

# A COMSOL® App to Analyze Bacteria Lethality During Sterilization Processes

Use of the Application Builder to create a flexible simulation tool dedicated to food safety

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## Abstract

This study aims to numerically investigate the effectiveness of heat penetration inside canned food during sterilization, with the goal of evaluating bacterial lethality. The proposed COMSOL® app allows end-users to easily carry out this analysis.

Three-dimensional geometries of generic container shapes can be automatically loaded into the simulation environment, along with various types of food products and specific reference thermal treatments. In cases where reference data for the

thermophysical properties of a specific product are unavailable, these can be automatically calculated by entering the percentages of its basic nutritional components (carbohydrates, proteins, fats, fibers, and ash).

The retort temperature profile over time can be imported from experimental reference data or defined in a simplified manner by specifying the temperature and duration of the heating ramp, the thermal plateau phase, and the final cooling.

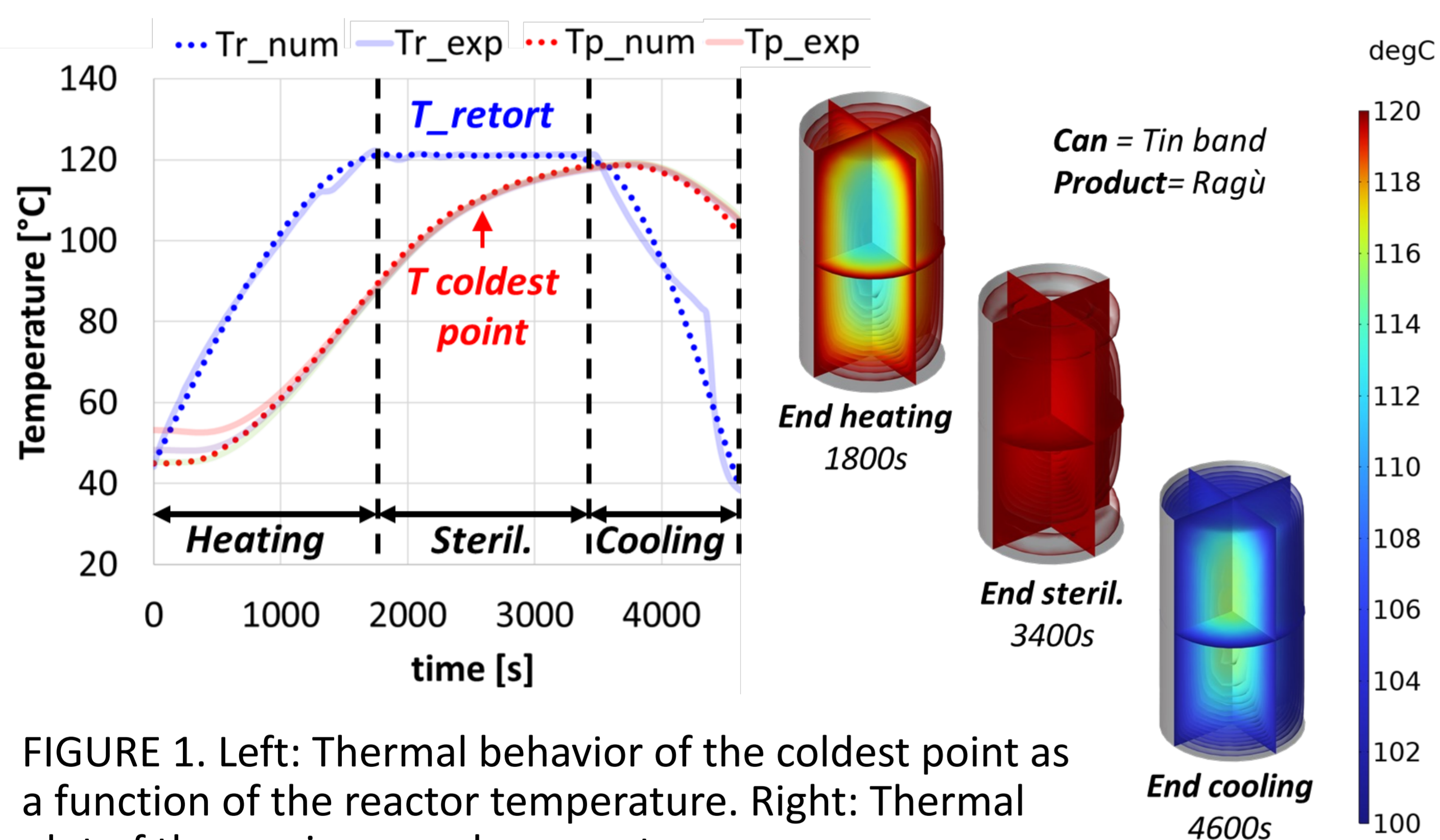


FIGURE 1. Left: Thermal behavior of the coldest point as a function of the reactor temperature. Right: Thermal plot of the can in several moment.

## Methods

A fully-parametric and experimentally validated model is used to create a COMSOL® app (executable stand-alone user interface). Many features have been implemented to automate the following tasks:

- **Geometry:** Searching /importing/positioning (file import, input field, data display),
- **Physical properties:** food and package selection from libraries (combo box, choice list, methods),
- **Heat treatment:** thermal and handling cycle (static, oscillating, orbiting) for the product (import, methods)
- **Interface management:** main window content (graphics, forms, ribbon, buttons, splash).

## Results

Temperature is solved over time during the transient analysis.

The main quality indices of the sterilization process are made available to the user through automatic post-processing actions (**bacterial lethality index “F<sub>0</sub>”**, **heat penetration factor “f<sub>h</sub>”** and **lag factor “J<sub>c</sub>”**).

Summary reports can be produced in an editable format at the end of the simulation.

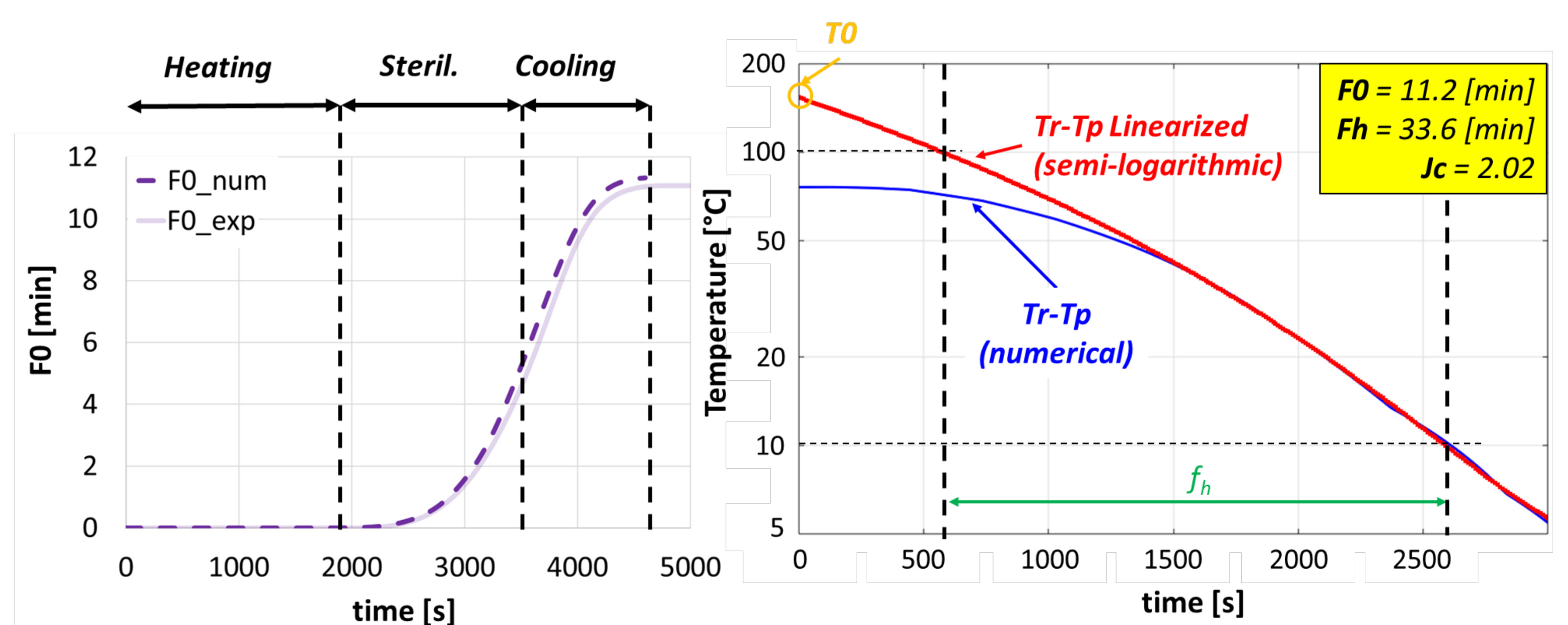


FIGURE 2. Left: Lethality index plot of the thermal cycle. Right: Calculation of the f<sub>h</sub> and j<sub>c</sub> indices by linearization of the curve “T<sub>r</sub>-T<sub>p</sub>” (difference between the reactor temperature and the coldest point temperature).

## REFERENCES

1. COMSOL, API User's Guide.
2. 2006 ASHRAE Handbook, Refrigeration, Ch. 9 - Thermal properties of food.
3. 2007 Handbook of food engineering, Ch. 11, Taylor and Francis Group.

