New Design for CO2 Cold Spray Cooling System

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Abstract

The de Laval nozzles used in high pressure cold spray often clog when operating at a high applicator temperature. A cooling system was designed by throttling CO_2 to extract thermal energy from the nozzle to prevent or reduce clogging. Previous designs of the throttle achieved ambient temperatures of -77°C in the vicinity of the nozzle. This temperature is close to the sublimation point of carbon dioxide. Further analysis showed the importance of the convective heat transfer coefficient (h_o) on the outer wall of the nozzle as the critical variable. This work proposes a new throttle design aimed to maximize h_o. Analysis was carried out using ABAQUS to ensure structural integrity of the throttling system, essentially a pressure chamber, in containing liquid CO2 under the specified conditions without yielding. Computational fluid dynamics simulations were used to better understand the mass flow rate vs. diameter relationship of orifices used in the new design. Heat transfer into the carbon dioxide tanks may also be a factor in the rate of carbon dioxide flow. Comparison of run time (time-to-clog) between designs were made. The drawbacks of previous iterations are discussed, and changes are proposed. The quality of deposited material will be compared in future work.

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