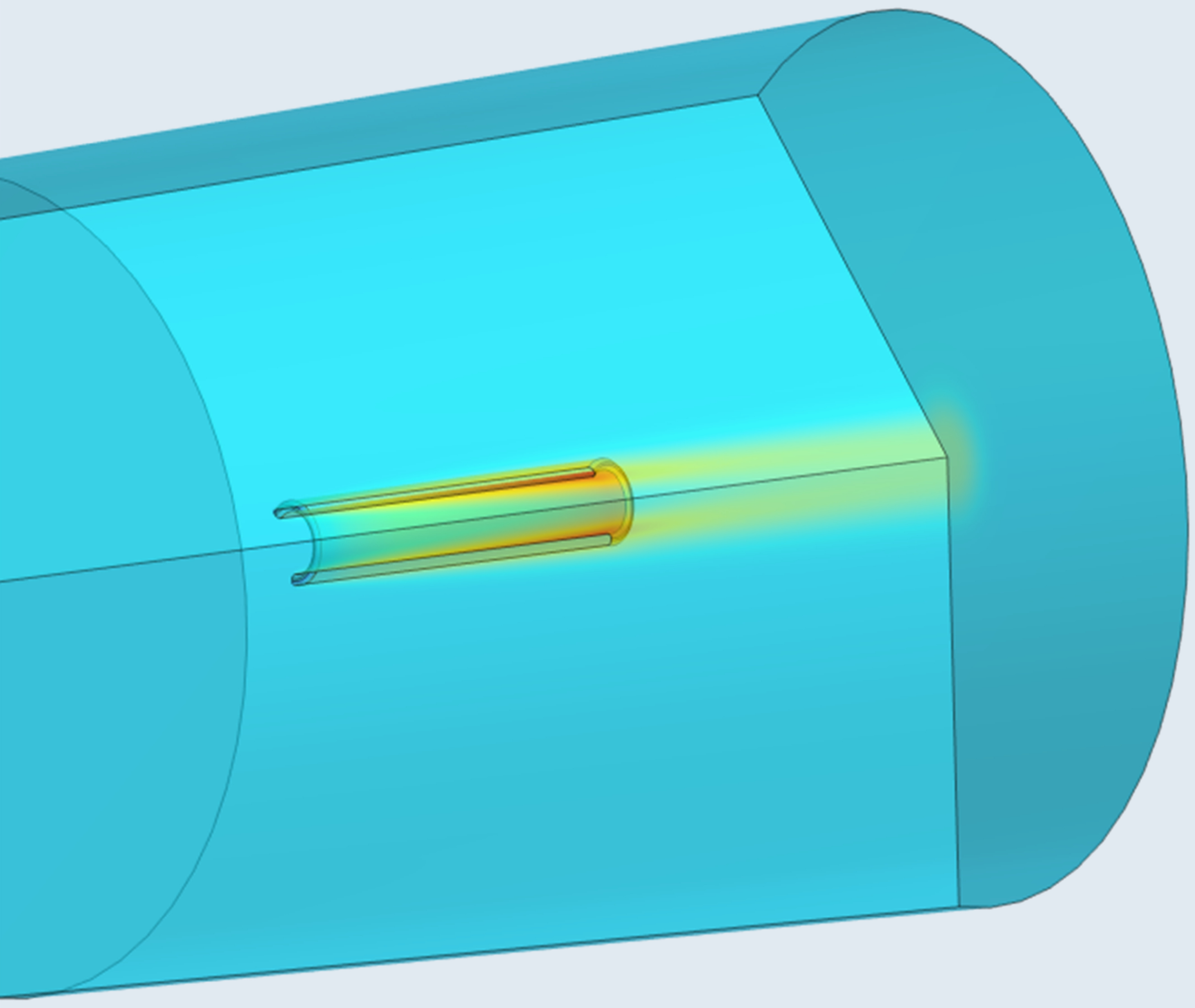

Analysis of Pasta Drying Synchronous Transport Phenomena

The development of a physical mathematical model able to predict the temperature and water content fields within a pasta sample during industrial drying is crucial to assess the optimal operating conditions.

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Abstract

In pasta drying, the process of trials needed to identify the optimal operating parameters to obtain a constant and high-quality product is often time and energy consuming. The process of forced convection consists of several phases with typical air temperatures in the range of 40°C -95°C and relative humidity between 40% and 85%. Air velocity varies from 1.5 m/s to 10 m/s. The drying time depends on these parameters and can last up to 20 hours. [1,2]

The aim of this work is to assess the best drying conditions by developing a physical-mathematical model capable of predicting the temperature and water content fields within a pasta sample which is exposed to a stream of drying air flowing under turbulent conditions. The model also implements the glass transition of the pasta sample, which induces important changes in its mechanical, rheological and transport properties[3].

FIGURE 1. Short pasta descends onto a conveyor system designed to transport the product trough a drying process that involves the use of hot and moist air.

Methodology

In a time-dependent simulation, the equations for energy, momentum, and mass balance are solved, considering the physical properties of both the air and the sample. These properties are modeled as functions of local temperature and humidity values, along with the inclusion of the product's glass transition using Kwei's model.

The model disregards the use of heat and mass transport coefficients at the sample-air interface by solving the transport equations coupling the two domains: a set of boundary conditions based on the explication of temperature continuity at the interface of heat and max fluxes are used[4].

Results

When exposed to hot air, the solid material undergoes varying rates of temperature increase in different regions. Specifically, the outer and upper portions heat up more quickly, while the inner regions maintain a lower temperature.

The outermost regions of the sample, directly exposed to the drying air stream, display a lower moisture content that gradually rises towards the inner layers.

The solid's glass transition involves a transformation in its state, starting from the interface and extending through its internal regions. This transformation leads to a decrease in the drying rate compared to the same system when the glass transition is not introduced.

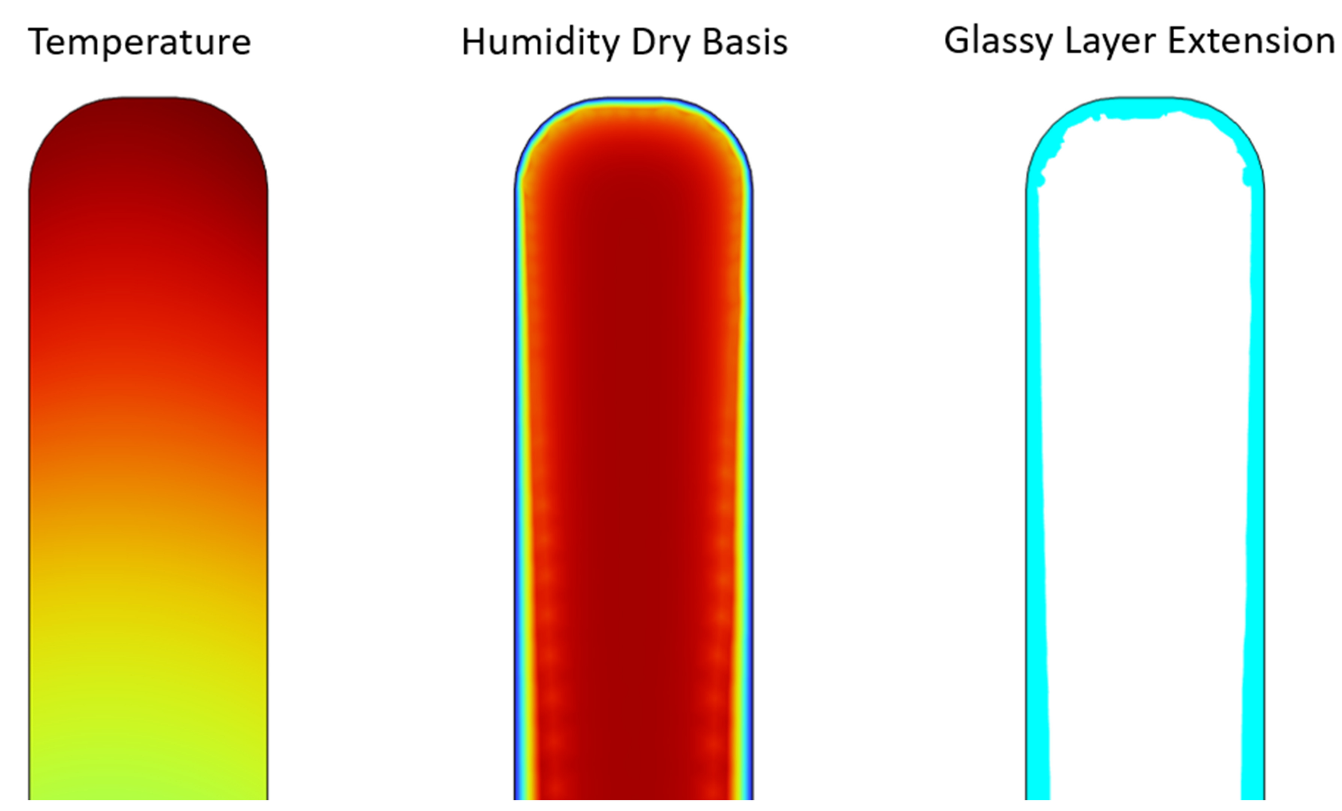

FIGURE 2. Left to right: half section of temperature distribution, moisture content distribution and extension of the glassy state within the sample.

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