Characterization and Performance Evaluation of a Helium Recovery System Designed for Cold Spraying

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Cold spray is a solid-state coating process in which powder particles are accelerated to high speed by the drag force of a supersonic gas stream and directed toward a substrate where they plastically deform and adhere. To enable bonding, the particles must reach a material-dependant critical velocity. For a wide diversity of materials, high deposition efficiency and high quality coatings are obtained using pre-heated nitrogen as the propellant. Gas pre-heating provides higher particle velocity but also raises the risk of oxidation and/or nitridation which in turn can be detrimental for the design functionality of applied coatings. Other materials simply cannot be deposited with N2 because higher velocity is required. Helium provides therefore a solution to these issues since it is inert and allows reaching the highest particle velocity. Helium is however 10 times more expensive than nitrogen, making it economically unviable for many applications unless recycled.

This paper describes and evaluates the use of a Helium Recovery System (HRS) from the point of view of the system performance as well as of gain in coating properties. A flexible, automated, full scale HRS system has been designed and installed in the McGill Aerospace Material & Alloy Development Center Cold Spray Facility, located at and in collaboration with the National Research Council of Canada. The fully automated HRS has been designed to recover helium from the cold spray chamber with sufficient purity (>99%) and flow capacity (5 to 220 sm3/h), allowing for a cost-effective operation by insuring a recovery rate of above 85%. This paper presents the characterization of the HRS for cold spraying in diverse conditions and provides data on He consumption for some targeted applications. In addition, a few comparisons of coating properties obtained from samples produced with He and with N2 are presented.