# The smart solution

## The K-Tron bench test gives maximum result from a minimum of material. By Bodo Reisert, senior systems engineer and Regula Sullivan, marketing publisher

One of the main problems an engineer encounters when designing a conveying system for bulk solids is correctly classifying the material properties of the bulk solid to be conveyed, especially in the case of powders. The consequences of an error in calculation can range from having to make changes to the system once it goes online to over- or under-sizing of the entire system. Conveying tests will determine the exact handling properties of a bulk material but are generally labour-intensive and costly. The K-Tron Bulk Material Bench Test is the ideal solution for most applications. Only a minimal amount of bulk material is needed to determine the key material characteristics and parameters necessary to design the right conveying system.

The Bench Test can be completed in about an hour by an experienced technician in one of the fully equipped K-Tron Test Laboratories located in the USA (Salina, KS) and Switzerland (Niederlenz). The test procedures and documentation are standardized to ensure the Bench Test is conducted and documented in the same way irrespective of the location of the Test Lab. The test equipment at both locations is identical and regular calibration ensures reliable results.

ABOVE: A small amount of bulk material can provide the key parameters needed when designing a conveying system

### Bulk density

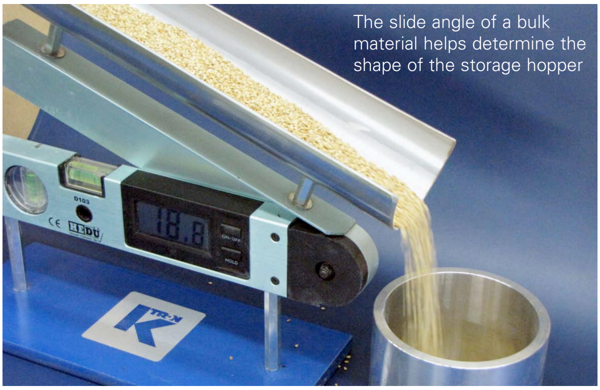
While conveying rates and storage capacities are often based on weight, many components in a conveying system – such as product source, receiver, rotary valve size or conveying screw – are defined in units of volume. Without knowing the bulk density of a bulk solid it is impossible to calculate the required parameters.

In fact, three bulk densities are required when designing a conveying system: loose, packed and fluidised.

Step one of the bulk density test is to fill a beaker with material. A straight edge is used to level the bulk solid and remove any extraneous material and the beaker is then weighed. This is repeated several times. The highest and lowest weights are discarded and the average of the three remaining weights is recorded.

The three cups are then set on a special platform and subjected to vibrations for a set period of time. The new, reduced volume of the bulk solid in its compacted state is then recorded and the packed bulk density is calculated.

The difference between loose and packed bulk density is relatively low for granulates or grainy materials, whereas powders may show a difference of 10%, or even as high as 50% in extreme cases.


The slide angle of a bulk material helps determine the shape of the storage hopper

## Flow angles

As with bulk density, there are three types of angles that interest the engineer: poured angle of repose, slide angle and drained angle. These measurements indicate whether or not the bulk solid will discharge easily from the receiver while also determining the size of the hopper needed to receive the required volume of material.

For the poured angle of repose a set volume of material is poured through a funnel onto a flat surface and the angle of the mound it forms is measured.

The slide angle is the extent to which the flat surface must be inclined before the material starts to move. The material is poured through a funnel onto a flat surface, which is then slowly inclined until the material begins to shift. After another few degrees the material flows smoothly off the inclined plane. This angle is used to determine how steep the sides of the receiver hopper must be to ensure complete material discharge.

In order to measure the drained angle, a clear container fitted with a slide gate at the bottom is filled with material. The slide gate is then opened, allowing some of the material to flow out of the container and the angle of repose of the material remaining in the container is measured. When measurements are taken and compared against the thousands of previous materials we have tested, it provides a very good indication of how the material will flow and behave.

## Particle distribution

In the next step, the material is sifted through several sieves with mesh openings ranging from 2mm down to 62 µm. Not only does this sieve analysis document the particle size distribution but also the behaviour of the particles within the sieve.

If the material begins to clog the sieve then this indicates that it has a tendency to be cohesive and influences the choice of filter design and filter media.

## Velocity

The preceding tests help us in designing the right hoppers, storage silos, and filters. Next we need some information about how the material will act when it is conveyed, as well as how much energy will be required for conveying. These tests include:

- Can velocity, the air speed below which material drops out of the air stream (measured in a vertical tube)
- Terminal velocity (measured in a vertical tube)
- Minimum conveying velocity at the pick-up point (measured in a horizontal tube)

LEFT: Testing for can velocity and terminal velocity are done in a vertical tube

In the first test an exact amount of bulk material is weighed and placed in a cup with a fine mesh bottom, which is then placed inside a vertical tube. Air is pulled up through the tube and the remaining sample is weighed. These steps are repeated at incrementally higher air velocities and compared to results of thousands of other samples to make a conclusion. For example, this provides the needed information to determine can velocity, which is the velocity at which dust will float vertically. This information is necessary information to determine size of a filter receiver or dust collector.

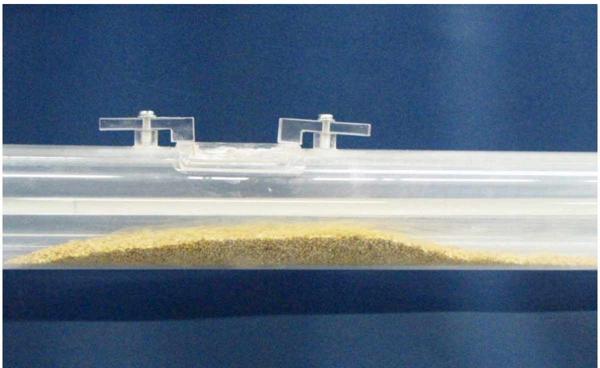
The second measurement tells us the minimum air velocity required to transport the bulk material through the vertical tube (terminal velocity). This value tells us something about the willingness of the bulk material to be conveyed and is a necessary parameter in sizing the conveying system. Terminal velocity is affected by the particle shape and size, as well the bulk density.

In order to determine the bulk velocity – the minimum air velocity needed to pick up bulk material, for example with a wand – a beaker of material is poured into a horizontal tube and the blower is turned on. For each air velocity setting, the time it takes for the bulk material to clear the length of the reference tube is noted. At the same time, the behaviour of the bulk solid is noted as it is picked up and conveyed through the tube. Visually the behaviour can be compared to an eroding sand dune, a comet tail or a solid mass. This test will also show if a material has the tendency to adhere to the conveying tube.

All these measurements and observations are important reference values in calculating the size of a conveying system.

## Abrasion

The final part of the Bench Test helps us determine how abrasive a material is. Test squares of aluminium, carbon steel and stainless steel are laid in three specially fitted test containers. A set amount of bulk material is then filled into each container. Compressed air is blown into each container. The test squares are then removed and tested for abrasion, and compared to many previous tests. The abrasion test is a good indicator of which material of construction should be used for the conveying equipment, however, the lifespan of the equipment in the field cannot be determined.



Minimum conveying velocity is determined in a horizontal test setup

## Conclusion

The Bench Test allows us to collect a maximum of information with a minimum of effort for most bulk solids. Key parameters needed for sizing the components of a conveying system can be determined with these simple tests.

It should be noted, however, that the Bench Test does not provide us with information as to the level of degradation a fragile material will experience during conveying or the effect of the conveying air on a hygroscopic material. With difficult to handle bulk materials 1:1 conveying tests are still the best way to ensure an optimal result.

As a project engineer I highly recommend the Bench Test. An hour of time and a relatively small sample of most bulk solids is enough to get a good picture of the material characteristics and conveying behaviour without having to rely on experience and estimation too heavily.

Over the last 20 years we have built up a database comprising data from over 17000 Bench Tests which can be accessed when designing new systems for known materials. Thus a relatively vague request such as "conveying system for free-flowing calcium carbonate" can become much more meaningful with just a few keystrokes.

For more information contact K-Tron on tel: 0161 209 4810 or visit: www.ktron.com