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Effects of Waveguide Position on Electric Field and Temperature Profile in Natural Rubber Gloves during Vulcanization Process Using Microwave Energy

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Abstract. Natural rubber gloves (NRG) become broader industry with the fierce competition and demands. The vulcanization process is the most important and takes the longest time in the cycle time of NRG manufacturing process, so it becomes of paramount importance to improve this process. The purpose of this research is to experimentally and computationally study the characteristics of the electric field and temperature profile in NRG during microwave vulcanization process. The effects of waveguide position placement are investigated for nine different positions. The experiment of NRG microwave vulcanization is performed for temperature distribution measurement. Three-dimensional models of NRG and microwave oven are considered. A mathematic model of the transient Maxwell's equation coupled with the transient heat transfer equation is solved using the finite element method (FEM) to determine the electric filed and temperature profile via computer simulation. The computer simulation results are validated against the experimental results. The validation confirms that the computational model is able to represent the practical transport phenomena in NRG with high accuracy. The outcomes clearly reveal that the waveguide position effects on electric field as well as temperature profile in NRG during microwave vulcanization process. The positioning of waveguides on both the front and back sides on the opposite side of the microwave oven provides higher intensity electric field and higher temperature profile than the positioning of waveguides in the middle of both the front and the back sides of the microwave oven. In addition, the middle back side is the appropriate position for waveguide in which NRG is uniformly dry and not burnt or overheated. However, it is found that there is no direct relationship between electric field and temperature changes. This research guides to essential aspects of the design of NRG vulcanization to improve the efficiency of microwave and heat delivering along with a basic of other heating systems to heat any sorts of material.