EXPERIMENTAL STUDY IN INJECTION SYSTEM OF INDUCTIVELY COUPLED PLASMA TORCH FOR NANOPARTICLE PRODUCTION

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In this project, the powder feeder system, which was designed and produced at the VKI for nanoparticle production in a plasma torch, was studied experimentally. The aim of the study is to characterize the system in order to feed the precursor powder to the plasma torch with a narrow particle size distribution at a low and stable flow rate. Initial design of the powder feeder system consists of a cyclone in order to achieve a narrow particle size distribution and three fluidized beds to achieve low and stable flow rate. Throughout the study, each component of the powder feeder system was analyzed experimentally with various experimental techniques, i.e. backlighting and Phase Doppler Interferometry (PDI) methods for particle sizing, light extinction and weighing methods for flow rate measurements.

Flow rate measurements with light extinction method in the first fluidized bed revealed that it is possible to acquire stable and low flow rates with the current fluidized bed designs. In addition to that, it was found out that particles deposit in the horizontal conveyor line, which connects the first fluidized bed and the cyclone, due to insufficient superficial gas velocities and increases pressure drop through the line. A minimum carrier gas velocity, which is known as saltation velocity, should be satisfied in order to prevent deposition. According to PDI measurements performed at the exit of the cyclone, particles, which are already collected in the dust hopper of the cyclone, re-entrain into the flow due to intrusion of central vortex into the hopper at the highest inlet velocity case. In order to overcome this undesired condition, the design of the cyclone was modified. As one of major outcomes of the characterization process, it was found out that filter placed at the air outlet of the system creates a large pressure drop and prevents the proper operation of the system. As the last step, it was shown that particulate flow at the exit of the third fluidized bed has a pulsating characteristic due to high pressure difference between the fluidized bed and second conveyor line.

Based on the outcomes of the experiments performed with each component of the system, a novel design is proposed that ensures the proper and continuous operation of the system.

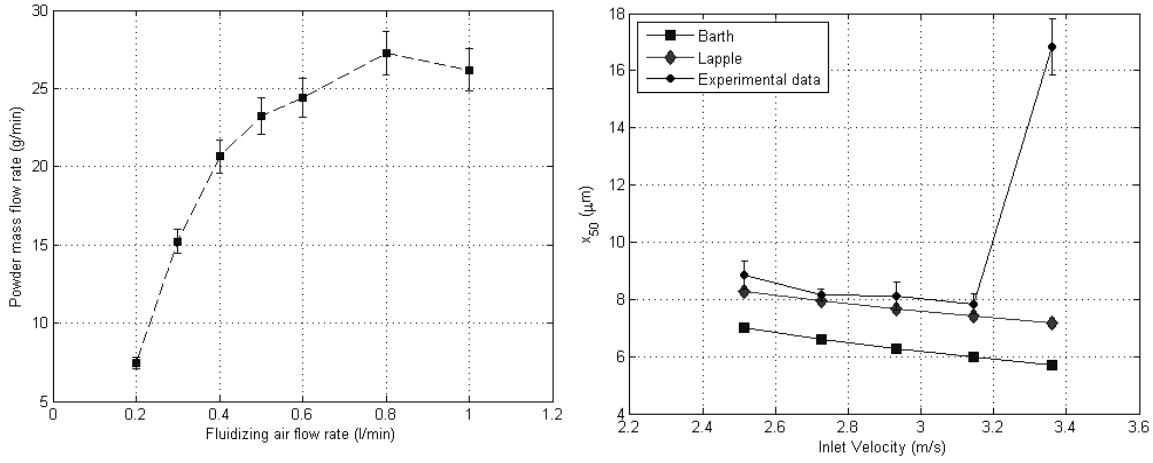

Figure 1: Powder mass flow rate at the exit of the fluidized bed (Left). Cyclone cut-off diameter: Comparison of experimental data and theoretical correlations (Right).