Virtual Prototype Evolution By COMSOL Multiphysics® of a Continuous Flow ABP Ohmic Sterilization Unit

R. Heslop[1]

[1]C-Tech Innovation Ltd., Capenhurst, Cheshire, UK

Abstract

Ohmic heating (Joule heating) is a volumetric heating technology which can effectively process almost any pumpable fluid with extremely high energy efficiency (>95%). This is particularly useful for very thick fluids, those that burn on to hot surfaces and those with high solids content which would cause difficulties for conventional heating techniques. Processing of animal by-products (ABP) faces all these challenges. The material must be heat treated to make it safe, a process which normally takes hours.

C-Tech Innovation have previously reported their innovative and efficient continuous sterilization method incorporating high temperature Ohmic heating technology for this purpose. By means of COMSOL Multiphysics® we were able to demonstrate the validity of the fundamental design (Figure 1), whilst highlighting avenues of design evolution.

The resulting temperature within a constant flow Ohmic heater is dependent on complex interplay of fluid flow, electromagnetic heating and heat conduction, each of which are intrinsically linked to the physical properties of the material being heated. By using the COMSOL Multiphysics® capability for combining the physics modules of fluid flow, Joule heating and heat conduction we were able to successfully show the capability to reduce pipeline length between the heater sections and also to obtain a measure of how far the pipeline lengths could be intelligently reduced. On this basis, the original serpentine (meandering) design of the preliminary prototype has been evolved to one of heater sections in straight line and with significantly reduced connecting pipelines between the heaters (Figure 2). This design evolution has significantly reduced complexity, cost and maintenance requirements of the system.

By the use of fine adjustment of the voltages applied at each heater electrode, beginning with the first electrode and moving downstream through the system, we were able to reduce the maximal surface temperature reached in the system, which had previously been excessively high in the preliminary design. In this part of the evolution we were able to make successful use of the parametric sweep analysis capability of COMSOL Multiphysics® whereby, the voltage applied at a respective heater electrode was incrementally increased, and the resulting temperature associated with each voltage setting, calculated in that heater vicinity (Figure 3).

The success of the virtual prototype evolution investigation now reported has enabled a successful build of the system on site at C-Tech Innovation, Capenhurst, UK, which now has the capability to provide experimental data which can be used to provide direct correlative comparison with the theoretical data of the COMSOL Multiphysics® model.

Figures used in the abstract

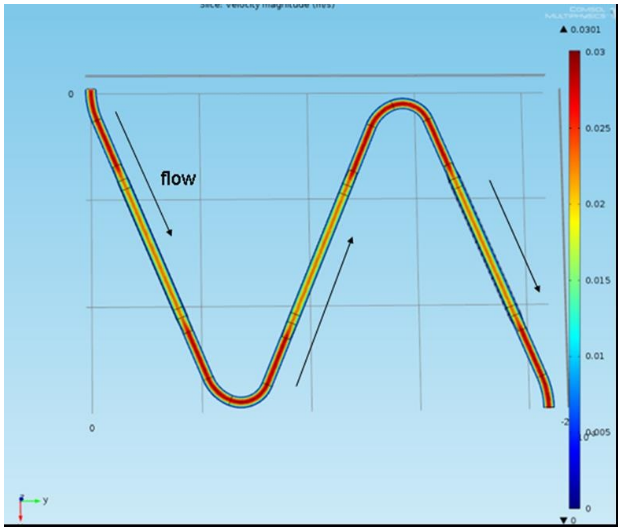

Figure 1: Preliminary prototype design

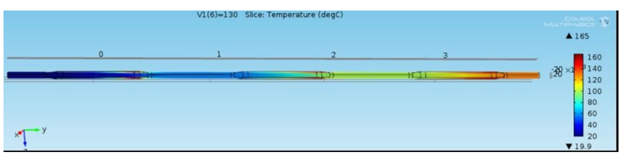

Figure 2: Steady state temperature distribution

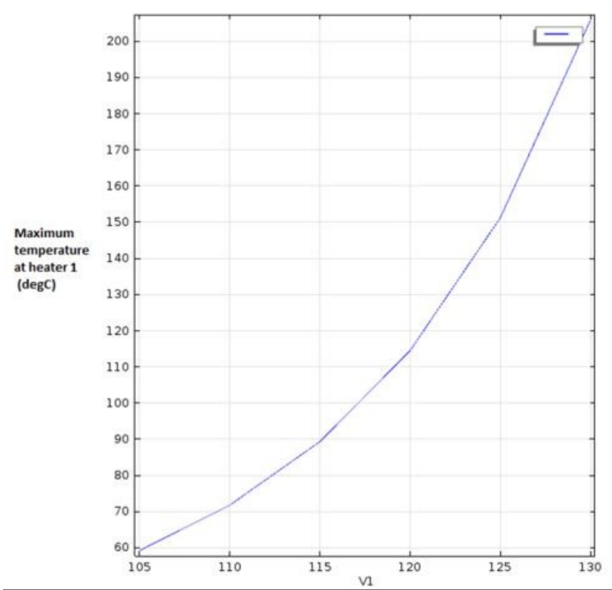

Figure 3: Dependence of maximum surface temperature on heater voltage