JENIKE & JOHANSON
Bulk Solids: Science/Engineering/Design

Flow of Solids®

Fall 2009 Newsletter

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OEMs Improve Vehicle Fuel Efficiency with the Help of SABIC Innovative Plastic's Noryl GTX Resin

Jenike & Johanson has been assisting SABIC Innovative Plastics for years (including when formerly-owned by General Electric). This article focuses on a specific expansion and upgrade project in Bergen Op Zoom, Netherlands to support the fast growing demand for their Noryl GTX product line.

Market Driver

The weight reduction and design freedom benefits from using high-performance Noryl GTX® resin in automotive fenders and other body panels have been proven in more than 12 million vehicles worldwide. Building on its many years of success using this SABIC Innovative Plastics resin, French automaker Renault has extended the technology to two of its newest models. In addition to the Clio, the Twingo and

President's Message

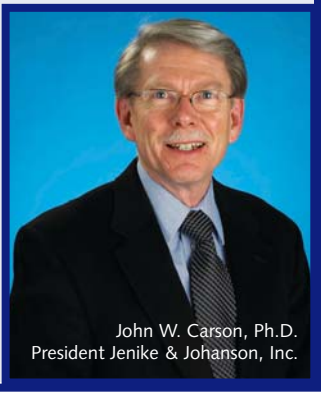
Highlighted in this newsletter are two of the literally hundreds of types of bulk solids that we at Jenike & Johanson test and design storage and handling systems for each year: resin blends and bio-feedstocks. Our last newsletter contained an article about our analysis of a 60,000 tonne bin at an aggregate quarry in Scotland.

Given this wide variety of materials and applications, you may ask, "What are the limits of J&J's technology?" The short answer is, "Provided the project involves the storage, handling and/or processing of particles, we can confidently apply our technology to virtually every industry and application."

Some examples of the ranges we have successfully worked on for our clients:

- Particle size: from nanometers to several meters
- Moisture: from bone dry to saturated
- Gas: from contact bed to fully fluidized
- Temperature: from sub-freezing to over 2,000° F (1,100° C)
- Storage vessel size: from less than one mm. diameter to more than 40 m
- Flow rates: from less than 1 g/min to over 24,000 tons/hr

Contact us to see how we can solve your most challenging bulk solids problems or design new facilities to avoid them.



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

Kangoo are the latest Renault vehicles to feature lightweight, durable and strong Noryl GTX 979 resin for the fenders as an alternative to steel. This high-performance technology has enabled Renault to achieve weight savings of 1.5 kg for the Twingo and 1.7 kg for the Kangoo. In addition, the versatile resin allowed Renault to reduce cost through improved part integration and incorporate style elements for competitive differentiation. In day-to-day use, fenders molded from Noryl GTX resin typically resist minor dents and damage better than steel fenders. They are also typically resistant to corrosion, may be recycled at the end of the vehicle's life, and result in lower insurance premiums.

If every car on the road in Europe today had fenders made of the new resins, the annual savings would equate to 530 million litres of fuel, about 650 million euro (based on 2006 average fuel prices) and a reduction of around 1.3 million tons of carbon dioxide (CO_2) emissions. "With increasing pressures on our automotive customers to reduce weight wherever possible, the use of lightweight thermoplastic materials as an alternative to steel for fenders has gone mainstream," said Derek Buckmaster, Market Director for Automotive Body Panels and Glazing, SABIC Innovative Plastics. "Thanks to more than 10 years of positive results with the technology and the increasing importance of component weight savings, Renault now uses Noryl GTX resin on the majority of its car models. We've worked side-by-side with Renault as long-term partners to help them meet changing market demands and regulatory requirements with new and innovative advanced material solutions."

The SABIC Innovative Plastics' resins can be painted or powder-coated simultaneously alongside the body without the need for a primer step. Noryl GTX resins have been selected for use by more than 10 different

OEMs around the world. Noryl GTX resins blend polyamide (PA) and modified polyphenylene ether (PPE) polymer technology. They combine the dimensional stability and heat resistance of PPE polymer with the chemical resistance and flow of PA polymer. The result is a chemically resistant material with the stiffness, impact resistance, and heat performance required for on-line painting.

Project Summary

In 2007, SABIC Innovative Plastics was undergoing an expansion of their GTX resins process in their Noryl plant in Bergen Op Zoom Netherlands. This expansion included a much more automated blending and extrusion system compared to the old system. This new system would require much less manual labor, improve product consistency, and enable improved product changeovers and process efficiency.

SABIC Innovative Plastics anticipated that one of the blend components would be very poor flowing (see accompanying photos). There were concerns that some of the solids handling steps were going to be problematic without proper attention to the details. Problems expected included the formation of large clumps that in turn would create flow stoppages in the process and subsequently negatively impact quality, product consistency and operational efficiency. The project team understood the importance of getting the process right the first time. This would avoid a number of costly issues later, including start up delays, perception issues that the process or product may not be satisfactory, and lost time to market.

SABIC Innovative Plastics requested Jenike & Johanson provide engineering support for this expansion. In the fall of 2007, SABIC Innovative Plastic's Ruud Trion, Process Engineering Lead from the Bergen Op Zoom, Netherland plant, and John Gerhart, Principal Engineer from the Selkirk, New York USA plant visited Jenike & Johanson's Corporate Headquarters in Tyngsboro, Massachusetts USA. While there they reviewed the process, constraints, materials, and goals for the project with Brian Pittenger, a Jenike & Johanson Senior Consultant. They also provided representative samples of the critical materials for flow testing in Jenike & Johanson's laboratory.

Flowability tests were conducted on the samples. These tests included considerations of volatile content, as well as worst-case expected processing conditions of temperature (elevated) and time of storage at rest during handling in the process. The cohesive strength, internal friction, compressibility, and wall friction was determined for each of the samples using Jenike Direct Shear testing methodology (ASTMI D 6128).

These tests enable the determination of critical arching and ratholing dimensions, required dimensions for processing equipment to ensure flow along walls and eliminate dead and stagnant regions. The data was used for proper sizing of vessels to avoid over-consolidation of material, as well as evaluating the impact of processing conditions to ensure the material remained suitably free flowing so as to be properly blended and fed to the extrusion step.

Based on these test results, the process flow requirements, and the existing constraints, Jenike & Johanson reviewed the planned expansion and recommended changes where necessary to the proposed conceptual process to ensure continuous, reliable, consistent flow of the material through the process. Several of the critical design challenges from a material flowability standpoint included severe pressure sensitivity of the resins with respect to cohesive strength, strength gain when stored at rest, compressibility, and highly frictional characteristics.

Included in Jenike & Johanson's recommended changes were functional layouts of feed options to achieve dosing of the materials in a loose, free flowing consistency at a rate of 11 kg in 10 seconds, intermittently and consistently batch-after-batch.

Project Results

Ruud Trion successfully implemented the planned expansion which included Jenike & Johanson's recommendations during late fall of 2007 and started the process in January 2008. Acceptance batches of the new GTX grade were made available in February and through much of 2008, new product integration was carried out between SABIC Innovative Plastics and Renault. By fall of 2008, the product line was approved and by early 2009 full production was underway.
The new Noryl GTX grade has given OEMs another high-performance technology option for body elements. To date, the process has been performing reliably, producing high quality, consistent product.

This new grade continues the goals of all the companies involved to push technology to find greener, more efficient, and more cost-effective solutions to overcome the global challenges all of us together face.

Ruud Trion stated, "The project achieved all its key goals realizing significant production targets, including substantial manufacturing cost reductions and product quality improvements. We consider J&J the global experts on solids handling. The work J&J did for us was a great help in understanding our product behavior and enabled us to make the necessary process improvements.

About SABIC Innovative Plastics

SABIC Innovative Plastics is a leading, global supplier of engineering thermoplastics with a 75-year history of breakthrough solutions that solve its customers' most pressing challenges. Today, SABIC Innovative Plastics is a multi-billion-dollar company with operations in more than 25 countries and over 10,500 employees worldwide. The company continues to lead the plastics industry with customer collaboration and continued investments in new polymer technologies, global application development, process technologies, and environmentally responsible solutions that serve diverse markets such as automotive, electronics, building & construction, transportation, and healthcare. The company's extensive product

portfolio includes thermoplastic resins, coatings, specialty compounds, film, and sheet. SABIC Innovative Plastics (www.sabic-ip.com) is a wholly owned subsidiary of Saudi Basic Industries Corporation (SABIC), one of the world's top five petrochemicals manufacturers.

We are impressed, not only by J&J's level of theoretical knowledge, but also by their insight in industrial practices and the translation from theory into practical solutions. From my experience, this distinguishes J&J from their competition.

- Ruud Trion, SABIC Innovative Plastics

In the News

Herman Purutyan named CEO of Jenike & Johanson

Jenike & Johanson is pleased to announce the promotion of Herman Purutyan from Sr. Vice President to Chief Executive Officer, effective immediately.

An 18-year veteran of the company, Mr. Purutyan holds B.S. and M.S. degrees in Mechanical Engineering from Worcester Polytechnic Institute, and an MBA from Babson College. During his career at Jenike & Johanson he has worked with hundreds of clients and authored over 20 publications in the field bulk solids storage, handling and processing. He is a frequent lecturer with AIChE's continuing education series, delivers in-house courses to individual companies, and is a contributor to ASME's Structures for Bulk Solids committee. He has been a member of the company's Board of Directors since 2000.

Commenting on the promotion, Dr. John Carson noted, "Herman's personality and leadership skills combined with his vision, business acumen, and technical insight make him the ideal person to lead J&J into the future." Dr. Carson will continue as President of Jenike & Johanson.

"Jenike & Johanson has helped thousands of companies across the globe achieve reliable handling and processing of over 10,000 different bulk solids in industries such as pharmaceuticals, cement, chemicals, energy, mining, consumer goods, solid waste and much more. I am proud of our reputation as the premier bulk solids handling experts in the world, and I look forward to continuing our growth in the future", remarked Mr. Purutyan.

Herman Purutyan
CEO Jenike & Johanson, Inc.

2009 Industry Awareness Survey Results

The 2009 Jenike & Johanson market awareness survey was a great success! Thanks to all who participated. A number of participants asked that we share our findings, so here are few of the highlights…

- About 90% read or skim newsletters sent by e-mail and most participants reported that they prefer to receive information this way.

- Electronic media seem to be the preference of most respondents, so our Newsletter will continue to come your way electronically, also.

- About 50% have visited the J&J website in the past 6 months. Those who visited found the website easy to navigate and a good source for useful bulk solids handling information.

Comments included both praise and requests, such as:
"Great and very useful laboratory!"
"Love your Webinars and always tune in."
"Your newsletters, along with your case studies and technical papers, are one of the few things that are saved and referenced in our company."
"How about a structural design class on bulk solids storage and processing?"
"How about focusing even more attention so people get a better awareness of all the safety issues in powder & bulk handling systems?"
"How about offering specific material industry reports?" (There were 52 different materials listed with heavy emphasis in coal, biofuel, cement, basic food ingredients, and basic chemicals.)
"How about routinely reviewing bulk solids terminology in your literature?"
"Educate more people, this area needs so much attention."

Some of the most frequently requested technical topics (in order of frequency) included: storage vessel design, pneumatic conveying, dust handling, obtaining flow property information on their materials, feeders, mixing and blending, and segregation control.

Again, we appreciated all those who participated in our survey. You are always welcome to send in your comments about how we are doing and what more you would like to see to mail09@jenike.com.

Behind the Scenes: Christian Balcom & Frank Mancini

Frank and Christian are responsible for conducting flow properties tests – both in our lab and on-site, training new technicians, assisting in the development and updating of lab SOPs, and maintenance of lab equipment.

Christian Balcom: Senior Lab Technician with J&J since 1997

I find working at J&J to be very rewarding. Sometimes the benefits our clients receive as a result of working with us is brought home to me by seeing products in the marketplace that I worked on. The average consumer has no idea what goes into the products they buy, but I no longer take these things for granted as a result of working behind the scenes. It's exciting when material characteristics challenge us to be creative and methodical in solving problems, and I'm amazed how the range of tests we conduct can be universally applied to such a wide variety of material types. We have come a long way in terms of lab capabilities since I started with J&J, including data acquisition, state-of-the-art high temperature shear tester, dedicated pharmaceutical labs, laser analyzer etc.

Frank Mancini: Senior Lab Technician with J&J since 2000

Since joining J&J I have been privileged to go on over 30 on-site testing projects. I have traveled all over the US and to Puerto Rico and Australia. The materials I have tested have ranged from the most benign food products to some not-so-friendly hazardous materials. I remember testing a product for terminally ill cancer patients. My on-site client contact told me, "If this material crosses this line, you will die." I replied, "I sure hope I get hazard pay!"

With the help of a talented team of colleagues, I find reward in helping clients solve their problems so their products can reach consumers. Especially with materials such as foods and pharmaceuticals, if we help the client, the client is able to help others.

Heating and Drying Bio-Feedstocks

Bio-feedstocks, i.e., plant-derived materials such as wood chips, saw dust, paper pulp, corn stalks, and switch grass, are increasingly being used as fuels and reactants in chemical processes. Unfortunately, the inherent moisture of bio-feedstocks may cause the materials to be cohesive and thus prone to arching and ratholing in silos, bins, and hoppers. Their non-uniform shape can also lead to mechanical arching, another cause of obstructed flow.

The key to designing systems for reliably handling bio-feedstocks is first to measure their fundamental flow properties and then, based on the test results, specify equipment that will ensure reliable flow. Critical flow properties include cohesive strength and wall friction. Cohesive strength measurements allow the calculation of outlet dimensions that prevent flow obstructions. Wall friction testing allows determination of hopper angles required for mass flow.

In microbial conversion processes (e.g. fermentors and digesters), control of the feedstocks' moisture content is often unnecessary and the moisture levels of bio-feedstocks are highly variable. Therefore, tests should be performed over a range of moisture contents to determine the moisture that gives the materials their highest cohesive strength and wall friction. Equipment should then be designed to handle this least-flowable material.

The moisture content of the bio-feedstock greatly influences the performance of thermal conversion processes, such as those involving combustion, gasification, or steam reformation. Reducing the moisture level of the feedstock increases its heating value. In addition, an optimum moisture content (typically 15-35%) often exists in processes where bio-feedstocks are converted into liquid or gas synfuels. A means to condition the feedstock, i.e., control its moisture content, is therefore desirable.

A common method to heat and dry bio-feedstocks is to inject a hot gas (sometimes flue gas) directly into the bulk material at the bottom of the hopper. Having uniform gas and solids flow is essential. If the solids flow pattern is not mass flow, water removal efficiency will be dramatically less than anticipated, since the residence time of the solids will be significantly less than intended. The distribution system used to inject gas must provide a constant gas velocity throughout the entire cross-section of the hopper since otherwise, channeling of the gas will cause the gas to bypass an appreciable portion of the solids.

Jenike & Johanson is prepared to assist you in developing reliable systems for handling, heating, and drying bio-feedstocks by applying proven, practical methods to ensure success with your bulk solids and process.



Why is my material not behaving as expected?

So you tried to do the right thing by having your material characterized to determine its critical flow properties, and based on the results the equipment you have should be able to handle it reliably. However, once the process was started up flow problems were encountered, which were extreme enough to cause serious interruptions, leading to lost revenue, added maintenance expenses, and a generally unsafe working environment for the operations personnel responsible for the equipment. What went wrong?

There are a number of environmental and process conditions that can affect measured flow properties. Therefore, it is critical that the conditions under which a material is handled at the full scale be recreated during the tests. One important consideration is moisture content. Higher moisture often results in reduced flowability, worst-case occurring somewhere below 90% of saturation. This can result in increased arching and ratholing tendencies or changes in sliding friction resulting in the need for steeper hoppers and chutes to maintain flow. Worst-case (contract or design basis) samples can generally be prepared through simple moisture addition. However, if the material being tested is hygroscopic or does not readily mix with water, then the worst-case condition may involve initial acclimation and testing within a high relative humidity environment.

Temperature also plays an important role on flowability. Some materials have relatively low melting or softening points, can experience chemical changes or show increased water activity at elevated temperatures. These behaviors can have a negative effect on flowability, which might be missed if a sample was tested at room temperature. As a result, if the material handled will be at an elevated temperature this may need to be duplicated in the tests.

If the process can result in down periods where material is stored at rest, due to production schedules, off-shifts or maintenance, etc., the material's flow properties could be negatively affected. Thus, the equipment may require features such as larger hopper outlets and/or steeper slopes in order to promote a resumption of flow when the process is restarted. To account for this effect during testing, samples are held under load for appropriate periods of time to determine increases in arching and ratholing tendencies, as well as adhesion to wall surfaces resulting in steeper hopper angles requirements.

Finally, it is imperative that the samples tested be representative of what will be handled in full scale. Some processed materials have transient behaviors that are impossible to reproduce once collected, packaged, shipped and tested in a lab setting. Examples include those coming directly out of reactors, crystallizers, dryers and mills, which result in residual active surface chemistry that only exists for hours or minutes. If the goal of testing is to assess the performance of handling equipment after the material has been received by a customer, then any such changes that affect measured properties would not be a concern. However, if the goal is to design handling equipment included within the initial manufacturing train, then such changes could yield misleading results when tested in a remote lab. In this case, the practical and typical approach is to bring the lab on site and test fresh material taken directly out of the process.

Each of the above factors may need to be accounted for individually or in combination during a testing program to ensure accurate flow properties are available for the design of process equipment. Following this approach will help prevent costly surprises at startup.

Flow of Solids Industry Calendar

November 9, 2009 Los Angels, CA – by AAPS
J&J Engineers will present the following:
- Analytical tool used to successfully predict pharmaceutical production scale performance

November 10, 2009 Philadelphia, PA – by MPIF
J&J Engineers will be organizing the program for the:
- PowderMet 2010 Technical Program

November 17, 2009 New York, NY – by Chem Show
J&J Engineers will be exhibiting their latest technology – see us at the show!

November 17, 2009 New York, NY – by Chem Show
J&J Engineers will present the following tutorials:
- Fundamentals of powder flow technology
- Troubleshooting common pneumatic conveying problems
- Blending and segregation and effects on product quality
- Selection of feeders for reliable flow and rate control
- Preventing bulk solids caking and particle attrition

December 7-9, 2009 Atlanta, GA – by ASME/AIChE
J&J Engineers will present the following ASME/AIChE courses*:
- Flow of solids in bins, hoppers, and feeders
- Pneumatic Conveying of Bulk Solids

December 8, 2009 Las Vegas, NV – PowerGen International
J&J Engineers will present the following paper:
- Improving Plant Performance by Retrofitting Coal Bunkers at Mt. Storm

March 15-17, 2010 Las Vegas, NV – by ASME/AIChE
J&J Engineers will present the following ASME/AIChE courses*:
- Flow of solids in bins, hoppers, and feeders
- Pneumatic Conveying of Bulk Solids

* For more information, please visit www.asme.org.

Off the Press - available through Jenike & Johanson

Opportunities and Challenges in Bulk Solids Handling
by J.W. Carson
Implications with Over-Blending of Bulk Solids
by E.P. Maynard
How Can I Improve My Pneumatic Conveying System's Energy Efficiency?
by E.P. Maynard
Understanding Powder Flow Behavior
by R.A. Barnum
Dominion Addresses Generating Problems due to Fuel Handling at Mt. Storm
by J.V. Khambekar, R.A. Barnum and K. Geisel
Design and Operation of Gravity dryer
by G.J. Mehos
Handle Bulk Solids Safety and Effectively
by G.J. Mehos and E.P. Maynard
Top 5 Bulk Solids Handling Design Mistakes in the Cement Industry
by E.P. Maynard
Startup and Running Loads Exerted by Bulk Solids Materials on Extractive Belt Feeders: Experimental Findings Compared with Available Models
by C.P.M. Holmes, M.S.A. Bradley, A.R. Reed and R.J. Berry

Off the Press - available through the publisher

Process Development, Optimization, and Scale-up: Powder Handling and Segregation Concerns
by T.J. Baxter and J.K. Prescott
Available through Elsevier, Inc.
When Powders Flow Like Water: Addressing Two-Phase Flow Effects in Tablet Press Feed System
by T.J. Baxter
Available through Tablets & Capsules
Operator Safety and Reliable Material Handling
by J.V. Khambekar
Available through Mining Engineering
Projecto de Silos e Transporte Pneumático Para Manuseio Confiável de Sólidos a Granel
by H.Purutyan, G.H. Hoyl, A. del Campo
Available through Química Industrial
How to Design Gravity Reclaim Stockpiles
by F. Cabrejos and A. del Campo
Available through Bulk Solids Handling

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Flow of Solids® Newsletter is published periodically by Jenike & Johanson, Inc., the leading authority on the flow of solids, at its international corporate headquarters, 400 Business Park Drive, Tyngsboro, MA 01879 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.