Case Study

Ajax Equipment: Go with the Flow with a Multi-screw Feeder

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From fine cohesive powders to shredded wastes, bulk solids can exhibit varied and awkward flow behaviours which can make the material challenging to handle. Multi-screw feeders can help secure a reliable and effective feed of these demanding materials from hoppers, silos and bunkers through positive transfer and control of discharge and feed rate.

It is well recognised that to get a dependable feed of bulk solids from a storage system it is essential to use the correct hopper geometry and outlet size. Less appreciated is the importance of the feeder design and interface between the feeder and hopper.

The Virtues of Multi-screw Feeders

Working with a suitably designed hopper, multi-screw feeders can provide a positive means of extraction and transfer of material. This helps to make sure all areas of the hopper flow, an essential requirement for achieving mass flow. Screw feeders also control the rate of feed, valuable for processes which require a consistent feed of material.

The benefits of multi-screw feeders are numerous and include compact construction, reduced headroom requirements, complete containment of the product as well as increasing the storage capacity and flow benefits of the vee-

shaped hoppers served.

The design of a screw feeder, including the number of screws, depends on the needs of the material and process. Below are three Ajax Equipment case studies illustrating how multi-screw feeders can be utilised in both retrofit and new installations, and how their design is determined.

Two Screws - Chemical Powder Handling

In response to feed variations in excess of 30% from a feed system at an Egyptian fertiliser plant handling milled phosphate, Bradley Pulverizer called Ajax Equipment in to investigate.

The plant experienced flow problems shortly after starting up with material not flowing and sticking in a large pyramid silo as well as occasional flushing – where new material immediately leaves the hopper rather than exiting in the order it entered. To encourage flow aeration pads had been installed to introduce a low volume of air and cause the material to move. However, the addition of air resulted in uncontrolled flow from the hopper leading to downstream equipment to become flooded.

One the roots of the flow issues was the flow regime, ‘funnel flow’, generated in the hopper. Funnel flow arises in hoppers where the converging wall inclination is too shallow to stimulate the hopper’s contents to slip as the hopper empties. This results in a narrow path from the surface of the solid to the outlet for material to follow, creating an environment where fresh material is the first to leave the hopper.

To determine how best to improve material flow at the plant, Ajax used powder testing to examine the powder’s flow properties. Tests found that the combination of the material’s high shear strength and much shallower wall angles than required for mass flow were the reason ratholes formed and allowed new material flow straight through.

Wall friction testing provided Ajax with the hopper wall inclination needed for the powder to move with mass flow as well as showing that there would be significant slip benefits to using 2B finish stainless steel over the existing mild steel surface. The benefits of mass flow include increasing the material’s residence time in the hopper and enhancing deaeration.

‘The magic solution’ to an Egyptian fertiliser plant’s variable feed.

Converting the entire hopper to mass flow would be expensive so Ajax Equipment recommended replacing a 2-meter section at the bottom of the hopper as a cost-effective measure. Introducing the proposed vee-shaped section would exploit plane flow benefits as well as provide a large outlet from which a new twin screw feeder, featuring special extraction geometry, could actively draw material from the full length and width.

In addition to the new hopper section and screw feeder, a flow insert was also installed to further enhance deaeration and extend the flow benefits into the existing higher region of the hopper as well as prevent a direct flow path to the outlet. The flow insert also helped to minimise the plant modifications necessary to secure a reliable operating performance.

Following the improvements, reliable and stable discharge was achieved, the residence time of material is much more even and the twin screws deliver feed stability within 0.5%. Ian Hancock, operations manager at Bradley Pulverizer, commented on the project, “Since the equipment has been installed the performance of the process has significantly improved. By providing complete control over the flow of phosphate powder, Ajax’s equipment has enabled production of the high-quality product desired, a welcome improvement to plant performance which the plant operator describes as ‘the magic solution’.”

Four Screws - Waste to Energy

In 2020 Enviropower approached Ajax Equipment to discuss how best to replace a poorly performing walking floor discharger below a bunker at their waste to energy facility. The refuse derived fuel stored had a low, variable bulk density and a tendency to form ‘bird’s nests’; a combination of characteristics challenging for any feeding technology.

Following trials with a large twin screw feeder, Ajax designed and manufactured a screw feeder with four screws, each measuring eleven metres long. Ajax recommended a quadruple screw feeder as this would be able to serve the full length and width of the bunker’s outlet, providing a positive transfer capability.

With the size of the feeder required and a poorly flowing material, the project presented multiple challenges. Many materials are a consistent size and shape or can be broken down to be so, however, by its nature waste is not quality controlled. To mitigate the effects of the material irregularity, Ajax included

several features to allow a range of materials and sizes to be handled including a careful combination of flight design and clearance. Over the outlet section relief overload flap plates were included to significantly reduce the potential for disruption should blockage occur. The feeder's design also makes it possible for individual screws to be removed while the remaining screws continue to operate, this allows the plant to operate normally even though maintenance is being carried out on the removed auger.

Quadruple Screw Feeder designed to work with poorly flowing refuse to provide a regular feed.

At 11m long and weighing over 18T, the physical proportions of the screw feeder also presented a challenge. The feeder was fully assembled at Ajax's works for a factory acceptance tests and inspection by Enviropower but was made in kit form allowing the components to be transported in sections and assembled on site.

Following the successful performance of the first quadruple screw feeder, Enviropower contacted Ajax in 2021 to order an identical feeder for the facility's other processing line. Commenting, Marc Linberry, operations director at Enviropower, said, "Ajax worked closely with us to overcome a couple of teething problems with the first quadruple screw feeder, and their fast response and determination to overcome these issues and provide us with reliable and well-functioning equipment left us with no doubt but to return to them when we wanted an identical system for our other biomass waste processing line."

Six Screws - Carbon Fibre Handling

The six screwed feeder at Ajax’s works in Bolton, UK.

Following Ajax’s supply of a hopper and single screw feeder on a successful upgrade of an existing milled carbon fibre handling line at Mersen’s Eurocentral, UK facility, Ajax Equipment was asked to design another system for a new line handling carbon fibre. “After the success of working with Ajax to upgrade the existing line we were happy to work with them again on this new line,” said Scott Keil, manufacturing manager at Mersen.

A new line provides the opportunity to design each component of the system together, ensuring efficiency of process and plant configuration. The new line’s extremely low density and very fibrous material had long thin particle shapes making it poorly flowing, very different to milled carbon fibre of the existing line. As a result of the difference, property tests were performed helping inform the design of the storage and transfer system needs for carbon fibre on Mersen’s additional line.

Mersen’s process required the carbon fibre to be stored in a large silo; due to the materials resistance to flow, the silo’s walls could not have any convergence as sloping walls would cause the material’s long and thin fibrous particles to arch and form a blockage over the outlet.

Ajax’s carbon fibre handling system installed at Mersen.

For the vertical walled silo, a fully live multi-screw feeder was required to extract the carbon fibre from the silo and prevent any hold-up of material.

To achieve this, Ajax designed a silo and six screwed feeder, driven as a pair of triple screws. The integrated design of the feeder and silo means that any arching and hold up of fibre is completely avoided and a positive, regulated feed is

consistently achieved. Ajax’s carbon fibre handling system also included a collecting screw conveyor with declumping features and an inclined screw.

“Commissioning with the new multi-screw system has gone exceptionally well with production totally satisfied that the Ajax feed of product to our mill is consistent and indeed superior to our original Silo set up,” commented Scott.