World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Shrinkage Evaluation in a Stepped Wax Pattern – a Simulation Approach

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Abstract : In the process of precision investment casting of turbine hollow blade/vane components, a part of the dimensional deviations observed in the castings can be attributed to the wax pattern. In the process of injection moulding of wax to produce patterns, heated wax shrinks in size during cooling in the die, leading to a reduction in the dimensions of the pattern. Also, flow and thermal induced residual stresses result in shrinkage & warpage of the component after removal from the die, further adding to the deviations. Injection moulding parameters such as wax temperature, flow rate, packing pressure, etc. affect the flow and thermal behavior of the component and hence are directly responsible for the dimensional deviations. There is a need to precisely determine and control these deviations in order to achieve stringent dimensional accuracies imposed on these castings by aerospace standards. Simulation based approaches provide a platform to predict these dimensional deviations without resorting to elaborate experimentation. In the present paper, Moldex3D simulation package has been utilized to analyze the effect of variations in injection temperature, packing pressure and cooling time on the shrinkage behavior of a stepped pattern. Two types of waxes with different rheological properties have been included in the study to gauge the effect of change in wax on the dimensional deviations. A full factorial design of experiments has been configured with these parameters and results of analysis of variance have been presented.

Keywords : wax patterns, investment casting, pattern die/mould, wax injection, Moldex3D simulation
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020