryer.

Design Issues

Process requirements dictated that the vessels dry the product uniformly to less than 1,000 ppm water, thus removing approximately 10% water by weight. The drying also had to be done in less than 60 minutes to assure product stability. For the dryer to be effective, two major design considerations had to be met. First, the velocity profile of the product in the dryer had to be uniform to control drying time. This was done by measuring the flow properties of the product in J&J's laboratory and calculating the velocity profile as a function of hopper geometry. The second major consideration was to keep the superficial gas velocity low enough to prevent the product from becoming locally fluidized and/or airborne. Based on heat balance calculations, Dow engineers estimated the amount of drying air that would be necessary to remove the required amount of moisture. They also estimated, based on experience, the maximum allowable superficial gas velocity that would minimize the amount of airborne particles.

Implementation

J&J engineers evaluated the feasibility of retrofitting the blending silos to meet Dow's requirements. The basic dimensions of the dryer were determined from the process requirements and J&J's previous measurements of the material's flow properties. Following this, J&J engineers analyzed the structural integrity of the modified vessel and how to introduce the drying air just above the top of the conical hopper section using J&J's recently patented technology. Once the design was complete, J&J supplied all the components needed to convert the blending silos to dryers, thereby enabling Dow to meet a very short timeline required to accomplish market objectives. Such a fast turnaround from project initiation to completion would have been impossible if new commercially available dryers had been purchased. In addition, by retrofitting rather than building new, the savings in capital cost exceeded one million dollars.

The units have been successfully operating now for over two years. The success of this project was due largely to the close working relationship between engineers from J&J and Dow. By sharing data, calculations, and ideas, the optimum design was arrived at quickly, and the new dryers operated from startup exactly as desired, meeting all performance criteria.

Did you know? Jenike & Johanson helps keep inflation down

The economy keeps expanding, breaking records, and the Fed Chairman Alan Greenspan says it is due to increased productivity. We at J&J, by improving our clients' operations, are helping the longest economic expansion flow unhampered .

Solving solids handling problems can result in major productivity increases. Just ask the powdered metal parts maker who can now use even the tail end of the batch (whereas it used to be scrapped due to segregation), or the chemicals manufacturer who has reassigned workers to tasks more productive than sledgehammering dryer surge hoppers.

If you'd like to contribute to this extraordinary economic growth by improving the productivity of your processes, call one of our specialists to discuss your solids handling issues.

Q&A with J&J

Q What is a mass flow feeder?

A In mass flow, all of the contents of a storage vessel move towards the outlet during discharge. This is in contrast to funnel flow, where portions of the contents remain stagnant, and may not discharge at all without assistance.

While the vessel design is critical in obtaining mass flow, the feeder design is just as important. For example, a constant pitch screw feeder will withdraw material only from one end, leaving stagnant material above the rest of the screw. This will create a funnel flow discharge pattern even if the vessel is designed for mass flow. By contrast, a proper mass flow screw feeder has an increasing capacity along its length to ensure that material is withdrawn from the full outlet area of the storage vessel.

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

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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 8-11, 2000, Chicago, IL

25th 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.

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

May 29-June 1, 2000, The Dead Sea, Israel

The Third Israeli Conference for Conveying and Handling of Particulate Solids. John Carson, president of Jenike & Johanson, will be presenting a keynote lecture titled Silo Failures: Case Histories and Lessons Learned. For more information visit the conference web site at: http://www.bgu.ac.il/me/bsh

June 3, 2000, New York, NY

MPIF: Optimizations of Powder Feed Systems. Brian Pittenger, senior project engineer with Jenike & Johanson, will present a paper titled Optimizing Powder Handling in P/M Parts Production.

June 13-15, 2000, London, UK

From Powder to Bulk: International Conference on Powder & Bulk Solids Handling. John Carson, president of Jenike & Johanson, will make a keynote presentation titled Feeding of Bulk Solids: A Review.

August 21, 2000, New Orleans, LA

ISA Expo 2000, sponsored by ISA and AICHE. Tom Troxel, vice-president with Jenike & Johanson, will present a one day seminar on pneumatic conveying of bulk solids. For more information visit the web site at: www.isa.org

September 12-14, 2000, Zurich, Switzerland

Polypropylene 2000, 9th World Congress, Annual Global PP Business Forum. Brian Pittenger, senior project engineer with Jenike & Johanson, will give a presentation titled Meeting and Exceeding Plant Design Capacity: Storage and Feed Technology for Reliable Polypropylene Processing.

October 19-20, 2000, Miami, FL

Powdex Conference/Exhibition (I•PRO). Eric Maynard, project engineer with Jenike & Johanson, will present a 6 hour tutorial†, Solve Solids Flow Problems in Bins and Hoppers.

Stop by and see us at booth 815.

October 25-27, 2000, Santiago, Chile

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

- Bin and Feeder Design
- An Introduction to Pneumatic Conveying

Hot Off the Press

Uniform Purging of Resins in Contact Bed Purge Vessels
by B.H. Pittenger, J.W. Carson, J.K. Prescott, and H. Purutyan, Polymer Engineering and Science, Sept. 1999, Vol. 39, No. 9, pp. 1802-1811

Six Steps to Designing a Storage Vessel That Really Works
by H. Purutyan, B.H. Pittenger, and J.W. Carson, Powder and Bulk Engineering, Nov. 1999, Vol. 13, No. 11, pp. 56-68

Sizing Hopper Outlets and Gates - Step By Step
by J.W. Carson, Chemical Processing, 2000 Powder and Solids Annual

Guidelines for Bin Selection
by J.W. Carson, Chemical Processing, 2000 Powder and Solids Annual

Step-by-Step Process in Selecting a Feeder
by J.W. Carson, Chemical Processing, 2000 Powder and Solids Annual

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