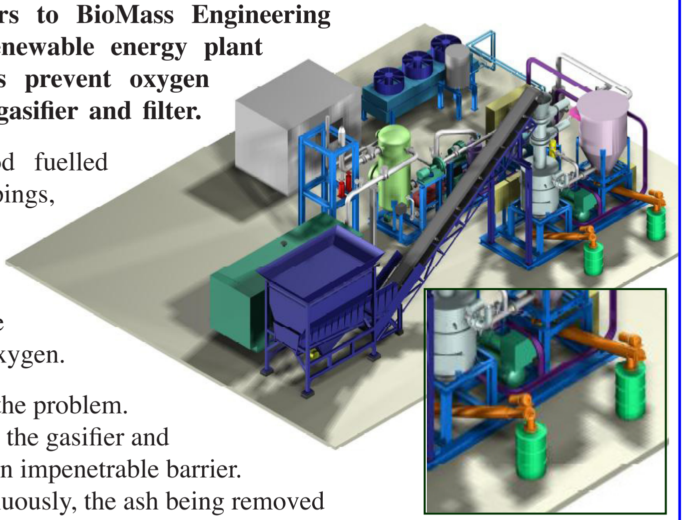
SOLID NEWS

Issue 6 — ***The newsletter of AJAX EQUIPMENT - the BULK SOLID performer*** — *Issue 6*

Plug Screw Feeders Improve Ash Removal from BioMass plant

Ajax Equipment Ltd has supplied 24 plug screw feeders to BioMass Engineering Ltd to handle ash removal from a gasification based renewable energy plant at Stoke-on-Trent, Staffordshire. The plug screw feeders prevent oxygen entering the furnace as ash is removed from the process's gasifier and filter.



Owned by O-Gen UK Ltd, the 4.5 Mwe reclaimed wood fuelled biomass gasification plant produces energy from wood chippings, forestery wood and energy crops, which will be exported to the National Grid. Maintaining an oxygen-free gasifier is essential. BioMass Engineering had tried using traditional screw feeders and airlock hoppers to remove and store the gasifier and filter ash, however, these allowed the ingress of oxygen.

The company contacted Ajax Equipment to assist in overcoming the problem. Ajax devised a plug screw feeder solution to remove the ash from the gasifier and filter. The screw densifies the ash as it leaves the screw to create an impenetrable barrier. "Adopting a plug screw feeder allows us to run the process continuously, the ash being removed without oxygen entering the system. The way Ajax Equipment approached the problem, and worked with us to find the right solution, has allowed us to improve the overall process's reliability," Jim Campion, managing director, BioMass Engineering, commented. The Stoke-on-Trent renewable energy plant is set to come into operation mid 2008. ❖

Titanium Dioxide Processing at Huntsman Pigments

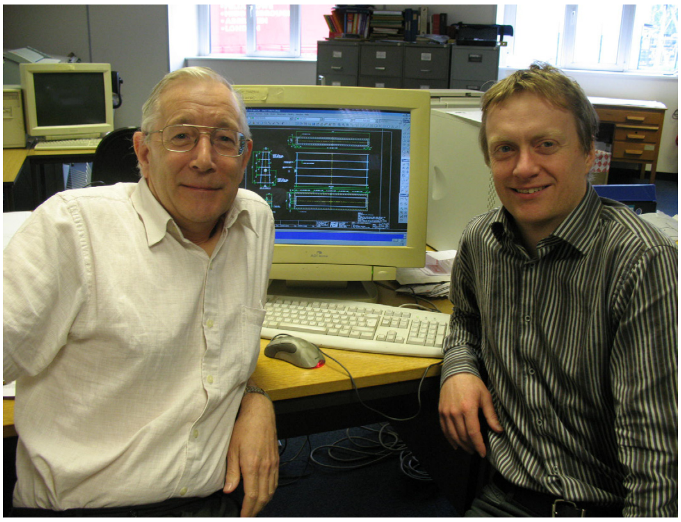
HUNTSMAN

Enriching lives through innovation

Huntsman Pigments Division - the Pigments business of Huntsman Corporation has chosen an Ajax Equipment hopper and feeder for production of titanium dioxide pigments at its Greatham, Hartlepool, site.

Manufacture of titanium dioxide is a continuous process where a tightly controlled and stable feed rate to the downstream milling process is essential. After conducting powder flow property tests on the powder to assess its wall friction, bulk density and shear strength characteristics, Ajax recommended and supplied a novel form of storage hopper and multiscrew feeder.

"We chose Ajax Equipment to supply the hopper and feeder because we know that the powder can be difficult to handle and Ajax's detailed design has been based on the measurement of the actual flow properties of the material," said David Lancefield, Group White End Technology Expert, Huntsman Pigments Division. ❖



Our design team says a sad farewell to Brian Greenwood, design draughtsman, who is taking early retirement after 28 years service; and gives an enthusiastic welcome to Richard Hawkins, also a design draughtsman. *cont page 4* ❖

Also inside…

New Powder Characterisation Technique… Lyn Bates answers your questions on hopper flow rates…IBC book review...Hot off the press

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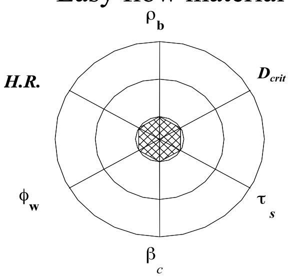
Predicting Powder Flow

Predicting the behaviour of powders has led some to look for a single number to use as a guide to flow. A variety of techniques are available that use the single number approach to quantify 'flowability', for example, angle of repose (Tenou et al, 1995), Hausner ratio (Grey and Beddow, 1969), Carr Index (Carr, 1965) and the more scientific Jenike Flow Function (Jenike, 1964). This approach however is fraught with problems. For example, there is no obvious reason why a powder that has high friction should also have a strong cohesive tendency or vice a versa, so whilst the situation may worsen for flow when both these features are present they are not necessarily correlated.

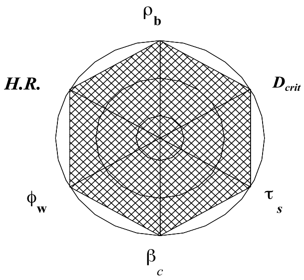
Improved powder flow predictability

A better approach to predicting flow behaviour is to take the measured characteristics of wall friction (ϕ_w) shear strength (τ_s), bulk density (ρ_b) and add three further factors: hopper or reactor wall angle (β_c) outlet size (D_{crit}) and Hausner ratio (H.R. - The ratio of tapped to loose bulk density. The greater the ratio the more sensitive the powder is to vibration and hence flowability worsens.) Using these factors we can produce a 'spider' diagram comprising a series of three concentric circles are divided by axes for each of the characteristics. These axes intersect with the smallest diameter circle where that particular characteristic describes 'easy flow' with subsequent bigger diameter circles defining 'modest' and 'poor flow'. Two idealised situations can then be presented figures 2 and 3 for an 'easy flow' material and a 'poor flow' one with the in-filled part of the 'web' detailing the particular characterisation attributes.

Easy flow material



Poor flow material



Circle	Wall friction (deg)	Bulk Density (kg/m3)	Shear strength (N/m2)	Hausner ratio	Outlet size (cm)	Mass flow Wall angle
Easy flow	< 20	1200	300	1.1	15	65
Average	25	800	1000	1.25	50	73
Poor flow	> 30	400	2000	1.5	100	80

Table 1: Parameters suggested by the tests reported in McGee Thesis (2005)

Note that the bulk density axis is the reverse of the others because decreasing bulk density usually means poorer flow. A practical example is that most milling operations lower bulk density and worsen flowability of powders when they are stored.

This tabulated data indicates that the 'easy flow' and 'poor' materials had the following characteristics:

'Easy flow' material

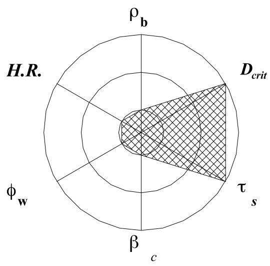
This would be a low friction material (<20 degrees), which would mass flow in a conical hopper with a wall angle of 65 degrees to the horizontal. It would have a high bulk density (around 1200 kg/m^3) but not be affected much by compaction or vibration so has a low Hausner ratio (up to 1.1). Its low shear strength (maximum 300 N/m^2) coupled with the high bulk density would guarantee flow through a small outlet (<15cm diameter). A practical example would be a free flowing grade of lactose with wall friction angle of 17 degrees against stainless steel, shear strength 197N/m^2, Hausner ratio of 1.1, rat hole diameter 9cm and requiring a 64 degree wall angle for mass flow in a conical hopper. With a bulk density 867kg/m^3 this particular example would have a small spike on the density axis of the spider diagram indicating a slight deviation form the ideal flow material.

'Poor flow' material

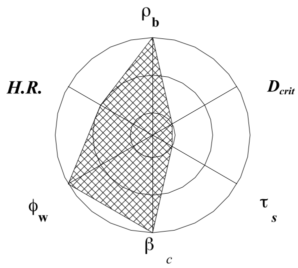
A high friction material (>30 degrees), which would barely mass flow in even the steepest conical hopper (>80 degrees) (in fact probably require a Vee shaped hopper). It would have a low bulk density (about 400kg/m^3), which would be significantly affected by compaction indicated by a high Hausner ratio (about 1.5). Its high shear strength (2000 N/m^2) coupled with the low bulk density would mean very large outlets (>100cm) would be needed to ensure flow. A practical example would be a grade of titanium dioxide with wall friction of 33.8 degrees against stainless steel, bulk density of 664 kg/m^3, shear strength 2690/m^2, Hausner ratio of 1.33, rat hole diameter 165cm and requiring a wall angle for mass flow in a conical hopper of almost 80 degrees to the horizontal.

"Integrating the three measured parameters: wall friction, shear strength, bulk density, and three calculated parameters: hopper wall angle, outlet size and Housner ratio, offers a more rounded and informative picture of flow characteristics,"
Dr Eddie McGee, Technical Director, Ajax Equipment.

Intermediate 1



Pharma Powder



This technique when applied to two other examples highlights particular aspects of the 'profile' that merit special attention. Intermediate 1 shows the resultant diagram for a chemical intermediate 1; all aspects for flow are good except the shear strength and outlet size. To overcome potential flow problems for batch handling of this material invertible IBC bins were used with a larger outlet that upsets the consolidation of the material to ensure reliable flow to process.

The pharma powder, on the other hand, has high wall fiction but low shear strength. Had this material been stored and transferred without thought to its flow characteristics difficulties with chute work featuring insufficiently steep slope and sharp corners would have occurred. The spider diagram in this case directs attention towards examining the effects of surface finish and using generous radiused corners as practical solutions to providing trouble free powder flow. ❖

SOLIDS HANDLING PROBLEM? AJAX M.D. LYN BATES IS HAPPY TO OBLIGE WITH SOME EXPERT HELP

Q. **My current hopper suffers serious arching and/or flow rate problems but I cannot alter the size of the outlet. What can I do?**

A. There are many remedies for correcting flow problems without changing the basic framework of the hopper and still work with the existing outlet constraints e.g interfacing with the feeder or process.

The technique used will depend on the type of blockage and impediment to flow experienced. Internal flow channel modifications are instituted for general arching and rathole problems, usually by changing the wall profile and/or fitting an insert. For example, a round outlet on a conical hopper that does not work in a mass flow manner can be made as effective as one twice the size by modifying to mass flow e.g. by changing the wall surface finish or fitting an internal insert which promotes flow at the hopper walls. Another technique for increasing the effective outlet size by a further 100% and completely eliminate the prospect of ratholes, is to convert the outlet approach to a plane flow pattern and this involves modification of the shape of the flow channel towards the outlet. If this fourfold increase in effective outlet size is still not enough to generate reliable flow an arrangement can be put in place to make the outlet work as an unconfined chute, and transfer the flow control to a region of the bin where there is more room to affect changes.

In many cases there is surprisingly small reduction in storage capacity because the slope of hopper wall to provide self-clearing of the contents is usually much less than the main hopper wall convergence. Such approaches must be based on measured bulk property values and account may need to be taken of the stresses on the hopper and inserts as well as any other implications of the changes. Ajax has undertaken many conversions of this nature from 100kg pharmaceutical batch hoppers to 4000T coal bunkers. ❖

❖ Solid News Forthcoming Events ❖

June 10-12, 2008
The 4th International Symposium on Reliable Flow of Particulate Solids (RELPOWFLO IV)
Tromso, Norway
Ajax Equipment technical director, Dr Eddie McGee, is chairing a session on Silo Design.

September 11-12, 2008
BulkEurope 2008
2nd International Conference and Exhibition on Storing, Handling and Transporting Bulk Solids Materials
Prague, Czech Republic
Lyn Bates is presenting a paper on 'How to Avoid and Cure Hopper Problems'.

Test rig for Wolfson Centre

Improving storage hopper filling

As powders flow from a storage hopper into a road and railway tankers they can become aerated making them more free-flowing and 'bulking out' the materials. In consequence, the tanker can often appear full (by volume) when in fact it is under filled (by weight).

The Wolfson Centre for Bulk Solids Handling Technology at the University of Greenwich is researching into the development of a technique to make the discharge of materials into the tanker more predictable and in so doing improve the condition of the materials after filling. Ajax Equipment is supplying the project's test rig, including static screw vertical elevator. It also has a wider technical support role in the project.

The Ajax static screw elevator will transfer material in a more densified and settled condition than a conventional screw elevator.

"Tankers and big bags are particularly prone to the problem of aerated materials distorting their filling efficiency. In one case a big bag filling machine rated for 5 tonnes per hour was actually running at 2 tonnes per hour due to aeration. Our project is about modifying the bulk materials flow behaviour so that aeration is significantly reduced," commented Richard Farnish, consulting engineer, The Wolfson Centre.

The test rig comprises two 1m^3 capacity hoppers, screw feeder, pipework and vertical elevator. It will be used to store and recirculate a range of materials such as fly ash, cement, flour and sugar, for example. "We asked Ajax Equipment to provide the test rig because of their technical and manufacturing skills and capability. The Ajax static screw vertical elevator is ideal for this application where we are faced with tight space constraints for the test rig," said Farnish.

Lyn Bates, managing director, Ajax Equipment will have a wider technical support role in the project. "A key feature of the test rig is that, apart from various other benefits, the new static screw elevator will transfer material in a more densified and settled condition than a conventional screw elevator" he said.❖

New Gantry Crane for larger handling projects

Ajax Equipment has invested in a new two tonne gantry crane enabling the company to handle larger solids handling projects. It marks the latest phase in a factory upgrade programme, following the installation of a two tonne electric hoist lift in the factory's loading bay.

"The new crane makes it easier for us to handle larger projects such as waste handling equipment and large conveyor projects as well as having important health and safety benefits," commented John Crowder, production director, Ajax Equipment.❖

Designs on Gardens and PED!!!

cont page 1

Over the years Brian Greenwood has seen quite a few changes in solids handling equipment design. Most noticeable has been improvements in industry and regulatory standards: ATEX, PED and easier to clean designs are just a few. "Although the jobs are now more complex and demand greater precision, you still need to understand the underlying principles of materials flow which is where Ajax is particularly knowledgeable," he said, while heading off to the local garden centre.

Meanwhile, Richard Hawkins has strengthened the design team's knowledge of PED, having previously worked for a pressure vessel manufacturer."Adherence to PED is becoming more of a concern for many industries, so when the need arises we'll be able to advise on the equipment design issues," Richard noted.❖

Hot off the Press

Ajax Equipment can often be found discussing the solids handling issues of the day in leading industry magazines.

So far this year we've reported on growing interest in continous mixing in pharmaceutical manufacture, the application of inserts on hoppers in chemical manufacture, residence times for food ingredients in hoppers, improving coal storage and applying powder characterisation to pharmaceutical equipment design.

To find out more about any of the issues covered in these articles contact Ajax Equipment.❖

Guide to Selection and Use of Intermediate Bulk Containers

The 'Guide to Selection and Use of Intermediate Bulk Containers (IBCs)' by Tom Taylor of the British Materials Handling Board (BMHB), presents a detailed overview of flexible and rigid IBCs for a range of industries.

The choice of IBC, rigid or flexible, brings with it specific approaches to filling, transport and emptying the IBCs. The guide includes a detailed review of the options here as well as reflecting recent significant advances in this area most notably in secure containment during filling and discharge.

Integrating the IBC with the process, 'Process Systems Design for IBCs' is an important chapter. This is where innovations in flexible screw conveyors, aero-mechanical machines and screw feeders have led to more integrated packages for loading and discharging stations. Examples from the chemical, plastics and food are included here and throughout the book.

Intermediate Bulk Containers (IBCs) are so widely used in the process industries that anyone faced with either considering or selecting an IBC system from the large number of systems now on offer, will find it a valuable read. ❖

The 'Guide to Selection and Use of Intermediate Bulk Containers (IBCs)', costs £20 plus £3 P&P (UK) and is available from BMHB, www.bmhb.co.uk.

Photo: Ajax Invertabin

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