The Effect of Pour Tube Tip Extension on Close-Coupled Gas Atomization Die Flow

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Abstract

Subtle changes in pour tube tip geometry, tip extension length, and gas pressure can significantly affect the performance of a close-coupled atomization system and the resulting powders. With characterization and control of these subtleties the powder yields and size distributions can be improved. A specially designed gas atomization die test bench was used to evaluate several parameters, including gas inlet pressure and aspiration (suction) pressure on a series of atomization tip extension lengths in commonly used gas dies at Ames Laboratory. By comparing the inlet and aspiration pressures, the die aspiration profile is created. The profiles for each die and tip extension were then evaluated for positive aspects, including when wake closure was achieved. Schlieren imaging and high speed videography were employed to visually observe and compare the effect of the tip length changes on the resulting gas flow patterns. Support from USDOE-EERE-AMO through Ames Laboratory under contract no. DE-AC02-07CH11358.

Introduction

The Ames Laboratory operates two close-coupled high pressure gas atomization systems. These atomizers are designed to produce both fine and coarse spherical metal powders (in the range of 5µ to 500µ diameter) of a wide array of different metals and alloys. [1] Generally the experimental scale atomizer can produce up to 5 kg of powder whereas the pilot scale system can produce up to 25 kg depending on the charge composition and density. These atomizers employ the technique of close-coupled gas atomization, where the stream of molten liquid metal is interrupted by a gas stream immediately upon exiting the melt containment crucible and pour nozzle. Figure 1 illustrates the basic atomization system and its components. Figure 2 shows an illustration of the atomization spray zone of a close-coupled atomization gas die. Figure 3 contains photographs of each of the atomizers. Each atomization system is contained in a stainless steel vacuum chamber. The metal charge is melted in a crucible by an induction heater. The crucible may be made of alumina (Al_2O_3), zirconia (ZrO_2), steel, or graphite. The crucible has a hole in the bottom through which a pour tube is inserted to drain the melt when the stopper rod is lifted. This pour tube guides the molten metal through the atomization gas die where the stream is broken up into droplets by high pressure gas in a close-coupled fashion.