

Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Real-time particle dispersion from a DPI using image velocimetry – Evaluation of powder adhesion, impact, and collision

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ABSTRACT

Dry powder inhaler (DPI) is a dosage form for delivering fine drug powders to the respiratory tract. Particle size and size distribution, proportion of fines, particle shape, particle surface roughness, flow rate and adhesion force have been reported to affect the aerosolization process. Several mechanisms for particle dispersion in DPI have been considered; a proposed mechanism to explain the particle dispersion phenomenon is the active site theory. However, there have been several conflicting reports, therefore, an agglomeration/fracture hypothesis has been also proposed. Particle dispersion is associated with events such as impact, acceleration, shear stress, and turbulent flow. The aim of this study is to use high-speed video imaging to provide direct experimental observation of the particle dispersion process in order to unveil a mechanism for particle dispersion. Mixture of micronized lactose and coarse lactose carrier was placed in a model inhaler device, a high speed video imaging was used to capture the dry powder inhalation process. The flow pattern was found to be turbulent. Particles were observed to collide with one another, causing detachment of micronized particles from the surfaces of the coarse lactose particles. Impact of the powder agglomerates on the device grid also contributed to deaggregation and dispersion of the particles. The findings suggest that collision and impact are important mechanisms for the dispersion of DPI particles.