Thermal Analysis of a Glassblowing Furnace

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Abstract:

Glassblowers are skilled artisanal craftsman who utilize high temperature furnaces as tools to generate malleable molten glass which is crafted into a desired final product. The furnace is a critical component to their job whose purpose deals with the heating, tempering, and cooling of artistic pieces. This study analyzes such a furnace by applying heat transfer concepts to model the thermal behavior and calculate energy consumption of the furnace based on different material characteristics. In coordination with the Green Energy Park in Dillsboro, NC, we obtained practical data based on the observation of their furnaces. Thermal resistance modeling was used to estimate the rate that heat is lost from a hot furnace. We considered two models, a flat plate model and a cylinder model. Each model has three layers, the first being refractory brick, the second being ceramic fiber insulation, and the third being solid metal plate. We considered methane consumption as a power source. This allows us to relate the energy lost by the furnace to the burning of methane. When modeled as a cylinder, the rate of heat transfer through the wall of the furnace was calculated to be 2.41kW. For the furnace to maintain this temperature 2.41kJ of energy must be supplied every second. Using the specific energy of methane, we found this to be equivalent to the power generated by 0.014 cubic feet per minute (CFM) from the burning of methane gas. The heat transfer rates of the flat plate and cylindrical models differ due to each layer's geometry. These models only consider the sides of the furnace without the top. Once the top is modeled, the estimated heat loss will increase. The top will be modeled using the thermal resistance method also. These results may enable the creation of better performing furnaces in the future.