THE RELEVANCE OF SURFACE IMPURITIES ON THE EFFECT OF TEMPERATURE ON POWDER FLOW BEHAVIOR

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Cohesive interparticle forces may have a relevant role in several industrial process operations involving particulate materials, such as fluidization, granulation and drying, as well as storage and solids handling units. Several of these operations require process conditions which involve high temperatures which, in turn, may affect the intensity of interparticle forces such as van der Waals, capillary and electrostatic forces. The mean by which the system temperature can affect all these forces is the change of particle hardness, the generation of liquid phases, which determines the formation of liquid bridges, and the modification of the particle dielectric properties. A direct measure of interparticle forces is possible but can be affected by large fluctuations and require a great number of repetitions. Interparticle forces, instead, play in averaged ensembles in bulk properties such as powder cohesion. It is of interest, therefore, to have the possibility to measure powder cohesion at the process temperature and to observe possible changes due to temperature variations to infer possible changes at the particle level. Powder shear testing is one of the available methods able to measure powder cohesion and it has the great advantage of measuring well established physical properties and of being able to produce highly repeatable results. It has to be remarked, however that to date no established procedure exists to relate powder cohesion measured at the bulk level to powder fluidization properties.

In this paper a systematic study on the effect of the process conditions on the fluidization quality of ceramic powders is presented. Tests were carried out on powders of industrial interests, characterized by different particle size distributions and by different amounts of surface impurities, ranging from easy-flowing to cohesive flow behaviour.Two different experimental facilities were used: a modified ring shear tester available at the University of Salerno and aX-ray high temperature fluidization facility available at University College of London. The first apparatus was used to characterize powder cohesion at different temperatures between ambient and 500°C. Experimental results have been interpreted in terms of possible changes in interparticle forces as a function of temperature. The powder samples without impurities show an increase of cohesion with temperature as a result of an increase of interparticle van der Waals forces. A larger increase of cohesion was observed in the case of the powder samples with chemical impurities. The behaviour can be explained only by considering a cooperative effect of both van der Waals and capillary forces. It is noteworthy that the amount of surface impurities that is able to determine significant changes of powder flow properties is still so small that no evidence of phase transition could be detected by means of sample thermal analysis.The same powders have been characterized in terms of fluidization quality by using the x-ray fluidization facility available at University College of London under the same temperature range.

Moreover the changes by temperature on the flow properties of the bulk solid evaluated with the shear cell and the behaviour of particles under fluidization conditions are analysed and discussed. Though a direct quantification of the particle-particle interactions in fluidized beds and of their changes under process conditions is very difficult, this paper suggests a method by which powder rheology can be used to indirectly evaluate the effects of the interparticle forces on fluidization.