SOLID NEWS

The newsletter of AJAX EQUIPMENT - the BULK SOLID performer

Issue 5 *Issue 5*

Keg Discharge Station Smoothes Hazardous Waste Disposal

Carillion, one of the UK's leading business and construction services companies, has recently used a keg discharge station developed by Ajax Equipment to assist in the disposal of hazardous waste at UKAEA's Harwell site in Oxfordshire. The discharge station was used to empty over 900 drums of waste for pre-treatment prior to landfill.

Carillion was responsible for the safe disposal of waste from 25 pits containing around 5,000 m^3 of chemicals and other hazardous materials mixed with chalk and clay, as part of the decommissioning of the UKAEA Harwell site. Initially the waste was stored in 205L/400kg (45/50 gallon) drums for a year while tests on the material were undertaken to assess the best means of disposal. The keg discharge station was used to safely empty the contents of each drum onto a conveyor for transfer to a sand and cement stabilising unit where the waste is chemically stabilised. The stabilised material is then discharged into the original drums and plastics IBCs prior to being disposed of at an appropriately licensed landfill site.

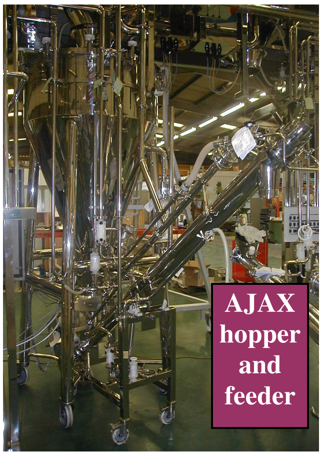
The Ajax keg discharge station provides an elegant and automated solution to removing the waste from the drums. The single operator machine allows up to four 205L drums / kegs to be emptied per hour. After removing the container lid, the drum is tipped through 90 degrees to bring it into contact with a stainless steel auger, which is then driven into the waste material and positively extracts it along the screw before depositing it onto a belt conveyor. A final stage of steep tipping is used so that any residue slides out of the drum.

"The Ajax keg discharge station saved a good deal of time and provided a bespoke device to extract the waste materials. Manual removal of the waste was out of the question given the hazardous nature of the material." commented Marcus Foweather, Remediation Director at Carillion. "The keg discharge station is perfect for our requirements and has worked well. We were able to process all 900 drums in about 12 weeks," he said. ❖

Agile Pharmaceutical Manufacture – Powder Handling Seminar

Ajax Equipment has recently organised a seminar on 'Powder Handling for Agile Pharmaceutical Manufacture' in collaboration with the International Society of Pharmaceutical Engineers (ISPE).
Bringing together pharmaceutical company AstraZeneca, and containment and milling specialist Hosokawa Micron, the seminar presented three perspectives on powder handling against the background of decreasing time-to-market for pharmaceutical products and increasingly high value, potent APIs and their containment.

"Many thanks to Ajax Equipment on behalf of the North West ISPE Committee for pulling together this presentation. The evening was a success and kept the audience interested and entertained. The support from companies such as Ajax, Hosokawa and AstraZeneca is essential for these events," said Roland Mugeli, Chair - ISPE NW Region.



AJAX hopper and feeder

Powder characterisation and its implications for system integration and peripheral requirements, together with the need for agile manufacturing plant capable of fulfilling a range of production requirements, was also presented by Ajax Equipment technical director, Dr Eddie McGee.❖

Copies of the presentations are available on-line at www.ispe.org/ and follow the link to chapters, UK and North West Region (Past Events Information).

Also inside…
Vertical shear cell testing… Lyn Bates answers your questions…AJAX Mobile Elevator and Screw Feeder Guide book review.

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Assessing the Flowability of Bulk Solids

In Issue 4 we introduced the Vertical Shear Cell (VSC) test developed by Ajax Equipment in the 'Ask Lyn' column. The VSC test results can be used to determine the hopper outlet size needed to achieve reliable flow.

There are two stages to the VSC test: stage 1 is to consolidate the material and establish its bulk density; stage 2 is to fail an unconfined failure surface and measure its shear strength - see figure 1. Analysis of the conditions at failure in a hopper has shown that a minimum diameter, D_{crit} for destabilising a rat hole or arch can be given by equation 1, where g is the acceleration due to gravity (9.8 m/s^2):

$$D_{crit} = \frac{4 * \tau_s}{\rho_b * g} \qquad \text{Equation 1}$$

The above analysis suggests that, as the diameter of the outlet increases the peripheral area (resisting shear) which supports the blockage goes up in direct proportion to the diameter; whilst the weight of product to overcome resistance to shear goes up with diameter squared. It is inevitable that the stress due to the weight of the bulk will eventually exceed the resistance generated by the powder's shear strength. It follows that the measured shear stress and the bulk density are two parameters that influence the size of outlet needed for flow.

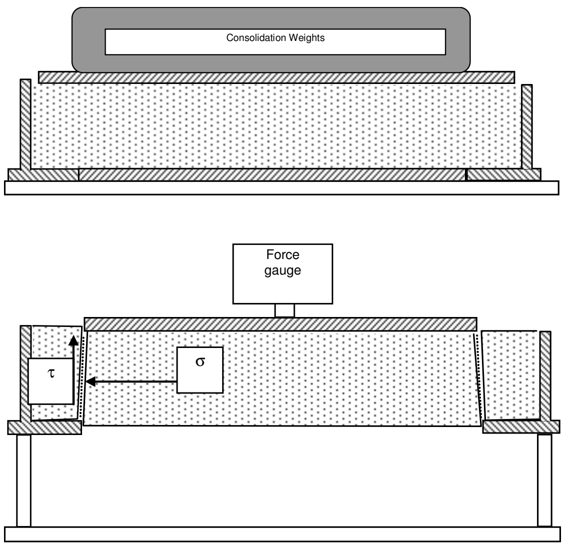


Figure 1 Vertical Shear Cell test: stage 1 – consolidation; stage 2 – shearing stage.

VSC predictions compared with flow behaviour in a hopper

The VSC has been used to predict flow behaviour in hopper for 33 powders, comparing predicted values and actual flow behaviour in practical trials in small-scale plant comprising a conical hopper fitted with a screw feeder. In all cases the hopper outlet size was 15cm diameter so the predicted outlet sizes can be set against this fixed value and compared with actual flow behaviour in the hoppers, Figure 2.

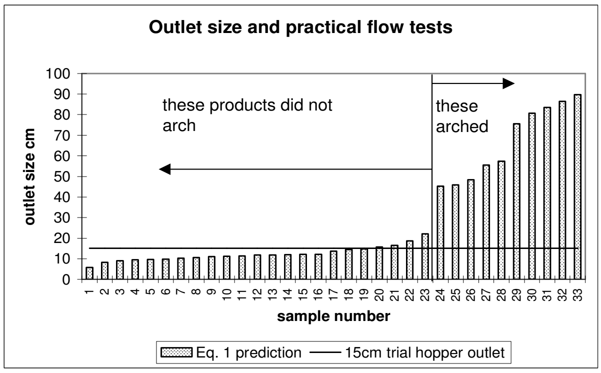


Fig. 2: Predicted outlet size compared with flow behaviour in hopper.

Defining Flowability

A large number of products have been tested using the vertical shear cell. Using Eq. 1 for outlet size as a basis, a new graph, figure 3, can be plotted with the y-axis representing the numerator (4 x τ_s) and x-axis representing the denominator ($\rho_b * g$).

Vertical shear cell tests can be used to design hopper outlet sizes for reliable flow.

This allows the data from 75 different products (all consolidated by 6.7kPa) to be presented in a space where lines of constant outlet size can be superimposed to partition a 'flowability' grouping for bulk solids. This is a significant result and helps characterise materials in a space where a sensitive plant parameter (outlet size/rat hole diameter) defines flow boundaries. Note the partitioning lines identify constant outlet sizes as follows: - 1m – poor flowing, 0.5m average and 0.15m easy flowing.

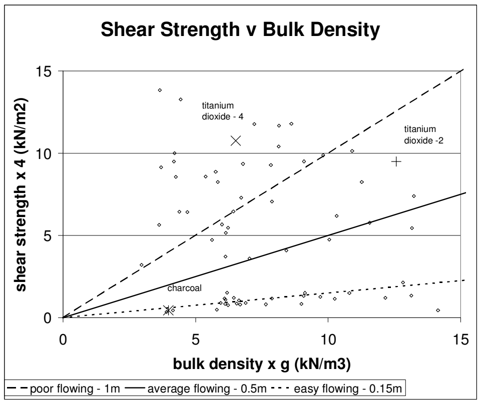


Figure 3: Data from shear tests plotted in sectors partitioned by constant outlet size to indicate easy modest and poor flow characteristics.

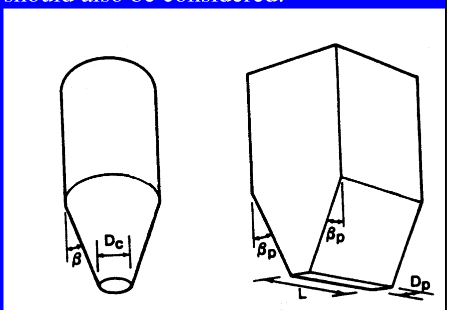
The tests indicate that titanium dioxide - which is prone to forming a rat hole or arch is towards or in the 'poor flowing' region whilst a charcoal is likely to flow through an outlet less than 15cm diameter so is 'easy flowing'. If the outlet is big enough to destabilise a rat hole then flow from the hopper is likely to be reliable.

A benefit of this form of data presentation over Jenike's approach is products that have similar strength e.g. grades 2 and 4 of titanium dioxide can actually be better distinguished from the flow function construct because the chart incorporates bulk density. In conclusion, the vertical shear cell tests can be used with a measure of confidence to design hopper outlet sizes for reliable flow. Moreover by combining bulk density and shear strength data in the one chart the process engineer can quickly identify an important quantifiable aspect of flowability.

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

***Q.* Lyn, How do I choose the form of hopper for a particular application?**

A. The first step is always to select the flow regime appropriate to the nature of the bulk material to be stored. Essentially this means choosing Mass Flow for products that deteriorate in quality under indeterminate residence time, unless the contents are to be fully discharged every time before introducing fresh material. Mass Flow should also be chosen, at least for the outlet region, if the material has poor flow characteristics. This should be continued to a span exceeding the potential 'rathole' size. Mass flow can also be chosen to mitigate the effect of segregation, although other measures may also be needed to minimise its influence. The use of a slot shaped outlet is useful for securing extra capacity, avoiding discharge rate restrictions, allowing less steep walls than a cone and avoiding ratholes, provided the feeder extracts from the whole area of the outer slot. Whilst a Vee-shaped hopper is good for flow it is poor for resisting pressure, so a balanced commercial decision is needed if ATEX is involved or large flat surfaces require stiffening. The choice of circular or rectangular body section is often made on structural, than on flow related, consideration, however the impact of shape on flow potential should also be considered.



Getting the right hopper shape for flow. Mass flow wall angles are predicted from wall friction tests but plane flow shapes can have shallower walls than cones

Progressive extraction feeders may not be essential for use with inert and easy-flow materials but, other than 'collecting conveyors' under such as dust filters, it is good practice for minimal energy to avoid 'dead' regions of flow along the hopper outlet.

The outlet size should be sized according to the measured or tested properties of the bulk material to ensure reliable flow, in practice it is more important to have the right hopper shape and wall angle than to size the outlet correctly as there are many ways to initiate flow, but few to rectify an incorrect wall inclination. See www.ajax.co.uk for more information on hopper design.

Mobile Screw Elevator

High Capacity, Innovative Design

Ajax Equipment has developed a high capacity, mobile screw elevator for manufacturing and logistics companies to use for the transfer of bulk materials to and from transportation vehicles and into hoppers.

The mobile screw elevator is designed to lift materials up to height of 6 metres and uses Lynflow technology to achieve efficient elevation at an inclination of 40 – 45 degrees. These machines are available in mild or stainless steel in a range of lengths and screw diameters, enabling transfer rates of up to 40 m³/hr. The elevators can be linked directly to a truck's connection or discharge device for ease of material transfer.

In a design innovation, the elevator drive motor is mounted half way along the screw length for better balance and ease of maintenance.

Ajax Equipment offers a high degree of customisation to meet specific application requirements.

In addition to the length, diameter and capacity of the screw, these can include a sack tip station with or without dust extraction hood, and big bag station for feeding the inlet or receiving the output. The screw elevator has can be lowered within its frame, making it ideal for movement and operation within the tight confines of an industrial plant or warehouse.

STOP PRESS…

New Sales Engineer Joins Ajax Equipment Team

Ajax Equipment has strengthened its technical sales team with the appointment of Nilesh Vora as a technical sales engineer. Nilesh has a BEng (Hons) awarded by Lancaster University.

New Apprentices for Future Growth

In an effort to keep pace with the growing demand for its high quality, well-engineered solids handling equipment Ajax Equipment has recruited two apprentices under the Modern Apprenticeship scheme. Christopher Rutter and Craig Charlton have joined Ajax Equipment straight from school and are working towards City and Guilds qualifications in Sheet Metal Working over the next four years.

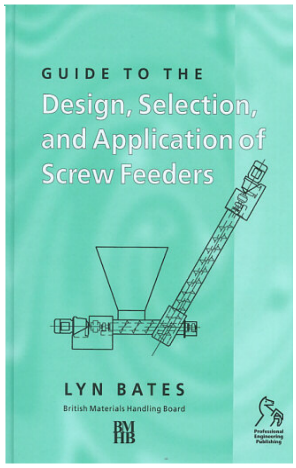
Ajax Equipment's production director John Crowder recruited the apprentices. John is an active member of CoVE – the Centre of Vocational Excellence in Bolton, which meets with schools and colleges in the area to review the needs of industry. Under the auspice of the Learning and Skills Council (LSC), the apprentices are offered day release and apprenticeship training by Ajax to attain the high quality skills needed to carry out fabrication work at Ajax.

"We are delighted that Christopher (left) and Craig have joined us. The work of CoVE allows specialist companies like our own to build close links with colleges, schools and LSC, enabling us to invest in the skills of our workforce at every level," says John.

AJAX is also pleased to announce that Colette Peachey is our new secretary. She is settling into the role nicely!

Screw conveyors have been with us since antiquity but, as Ajax Equipment managing director Lyn Bates points out in the introduction to the 'Guide to the Design, Selection and Application of Screw Feeders', a lack of knowledge of the way bulk materials behave continues to impede progress towards radical improvements in industrial performance. This guide will go some way towards helping companies to achieve this radical improvement.

The **'Guide to the Design, Selection and Application of Screw Feeders'** is in seven parts: classes of screw equipment (conveyors, elevators and feeders), screw feeder types, screw construction, interfacing screw feeders with hoppers, screw selection criteria, special forms of screw feeders where feeders are used in a direct processing role and case studies.



In many respects, the 'Interfacing screw feeders with hoppers' chapter represents the guide's key to understanding screw feeders as most practical screw feeder problems occur here. This chapter introduces the many variables that influence screw feeder performance, such as the design of the hopper, the material's flow properties, mass flow from hopper to feeder, avoiding arching and preferential flow and, particularly, the design of the screw. For some the guide will provide an important refresher on screw feeders with the opportunity to go into more detail. Most readers will find it a handy reference when specifying a new screw feeder or looking for ways of overcoming a feeder problem.

The **Guide to the Design, Selection and Application of Screw Feeders** is published by Professional Engineering Publishing for the British Materials Handling Board (BMHB), 168 pages, ISBN 1 86058 285 0. The book costs £50 plus postage and packing. See books@ajax.co.uk

❖ Forthcoming Events ❖

9th International Conference on Bulk Materials Storage, Handling and Transportation (ICBMH 2007), 9-11 October 2007, University of Newcastle, Australia. Lyn Bates is presenting a paper entitled "Rules and Tools for Retrofits". The paper will cover the technical aspects as well as existing plant and commercial constraints of installing retrofits. For more details visit www.icbmh2007.com.

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