Design and Testing of a Low Rate Powder Feeder Prototype to Control Feed Rate of Microsized Spherical Particles for Powder Deposition Processes

Overview
The Penn State Applied Research Laboratory is currently working with United Technologies Research Center to develop a low rate powder feeder for the cold spray process. The goal of this project was to improve the current design of the system in order to develop a powder feeder prototype capable of uniformly feeding powder particles of sizes within the 1-5 micron range.

Objectives
The overall objective of this project was to improve the design of the current powder feeder to better produce uniform feeding of micro-sized particles. A fluidized bed was added to the current low rate powder feeder to improve the design and the team manufactured a working prototype to test the effectiveness of the design in accurately controlling the feed rate of the powder particles.

Approach
- Met the sponsor and understood the problem statement.
-Created a list of the required deliverables and objectives of the project.
- Conducted background research on the cold spray process and powder feeder.
- Conducted a patent and literature search to find a suitable method of agitation to reduce particle agglomeration and improve uniformity of feed rate.
- Generated three conceptual designs including the introduction of a fluidized bed, external mechanical vibration, and an update of current design.
  - Evaluated and selected the fluidized bed as the best solution based on customer needs and an analytical hierarchy process (AHP) matrix.
- Conducted theoretical analysis including flow rate and pressure drop calculations.
- Determined the optimum carrier gas flow rate to lie within 0.20 and 0.57 liters per minute.
- Determined powder particle exit velocities to lie within 400-1200 m/s based on varying powder diameters and incoming carrier gas flow rate.
- Developed technical specifications and technical drawings using SolidWorks for the piston, top cap, diffuser plates, bottom cap, stainless steel housing and exit feed tube.
- Manufactured the prototype, which included a 2 micron diffuser plate, 0.5” housing, a piston with 0.001” tolerance to the inside diameter of housing, and a 0.25” outlet tube.
- Created a final report including all experimental and analytical results of the prototype.

Outcomes
- The fluidized bed solution was theoretically determined to improve the uniformity of flow for micron-sized particles.
- The powder feeder will generate $29,688 profit per year based on an estimated 2 units sold per month with a unit profit of $1,237.
- Manufacturing and prototype development hours were reduced by approximately 20-30 hours as a result of this project.
- The prototype has significantly reduced the downtime needed to refill the powder after operation.