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Complexity vs. Clarity: Modelling Effects of Lancing into Process Material Through Furnace Tap-Holes

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Pyrometallurgical furnaces are integral for extracting valuable metals from ores, operating at temperatures exceeding 1600◦C. These furnaces represent complex multiphase systems, posing significant challenges for direct industrial-scale study.

Multiphysics models provide critical insights into these complex behaviors, assisting furnace designers and operators in making informed decisions regarding design and operation.

In most furnaces, materials are charged, smelted, and accumulated, followed by a tapping process. The furnace features a 'tap-hole', a channel through the steel and brickwork, used for periodically opening and closing. The opening process involves lancing to remove refractory clay, akin to using a cutting torch. High temperatures are achieved by oxygen reacting with the steel lance. Once the lance penetrates the clay, unburned oxygen gas can enter the furnace, potentially impacting the molten material inside.

A multiphase fluid flow model was employed to study bulk flow inside the furnace, assessing the significance of lancing. Given the high-temperature processes and the compressibility of oxygen gas compared to other process materials (metal and slag), an evaluation of compressibility effects on the study's outcome is essential.

Using the compressible solver, which requires solving the energy equation, introduces the need for additional material properties as a function of temperature, leading to potential uncertainties. In this study, two solvers, multiphaseInterFoam and compressibleMultiphaseInterFoam from OpenFOAM v2212, were tested on a large-scale process. Typical meshes of around 3.2 million elements were used, necessitating high-performance computing hardware.

This paper presents a comparative analysis of the results and performance of the two solvers under various conditions.

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