DUST SUPPRESSION

A fundamental consideration for handling and discharge arrangements for cereal products in the chain from field to end of process is that of controlling the generation of fugitive material (dust) into the atmosphere. The need to control dust levels is driven by a number of factors such as the long term health of operators, plant hygiene or plant operational safety (ATEX/DSEAR).

High dust levels can result from the stripping away of 'piggy back' fines (i.e. dust that has attached to the outside of larger particles and is transported with them through the process) by impact or counter directional air flows. Alternatively, dust can be generated through the breakage of larger particles (i.e. impact or shear plane damage).

Handling operations that deliver the former set of condition for removal and transportation of 'piggy back' fines would typically include the filling of bulk storage units by either gravity of pneumatically – where significant distances for free-fall conditions or trajectory establishment exist.

The direct generation of dust through particle damage can occur in large stores where the discharging flow channel expands and flows through static regions of product (often referred to as internal mass flow [1]) or where constant capacity feeders such as augers, drag links or belts extract from long outlets without optimised design or interface considerations – in which case the feeder will tend to drag conveyed product beneath a non-activated region of product.

Any fines/dust generated through either of these common handling operations may not necessarily become a problem in later stages of operations. For example if fines/dust are generically considered to be represented by sub 3.15mm (for example) and constitutes 2 percent by weight per cubic metre of product, there may be no issues of excessive dust mobilisation through subsequent handling provided that that size fraction remains homogenously distributed within each volume of product.

However, problems often result when products are loaded into storage schemes where many cubic metres are stored. In such instances the simple operation of filling the store has a strong likelihood of mobilising the resident fines and redistributing them within the bulk – with the result that some volumes of material may contain less than our nominal 2 percent wt, whilst others could contain in excess of 10 percent wt. Thus during the discharge or load out operations that the store may provide, the dust levels may fluctuate considerably depending upon the severity of the redistribution of fines, the method of extraction and the inventory level within the store.

The implication of this variance in dust content lies in how the specification for any locally applied dust extraction system has been developed. Using the 2 percent wt fines model again, it can be understood that this value should be used to size the filter area for an extraction system and the type of filter operation.

On first consideration, the use of the 'specification' fines content would seem a prudent basis for design. Economic considerations tend to dictate that the specification of the filter would be closely matched to the application requirement. However, once installed and commissioned the intermitted fluctuations in fines/dust content are likely to overwhelm the ability of the dust extraction system.

Such overload conditions would result in blinding of the filters (assuming that the cleaning method was configured to operate on a timed interval) or excessive air consumption (in the case of a reverse jet pulse system triggered by a pre-defined maximum pressure drop value).

An assessment of the potential dustiness or brittleness of the material being handled can provide the first element of a structured approach to pre-empting dust levels or the scope for variations in fines/dust released in handling operations and, in turn, developing an effective specification for associated plant.

The assessment to characterise bulk particulate materials for dustiness or breakage behaviour can be undertaken at laboratory scale. The evaluation of dustiness (i.e. surface attached 'piggy back' particles) can be effected through the use of a Warren Spring type tester which takes the form of a closed drum that has internal 'lifting' slats attached at six points around its circumference that extend down the length of the chamber.

The test sample is tumbled inside the drum whilst an air flow is allowed to pass from one end of the chamber to an exhaust port at the opposite end which delivers dust laden air onto a filter element. The gain weight of the filter is taken as a benchmark indication of the ease with which dust can be liberated from the parent particles.

Breakage tests can be undertaken that project particulate material at controlled velocity against steel targets that are arranged around a centrifugal accelerator. Assessment of breakage is simply undertaken by the comparison of particle size distribution shifts (towards increasing fines) in response to increasing impact velocities.

Both of these methods represent useful techniques for obtaining information for comparison of the likely dust and breakage behaviour for different cereal crops, seasonally sourced crops or pelletised products. The tests can also accommodate variables such as temperature or moisture content variation (both of which can be influential factors relating to dustiness).

In terms of counter measures to deal with excessive dust mobility, one of the key aspects of best practice is to avoid the establishment of high velocity movement of particles or dispersion at transfer points – both being factors that facilitate the penetration of air into the bulk material and the stripping out of fines/dust. Finer material having a lower mass and correspondingly relatively large surface area, have a high drag factor – which endows them with a substantially higher mobility in air compared to coarser particles.

Belt transfer points are a prime example of where dispersed particulate movements occur, which means that not only can a degree of breakage occur, but also that an existing or additional fines can be easily dispersed to atmosphere or dragged by air flows along transport tunnels. The application of 'hood and spoon' transfer point design can help considerably in delivering a focussed flow of material sympathetically to the direction of belt travel. This is a technique that has found a high level of utility in pellet handling operations where breakage must be minimised.

In conclusion, it is hoped that it can be appreciated that a problem such as dust emissions at certain points in a process is usually the end result of a cumulative breakage and concentrating of fines/dust that has occurred through the plant. Methods exist to design out a wide range of the causes of dust and variable dust loading, but also to reduce the magnitude of problem caused by inherently dusty materials.