Gas flow optimization in batch furnaces via CFD

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ABSTRACT

Computational fluid dynamics (CFD) is an engineering tool which uses numerical methods of applied mathematics to analyse fluid flows and in wide use for e.g. aircraft design, power generation, and automotive applications. Using flow simulations in powder injection moulding/sinter-based additive manufacturing batch furnaces, both the furnace design and the batch arrangement can be investigated.
In this paper, the current MIM/AM furnace concepts are examined with respect to their design, modifications are discussed and the geometry influence of the sintered parts on the flow behaviour in the retort is shown.

INTRODUCTION

In the production of PIM and sinter-based AM components, heat treatment procedures are demanding production steps that must not be underestimated in terms of error potential. Especially during debinding and sintering, uneven heat input and and heat distribution, often combined with insufficient or inappropriate gas flow lead to reject parts. The crucial factor for a "clean" furnace run is a gas flow in the retort that is as unobstructed as possible, ideally laminar and homogeneous. For this reason, batch furnaces are usually used for the treatment of these parts, which can be used both at atmospheric pressure and, above all, at partial pressure. The influence of the pressure on the flow behaviour has been sufficiently proven. While strong turbulence on and around the components is to be expected at atmospheric pressure (1000 mbar), partial pressure (200 mbar) leads to a significant improvement. In addition, a reduced pressure leads to a reduced debinding temperature, depending on the vapour pressure curve of the binder used. Another influence on the gas flow characteristics and consequently on the result of a debinding and sintering run is the arrangement of the gas inlet and outlet and the gas distribution in the retort. The aim should be to choose an arrangement that allows a direct, undisturbed flow of the gas. The third factor