Enhancing Cooling Efficiency Of UniVessel® SU 10 L Using Submodeling And Design Of Experiments

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Abstract

The investigation into the cooling performance of the UniVessel® SU 10 L was conducted through a series of studies utilizing Conjugate Heat Transfer and Heat Transfer in Solids, focusing on design iterations to optimize the cooling channel. The studies aimed to assess temperature distribution and stability of boundary conditions, specifically targeting the cooling of moist air exiting the system. This led to the development of a submodeling approach to enhance computational efficiency and accuracy. The submodeling concept allowed refined mesh resolution and parametric sweeps, examining factors such as inlet temperature, wall thickness, and cooling temperature distribution. Utilizing Design of Experiments (DoE) methods with MODDE®, a Sartorius DoE Software Solution, both full fractional and fractional designs (L27) were employed and compared to analyze the influence of various factors on the outlet temperature. The findings revealed significant correlations between these factors. This comprehensive approach enabled the identification of key influences on system behavior, providing a foundation for targeted design adjustments to achieve desired cooling performance. The integration of DoE methods with these heat transfer simulations facilitated a deeper understanding of the system, offering valuable insights for future design optimization.

Figures used in the abstract

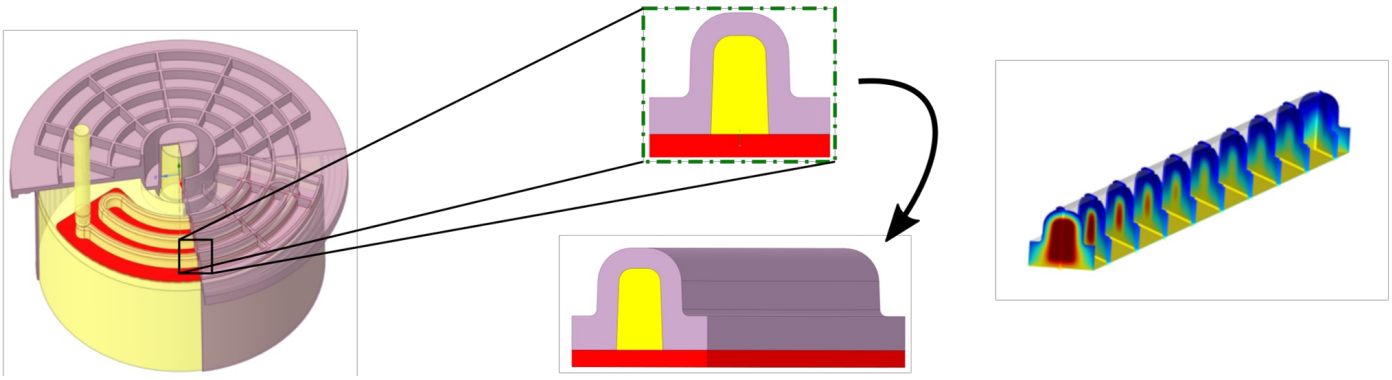

Figure 1 : Concept of Submodeling Applied to the Cooling Channel of the UniVessel® SU 10 L