Development of Atomiser Nozzle Design to Increase Yield

James Ashby
Liberty Powder Metals Ltd.
Middlesbrough, UK

Christopher Smith
Materials Processing Institute
Middlesbrough, UK

Abstract

In this work physical simulation and computation fluid dynamics (CFD) techniques have been employed to recreate the atomization pressure and flow characteristics experienced in and around the nozzle segment of a close coupled inert gas atomizer. Verification of the model is carried out using measurements taken during live manufacturing which includes monitoring of production variables using purpose-built measurement devices and characterization of the resulting powder. The objective of this work is to increase the degree of control over the as atomized powder yield by concentrating the particle size distribution of the powder manufactured within the -45+15µm fraction, as typically used in laser powder bed fusion type additive manufacturing. This objective is achieved through changes in machine operating parameters and revisions to the nozzle geometry. This work was completed as part of the DANDY (Development of Atomizer Nozzle Design to increase Yield) project in partnership with the Materials Processing Institute and Capital Refractories, funded by Innovate UK through the Sustainable Innovation Fund SBRI Phase 2 competition.

Introduction

Liberty Powder Metals Limited is a growing powder metal powder enterprise manufacturing steel, nickel-based, and cobalt-based alloys using vacuum induction melting inert gas atomisation (VIM-IGA). The primary applications for these metal powders are additive manufacturing (AM) technologies including Laser Powder Bed Fusion (L-PBF), Directed Energy Deposition (DED) / Hybrid Manufacturing, and Electron Beam Melting (EBM) among others.

Gas atomisation is the standard manufacturing route for the feedstock used in these technologies for most users, due to the high sphericity and good flow characteristics of the metal powder manufactured this way. However, the yield obtained within the particle size range suitable for use in L-PBF (typically -45+15µm or -53+20µm) is limited as the particles are produced in a wide distribution that is typically described by a gaussian distribution.

Although combining the usable powder fractions from a full powder distribution across the various AM technologies could potentially provide applications for 100% of the gas atomised powders (as described in Figure 1), the reality is that manufacturing and product specifications requested by end users do not often overlap. This means it is not often possible to manufacture powder from one atomisation run, or heat, suitable for each application. There is also a mismatch in market sizes; even if suitable supply chains were established where multiple products could be supplied from one atomising batch, effectively increasing the