Designing Granular Materials

Material Flow Solutions, Inc.

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In the powder handling industry, large granular particles are preferred due to the lack of cohesive flow problems. However, large particles have low surface area and, hence, limited chemical functionality. One solution to this particle design process quandary is to use an agglomeration process that creates a large porous particle from a series of small nanoparticles. Unfortunately, these engineered materials are generally both highly porous and friable, resulting in significant degradation during use. Whatever the reason, particle size degradation of particles is a problem in today's production facilities. Degradation produces fines that limit the life of catalysis in fluid bed operations. It causes fines production in pharmaceutical, nutraceutical and food products that subsequently segregate, resulting in quality problems. Particle size degradation causes consumer acceptance issues with many products from food to bath products. Degradation issues also lead to dust generation problems and environmental discharge concerns. Thus, measuring and understanding degradation is critical to help engineers and materials scientists design products that minimize these effects.

There are several key issues to developing a robust method to mitigate size degradation effects. Degradation is caused by different external influences. Placing material in a condition where it is exposed to large stresses and high strains can cause a reduction in particle size due to particle breakage under the stress/strain behavior. Impact can also result in particle breakage. Particle size degradation can be quantified by observing the shift in particles size after subjecting particles to a controlled impact condition or a controlled strain condition.

Conducting degradation tests at a controlled constant impact or stress/strain condition for various times generates a series of particle size distribution curves as a function of the time stress/strain are applied which can be used in conjunction with a technique called population balance modeling to determine the prominent breakage mechanisms. Examining the structure of the granular material also leads to what may be causing these mechanistic degradation effects. Often the primary particles are liberated from the particle matrix by an initial breakage event followed by abrasion, resulting in significant amounts of finer material. Strengthening the binding action between the original particles helps reduce particle size degradation of granulates. Thus, a population balance degradation study provides a powerful analysis tool for determining the modifications to the structure of the particles that will lead to a reduction in attrition – and successful product design.

At Material Flow Solutions Inc., we can provide you with a population balance model analysis of your product to aid with your product design – helping you "get it right the first time."

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