Optimising furnace heat transfer

Lovells Springs is in its 80th year of business as a manufacturer and supplier of premium quality springs and suspension components to suit a broad range of applications for the automotive, agriculture, mining and railway industries.

The process of spring manufacture involves many stages, including oil quenching and tempering, shot penning and powder coating.

The most costly process of spring making is heating the steel. This process involves moving a fixed length of steel bars/rods (about 11-23 mm in radius) on refractory blocks into a furnace of approximately 1,000 C. These furnaces are custom built and are the heart of the operation. The heating and tempering furnaces are electronically controlled to precise temperatures which is the key to the production process. Once heated, the springs are made by hot coiling the steel rods.

Lovells would like to understand and optimise their furnaces. Currently, they do not have any mathematical models of the process and they believe that a mathematical model could make significant improvements, especially in the design of a new furnace.

In particular, Lovells would like to develop mathematical models to achieve the following

- To assist in a new design of a furnace that allows the use of the waste/radiance heat which is exhausting from the furnace to heat the metal bars as they are moving into the furnace. Some of the questions Lovells would like to answer include the optimal distance between each bar as a function of bar size and the optimal length of the furnace roof attached to the main heating chamber that enables the waste/radiance heat to flow and to heat the bars before their entering the main heating component of the furnace.

- Lovells would also like to optimise their entire process of heating the steel. For this purpose, they require a model for the rate of heating of the bars, when they are heated by radiant heating in one part of the furnace and by convective heating in another. This will allow further optimisation of the process.