

# De-agglomeration and bounce of the iron oxide agglomerates due to the impaction

M. Ihalainen<sup>1,2</sup>, T. Lind<sup>1</sup>, T. Torvela<sup>2</sup>, J. Ruusunen<sup>2</sup>, A. Lähde<sup>2</sup>, P. Tiitta<sup>2</sup> and J. Jokiniemi<sup>2,3</sup>

<sup>1</sup>PSI Paul Scherrer Institut, The Laboratory for Thermal-Hydraulics, CH-5232 Villigen PSI, Switzerland

<sup>2</sup>Fine Particle and Aerosol Technology Laboratory, Department of Environmental Science, University of Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland

<sup>3</sup>VTT Technical Research Centre of Finland, Fine Particles, P.O. Box 1602, 02044 VTT, Espoo, Finland

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Presenting author email: mika.ihalainen@uef.fi

The impaction behaviour of aerosol particles has applications in fields such as powder processing, nuclear safety, and health research. To be able to understand better how agglomerates adhere to surface, bounce, and de-agglomerate, both the de-agglomeration and bounce have to be monitored simultaneously. For this purpose a method to study impaction behaviour was developed described by Ihalainen *et al.* (2012). This method is applied here to evaluate the de-agglomeration and bounce of the iron oxides particles impacting at varying velocities onto impaction plate covered with aluminium foil.

Iron nanoparticle agglomerates with two different oxidation states were produced using an atmospheric pressure chemical vapour synthesis (APCVS) method (Lähde *et al.*, 2011). Iron pentacarbonyl was applied as a precursor material and two different oxidation conditions (0.05 v-% and 21 v-% of oxygen) were applied.

The impaction of the iron oxide agglomerates was studied with the following method (Ihalainen *et al.* 2012). The agglomerates were first size classified with a Differential Mobility Analyzer (DMA) to obtain monodisperse number size distribution of the agglomerates. Then the agglomerates were impacted onto an impaction plate located in a single stage Micro Uniform Deposit Impactor (MOUDI). On that impaction plate, there was also a Transmission Electron Microscope (TEM) grid for the offline analysis of the impacted particles. The bounced particles were collected into a low pressure sampling chamber located downstream of the MOUDI. Both a Scanning Mobility Particle Sizer (SMPS) and Transmission Electron Microscopy were used to analyze the bounced particles. Estimations for the mass concentrations before and after the impaction in aerosol phase were obtained using the SMPS data. An Aerosol Particle Mass (APM) analyzer was utilized in combination with the SMPS to evaluate the size dependent effective density of the agglomerates.

The geometric mean diameter (GMD) of the bounced particles showed similar trend in the both oxidizing cases (Fig. 1). At the lowest pressure difference over the jet plate of the impactor, the particle size was near 200 nm. As the pressure difference increased, which means that the impaction velocity will increase, the GMD value decreased to a value of about 100 nm in both cases. At higher pressure differences, i.e. higher impaction velocities, there was more kinetic energy available for the de-agglomeration thus leading to smaller fragment size.

The mass fraction of the de-agglomerated and bounced particles, are shown in Fig. 2. It describes the ratio of the mass concentration of the bounced and de-agglomerated particles to those before the impaction. It was found that the bounce fraction was the lowest at the slowest impaction velocities and the highest when the impaction velocity reached its maximum value. In addition, not all the particles de-agglomerated during the impaction process but some of the agglomerates bounced intact in both cases. On overall, the change in oxidation conditions did not affect significantly on the fragment size or mass fraction of the bounced particles. Further analysis will be carried out to characterize the properties of the particles, such as the primary particle size.

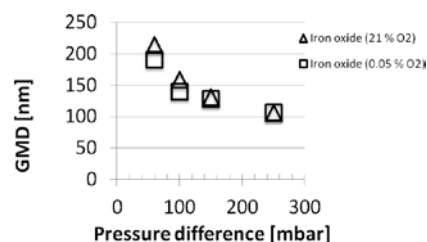


Figure 1. Geometric mean diameter (GMD) of the bounced particles measured with a SMPS.

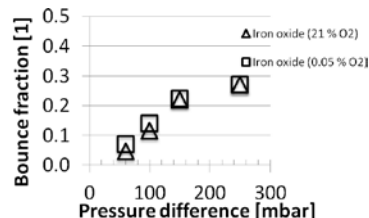


Figure 2. Mass based fraction of de-agglomerated and bounced particles.

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