Contribution ID: **9** Type: **Oral Presentation**

A comprehensive numerical modelling of Plasma Arc Melting (PAM) process and simulation of inclusions removal

Tuesday, 24 September 2024 11:10 (20 minutes)

Titanium alloys are increasingly used in aeronautical applications, a sector that requires highly controlled materials. In particular, inclusion cleanliness is a necessary and mandatory condition for safe use of aeronautical components. During the production and processing of titanium alloys, inclusions could appear, with two distinguishable types: low density inclusions (LDI) and high-density inclusions (HDI). LDIs result from the contamination of titanium by oxygen or nitrogen during production stages, while HDIs originate from refractory metals such as molybdenum or tungsten carbide.

Plasma Arc Melting Cold Hearth Remelting (PAMCHR) is one of the most effective recycling and refining process for titanium alloys. The furnace comprises three parts; a melting crucible where raw materials are loaded and melted, a refining crucible where the elimination of the inclusions must be completely, and finally, an ingot mold where the secondary ingot grows and solidifies. Firstly, this work reports the thermal modeling of the melting of raw materials in the melting crucible as well as a complete 3D numerical simulation of the thermo-hydrodynamic behavior of the metal flow in the PAMCHR furnace, based on the software Ansys-Fluent CFD. Simulation results are presented for a pilot furnace with a comparison between the measured and calculated pool profiles that shows a satisfactory agreement. Additionally, a numerical analysis of the residence time distribution (RTD) is presented. A RTD trial was carried out where a copper tracer is introduced into the feed material flow (Dirac function), and the profile of the mass fraction is measured in the secondary ingot. Perfectly stirred reactors (PSR) accurately model the flow in each of the crucibles of the pilot furnace. A Lagrangian calculation of particle trajectories in the liquid metal pool is also performed. The effects of critical parameters such as particle size, density, injection location and plasma torch trajectory on particle residence time are evaluated. The calculated rates of inclusions are then compared to an experimental injection in the pilot furnace.

Speaker Country

France

Primary author: AYADH, widad (Université de lorraine et IRT M2P)

Co-authors: Mrs BIAGI, Alessia (Aubert & Duval); Mrs CARDON, Amandine (Safran tech); Prof. BELLOT , Jean Pierre (Institut Jean Lamour - UMR CNRS 7198, LabEx DAMAS, Université de Lorraine); Mr KROLL-RABOTIN, Jean-Sebastien (Institut Jean Lamour - UMR CNRS 7198, LabEx DAMAS, Université de Lorraine); Mr DELFOSSE, Jerome (Safran tech); Mr MARIN, Raphael (IRT M2P); Mr HANS , Stephane (Aubert & Duval)

Presenter: AYADH, widad (Université de lorraine et IRT M2P)

Session Classification: Session 3

Track Classification: Modeling of Metallurgical Processes including Heat/Mass Flow Modeling of Liquid Metal and Solidification