FLOW BEHAVIOR OF MINERAL PARTICULATES THROUGH CONICAL SILOS.

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DECLARATION.

This dissertation had not been previously presented, in whole or part, to any University or Institution for a higher degree.

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ABSTRACT

Silo or Bin is used very widely in Mining, Processing, Pharmaceutical, Cement, Ceramics and Packaging industries. The purpose of the silo is to hold material until it is ready to use in subsequent processes such as processing, chemical, physical or transport. According to the Oxford Dictionary (DK illustrated), a Silo is a pit or airtight structure in which green crops are kept for fodder or it can be a pit or a tower for the storage of grains ,cement etc, or it is an underground storage chamber for guided missiles. The capacity of a silo may vary from Kgs. to Tons.

In this research, a silo is used as a conical shaped container with an orifice through which mineral sands of varying sizes were allowed to pass and their flow behavior were examined with respect to their material physical properties and silo parameters.

In the first stage of the project, the flow behavior was studied using beach mineral sands with glass funnels with orifice diameters 3.5, 4.8 and 8.0 mm and heights 8, 10 and 24cm respectively to simulate silos of varying orifice. The capillary part of the funnels were cut uniformly at the neck regions to prepare them for the tests.

It was decided to use naturally occurring geo-materials of different mineralogical, chemical, and physical characteristics for the investigation. For this purpose, samples of beach sand from several locations along the western coast of Sri Lanka were collected and sampled using the sampler riffler, thereafter sieved through 2mm sieve to remove sea shells and other extraneous impurities followed by spiral separation and tabling. Subsequently, magnetic separation and high tension separation were carried out to separate magnetic and non magnetic fractions according to the standard procedure. The fractions separated consisted of ilmenite, rutile, garnet and zircon. A sample of silica was also obtained from the glass sand deposit at Naththandiya.

Each sand sample was sifted using the standard test sieves. Before conducting the flow properties of these minerals they were dried at 110^{o}C for 2 hours and the test was conducted 3 times and the average flow rate obtained thus was plotted against the particle size and the

d/D ratio for each material. Where, d = average particle size diameter and, D = funnel orifice diameter.

Interpretation of flow rate measurements and analysis of data indicate that all beach mineral sands used in the study had the same flow rate pattern. The mass flow rate vs d/D curves consisted of three significant zones representing bridging effect, constant gradient zone with a negative gradient and the no-flow zone, which spilled over to the fine particle fractions.

The effects of charge particle nature, moisture contained, repose angle, surface morphology of mineral and the orifice diameter of the funnel on the flow properties were also investigated. As the particles studied were naturally occurring, they were sub-angular having rounded edges. Another series of experiments were conducted using spherically shaped silica gel particles having diameters 1.2, 2.2, and 3.3 mm respectively.

In the second stage, a pilot plant in the form of a conical silo was fabricated in the workshop and the experiments were conducted using mineral samples each sample weighed approximately 3 to 6 kg. The samples for the second stage was obtained from two sources, Lanka Mineral Sands Ltd and the river sand pits at Ingiriya. After a tedious process of size separation mostly involving sorting of particles of different size fractions by hand picking and sieving.

The results obtained agree very closely with those obtained using the glass funnels. It is evident that there are three zones in the performance curve -flow rate vs particle size with the bridging effect region corresponding to d/D ratios of ¼ to $^{1}/_{5}$ for relatively larger size particles and the region exhibiting the 'floc effect' resulting from residual charges in the fine sizes and air trapped within the flocs. The mineral particles used were pre-dried (dried at 110 ^{o}C for two hours).However, the presence of moisture in the powder seems to have a significant contribution on the flow rate.

The importance of the performance curve and its characteristic features have been discussed and also the relevance of the performance curve in designing silos.

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