In-line/On-line bulk density measurement

Many granular and powdered products are manufactured to specifications which may directly or indirectly define some of their physical properties including particle size and bulk density. Changes in properties such as size distribution and bulk density can affect functionality, and can contribute to overfill or under fill problems on some packing off stations. Departure from specification can also be costly through loss of quality premiums, the cost of rework or in extreme cases, the cost of disposal.

Bulk density is a measure of how closely particles are packed together, and depends on the conditions under which the measurement is made, so can in principle, have an infinite number of values. There are, however, two limiting cases, readily taken under well-defined conditions which give measurements that are used for quality control and process control purposes. The first is the well known *tapped* bulk density, in which a sample of powder is consolidated, under standard conditions, in a proprietary machine before its density is calculated; for a large number of taps, the tapped bulk density approaches a constant and limiting value. The other is the *loose poured* bulk density in which a powder sample is released under standard conditions into a standard container, this time, with care being taken to avoid vibration or consolidation during the measurement. While *tapped* and *loose poured* bulk densities are easy to measure, the samples must be taken and the measurements made off line.

The instrument shown schematically in Figure 1 takes a continuous measurement of bulk density returning a value close to the loose poured bulk density. The operating principle is self evident from inspection. The angle of repose, shown as θ, is for practical purposes, constant, so the powder in the measuring cell occupies a defined and constant volume which can be measured or calculated. The weight of powder in the measuring cell is given continuously by the load cell, and this in conjunction with the cell volume gives bulk density. For many applications, an absolute measure of bulk density is not necessary. Our experience with various designs shows that the instrument is robust, and capable of excellent accuracy and reproducibility.

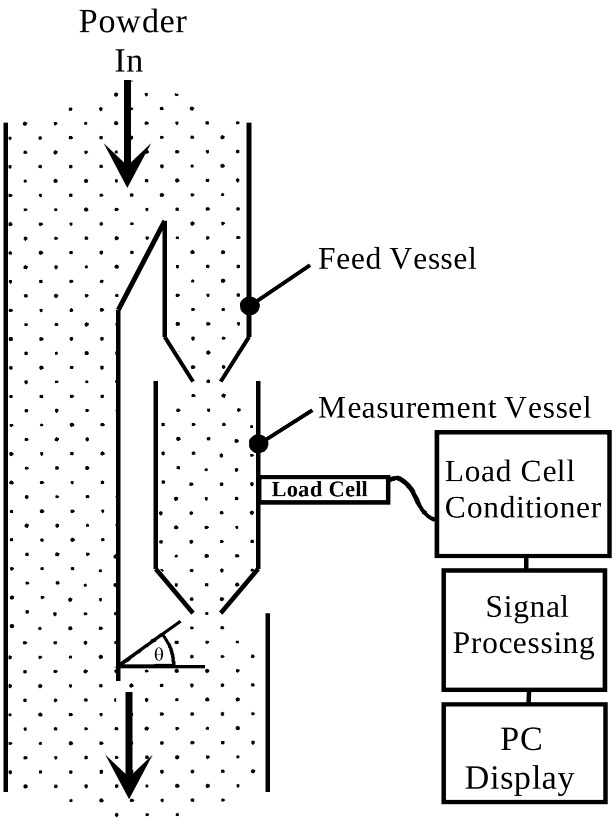

Figure 1. Schematic Diagram of Instrument for Measuring Bulk Density.

Figure 2 shows the bulk density of bread crumbs being discharged from

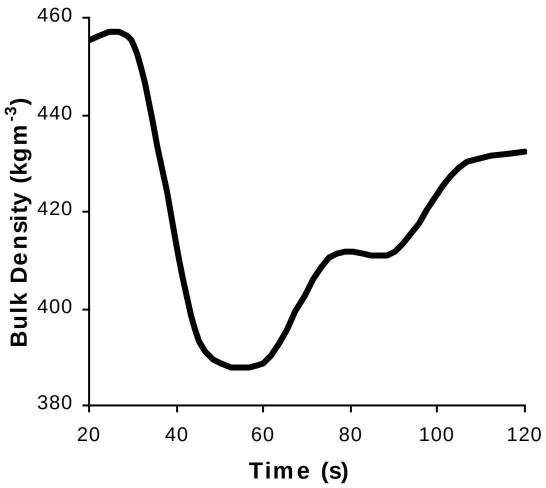

Figure 2. Discharge of breadcrumbs from a funnel flow hopper.

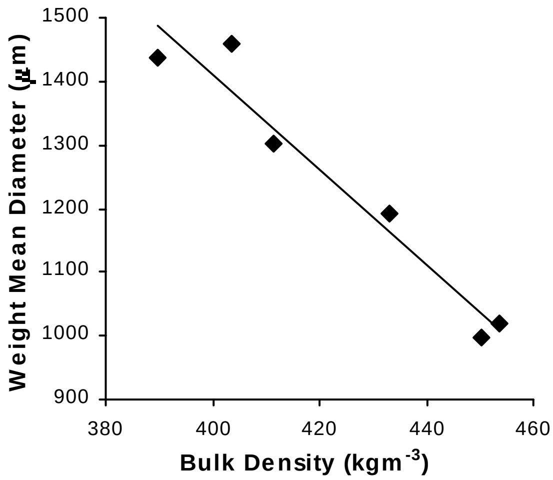

Figure 3. Variation of weight mean diameter with bulk density for breadcrumbs discharged from a funnel flow hopper.

a funnel flow hopper. The trace reflects the notorious segregation phenomena associated with the funnel flow discharge of a polydisperse material. Figure 3 is a plot of the weight mean diameter of the breadcrumbs, sampled during the discharge, plotted against bulk density.

Bulk density can be measured in-line, and for many applications, this simple instrument could have a useful role in process monitoring and control.

Professor Clive E. Davies
Institute of Technology and Engineering
Massey University
Private Bag 11 222
Palmerston North
New Zealand

C.Davies@massey.ac.nz
Phone ++ 64 6 356 9099 Extn 7436
Fax ++ 64 6 350 5604