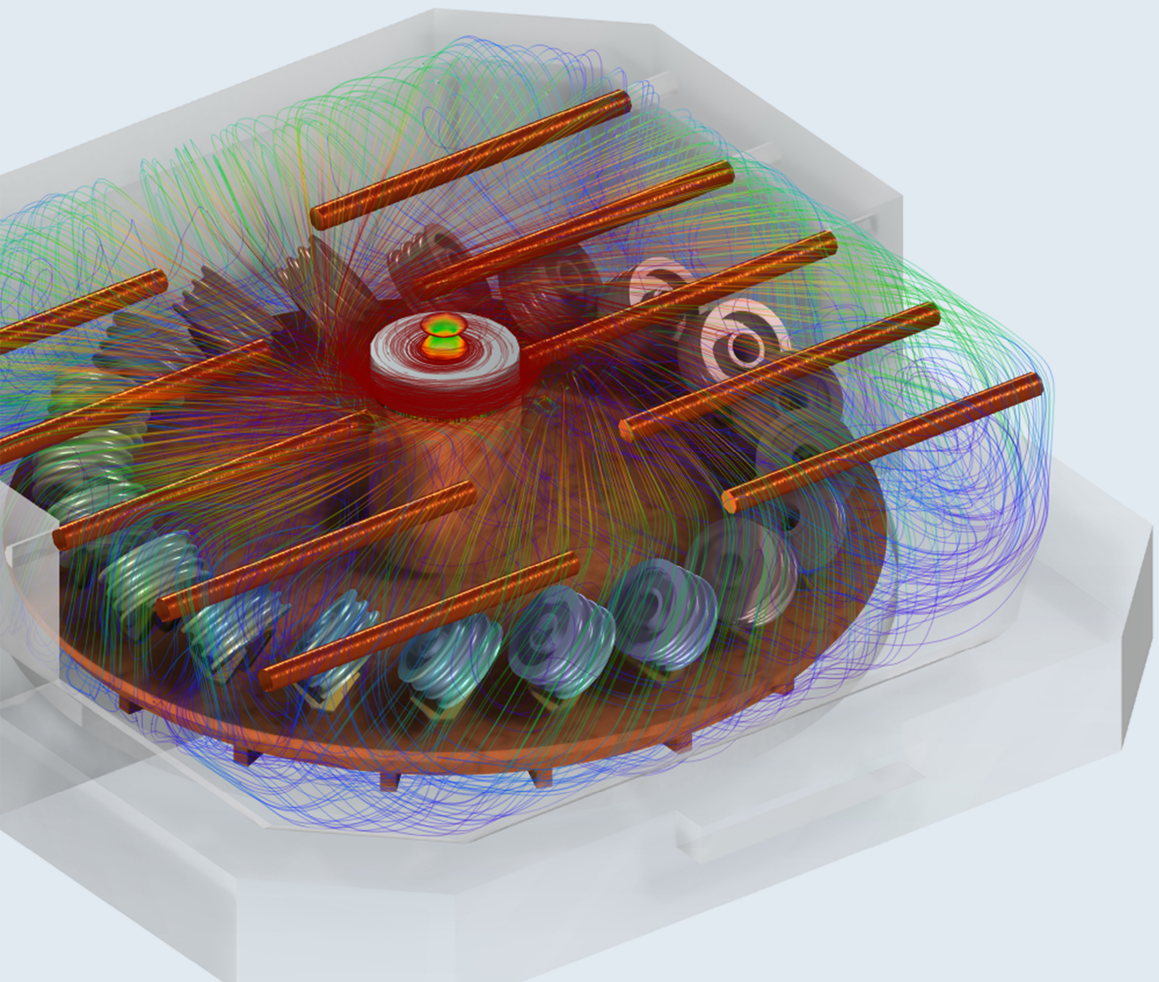

Using of General Extrusion Operator in Heat Transfer Applications

Simulate a rotatory furnace for heat treatments by applying a method not involving moving mesh

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Introduction

Heat transfer in **continuous furnaces** is a topic of high interest in several industrial fields, such as glass production, food industry and metal treatment. **Movement of the pieces** is often needed in continuous production lines. At a chosen instant, the product **thermal level** depends by the **residence time** already spent inside the furnace.

Numerical models based on a **moving mesh** approach can be applied to simulate thermal transient, but often it involves in **heavy models** to manage, and it is not always achievable in **complex industrial applications**. An innovative method based on the use of the **general extrusion operators** is used to archive this result.

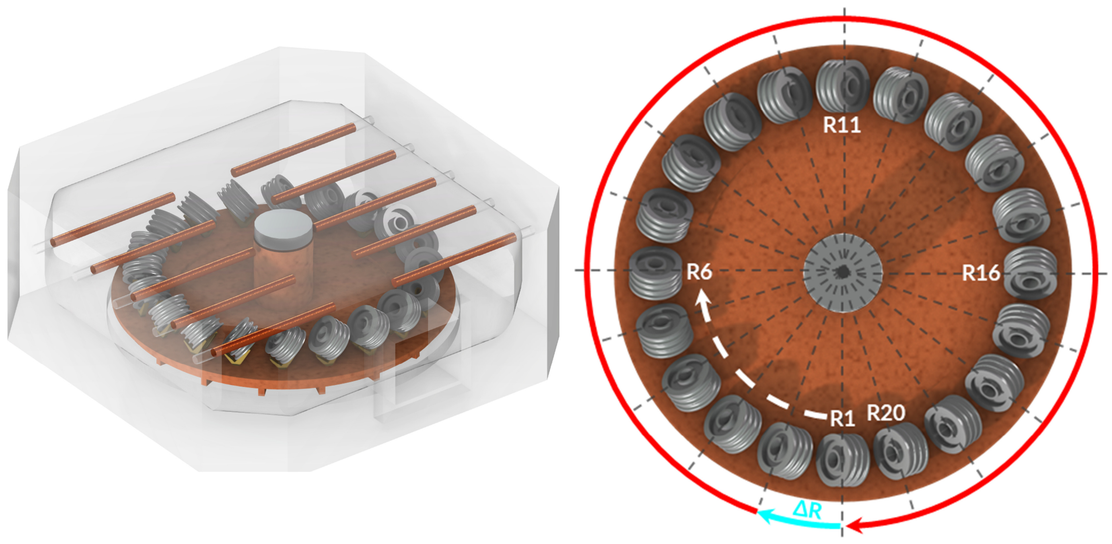

FIGURE 1. Geometry of the system (LEFT) and schematic representation of the pieces advancement (RIGHT).

Methods

Temperature solved in each pulley at the end of a transient study (pulley source, P_s) is **projected** as initial condition to the next (pulley destination, P_d) by a **general extrusion operator**, according to the following matrix rotation:

$$\boldsymbol{T}: P_s \rightarrow P_d \qquad \begin{cases} x_t = x\cos(\varphi) - y\,sin(\varphi) \\ y_t = x\sin(\varphi) - y\,cos(\varphi) \end{cases}$$

N-steps of initialization and 2N-steps of maintenance are solved to obtain a **permanent** "snapshot" of the temperature state inside the **furnace**.

Results

Figure 2 reports **thermal maps** of the pulleys in a **permanent operating condition** of the furnace.

Each pulley entering the oven (bottom part) appears cold. By "rotating" clockwise, **pulleys gradually heat up** until they achieve their expected heating conditions.

Results well show as the applied method allows to consider **heating due to the residence time** already spent by **each piece** at **each position** inside the furnace over time.

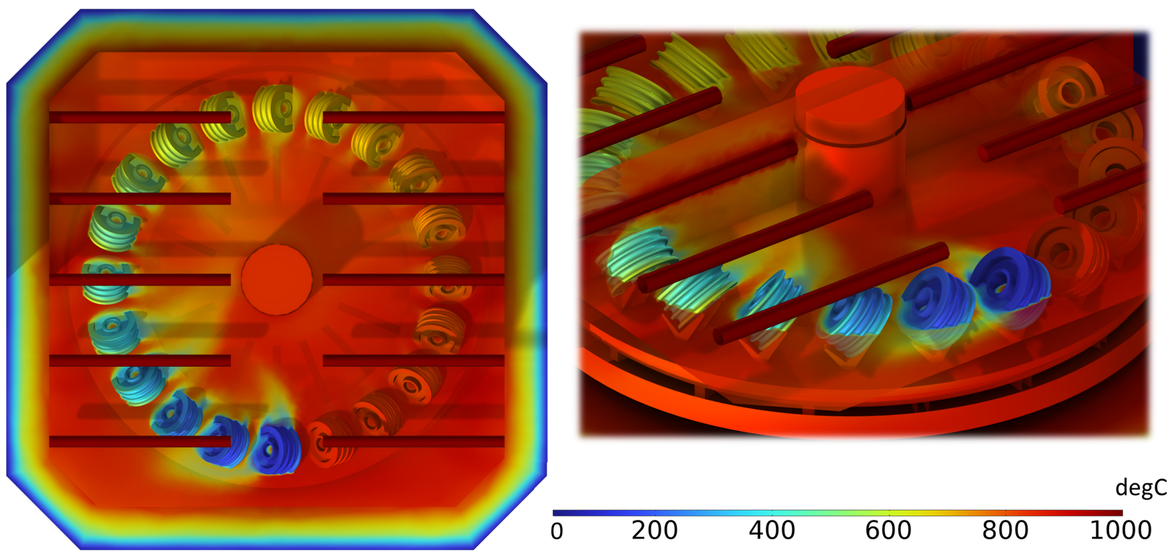

FIGURE 2. Thermal maps on "rotating" pieces inside the furnace.

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