Infrared Radiation applied to Blow Molding and thermoforming

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Abstract:

The infrared heating of polymers is often a crucial step during Injection-Stretch Blow Molding (ISBM) or thermoforming processes, because radiative heat transfer can be very efficient in comparison to conductive or convective heat transfer. Indeed, the thermal conductivity of polymers is really low ($0.1 \leq k \leq 0.6$ W/m/K) and consequently optimising the heating and/or cooling steps remains a challenge. The results presented are based on intensive research work, conducted at the ICA Institute over the past ten years.

After a brief introduction, the authors expose basic concepts dealing with radiative properties and more particularly infrared. The main radiative properties (emissivity, reflectivity, absorptivity …) both for emitters and polymers are measured and analysed. In addition, different methods to determine relevant parameters such as filament lamps temperature are detailed. The development of accurate surface temperature measurements using infrared camera is subsequently described. This powerful non-contact measurement device can also be applied for estimating heat transfer coefficient.

The infrared heating modelling of polymer preforms (tube-shape or sheet-shape), typically used in ISBM or thermoforming processes, is then presented. For many thermoplastic polymers, the assumptions of cold and non-scattering medium allow to simplify the Radiative Transfer Equation. Using previous assumptions for radiation modelling, the Beer-Lambert law together with the ray tracing method is suitable to simulate heating of semi-transparent polymers. Different results will be then presented, dealing with ISBM or thermoforming processes.