# UNIVERSITI TEKNOLOGI MARA

# DEVELOPMENT OF GAS-PRESSURIZED DISPERSIVE AND NON-DISPERSIVE IMPACT TECHNOLOGY FOR LACTOSE POWDER FLOW CHARACTERIZATION

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**PhD**

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# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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# ABSTRACT

The conventional powder flow testers require sample volumes larger than 40g and are met with experimental hiccups due to powder cohesion. In this study, gas-pressurized dispersive powder flow tester uses high velocity air to disaggregate powder (9 g) and eliminate its cohesion. The pressurized gas entrained solid particles leaving an orifice where the distance, surface area, width and weight of particle dispersion thereafter are determined as flow index. The flow indices of seven lactose grades with varying size, size distribution, shape, morphology, bulk and tapped densities characteristics were examined and compared against Hausner ratio (HR) and Carr's index (CI) which were chosen as standard parameters throughout this thesis. Both distance and surface area attributes of particle dispersion had significant negative correlations with HR and CI values of lactose and varied with powder physical characteristics. Further, this study re-invented gas-pressurized powder dispersibility tester (9 g) to accommodate a lower test sample mass (2 g). Powder contact surfaces with smooth, diffuse and dense asperities were designed as rough surface was foreseen to result in cohesive powder exhibiting poorer dispersibility thereby allowing differentiation from free-flowing powder. Using smooth-surface variant, the powder dispersive distance and in particularly surface area were correlatable to HR/CI to a greater extent with 2 g than 9 g load while dense asperities surface shows insignificant correlations with HR/CI as a result of powder shearing against the asperities into less aggregative particles which were not reflective of those in HR/CI tests. Due to large test space required in dispersive mode, impact chamber was established where the test powder bed was weight-impacted to produce impact crater and ejecta, and imaged quantitatively to produce parameters crater profiling signature, regional topography, Otsu threshold and edge segmentation. The crater signature profiling and regional topography were correlated to HR, CI, dispersive distance and surface area. A poorer powder flow was characterized by higher values of crater signature profiling, regional topography, HR, CI, and lower dispersive distance and surface area. The gas- pressurized dispersive and non-dispersive impact technology demonstrated comparable powder flow characterization performances to HR and CI methods using 2 g to 9 g of test sample. It enables the flow properties of powder with varying degrees of flowability to be characterized using a small sample size.

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# TABLE OF CONTENTS