The challenges of powder flow characterisation and simulation

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Abstract

As evidenced by frequent problems during storage, processing and final product quality – powders are challenging materials. They are bulk assemblies which consist of intricately diverse particles with varying quantities of entrained gases and liquids. These different constituent phases, as well as their interactions, may be highly sensitive to variations in the powder's stress and flow regime, as well as changes in environmental conditions. This complexity facilitates the industrial value of powders as they can be aerated to behave like fluids or compacted into solid tablets – however this also results in more challenging characterisation and simulation.

When developing characterisation and modelling techniques, it is also important to understand the processing environments to which the powder is going to be subjected to. It is not uncommon for the same powder to perform well in one process but poorly in another. Powders are employed across a diverse range of sectors, including the pharmaceutical, chemical, food, construction and Additive Manufacturing (AM) industries, to name a few. Each of these sectors has its own range of specialised unit operations, within which it is necessary to predict and control powder flowability. The complexity is evident as it is also essential to consider the objectives of the analyst. The characterisation may be utilised and interpreted differently across R&D, processing and Quality Control (QC) departments.

This presentation discusses the challenges associated with developing appropriate analytical and modelling techniques to fully characterise powders and predict their performance in specific unit operations, based on the intricacy of powders described above. Experimental characterisation techniques need to be representative of the process conditions to which the powder is subjected, whilst also maintaining low operator dependency and high reliability. Whereas modelling techniques need to simulate each powder and granular system as a multiphase continuum, whilst considering that flow behaviour is a function of both bulk material and individual particle properties.

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