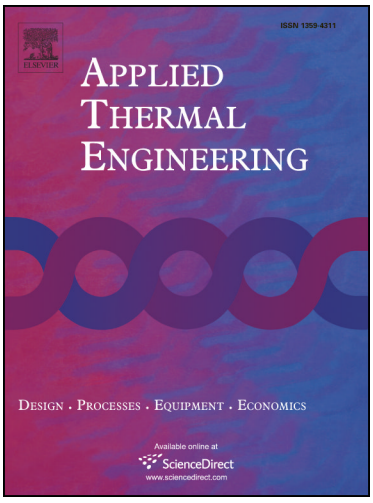

Application of genetic and simulated annealing algorithms for optimization of infrared heating stage in thermoforming process

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Application of genetic and simulated annealing algorithms for optimization of infrared heating stage in thermoforming process

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Abstract: In thermoforming, the shaping of the thermoplastics takes place essentially in two principals steps: infrared heating (IR) in an oven and then shaping the desired product using a mold of given geometry. The quality of the molded product depends directly on the temperature distribution in the material during infrared heating and indirectly on the temperature and optical properties of the radiant zones. To ensure that the energy flux intercepted by the thermoplastic sheet is uniform, we propose the application of two meta-heuristic algorithms MA (Simulated annealing algorithm) and GA (Genetic algorithms) to detect, from a fixed and random set of temperatures of the radiant zones of oven, the best temperatures that must be assigned to the heating zones. For numerical heating analysis, the nonlinear heat conduction problem is solved by a specific 3D volumetric enthalpy-based finite element method. The view factor is estimated by a semi-analytical method. An example of optimization of the heating stage of the high-density polyethylene (HDPE) grade sheet is presented.

KEYWORDS: Simulated annealing; genetic algorithm; optimisation; infrared heating; finite element; thermoforming.

1. INTRODUCTION

The shaping processes of the thermoplastic parts are numerous and very complex. For thermoforming, the quality of a part depends on several variables such as: properties of the sheet (thermo-physical and thermo-mechanical), heating time, deformation mechanism and residence time in the mold cavity (solidification) [1-3]. The prediction of thickness and residual stress distributions induced in the thermoformed part requires robust modeling of energy, momentum equations and fluid-structure interaction between the air and the viscoelastic plastic sheet [3-5]. However, for the