Modeling of Energy Efficient Continuous Sterilisation of ABP From Food Wastes

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Abstract

Introduction
Ohmic 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 has develop an innovative and efficient continuous sterilisation system (Figure 1) incorporating high temperature ohmic heating technology which can perform the duty in just a few minutes greatly improving the energy efficiency.

Use of COMSOL Multiphysics®
For this application a three stage ohmic heater was simulated. COMSOL Multiphysics® was used to model flow through the ohmic heater and associated pipework, combining fluid flow of a very viscous material with joule heating. This enabled the temperature profile through the heater to be defined and the electrical fields modeled. Particle tracking was also utilized to show the movement of the solid particles present in the fluid.

Results
Modeling of laminar flow within the ohmic heater shows a more rapid flow of material at the centre of the heater (Figure 2). Ohmic (joule) heating was also simulated within the system. The power density distribution profile, emphasizes the imbalance in heat generation in the regions close to the electrode edge. Figure 3 shows the high level of heating which is seen at the electrode corners. The combination of laminar flow and ohmic heating together enable us to view temperature distribution within the heater. Figure 4 shows the heat profile within the final ohmic heater section. This model details the maximum temperatures reached in the system and the level of uniformity at the outlet. The required temperature of 180 degrees Celsuis across the whole material to achieve the necessary bug kill was shown to be achieved within 5 minutes using this technique.

Conclusion
The modeling work defined the necessary process conditions and electrode design to enable even heating of the material to the required temperature for safe sterilization. It also ensured that

localized areas of high temperature were not excessive for the material of construction of the heater. The modeling results were backed up by laboratory trials which were successful and has enabled the work to moved on to a demonstrator build as a pre-treatment to an anaerobic digestion process, due to be operational summer 2014.

Figures used in the abstract

Figure 1: Ohmic heater pilot plant

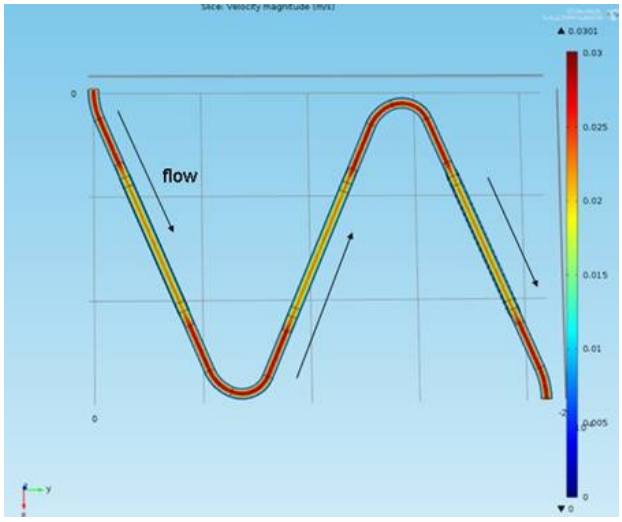

Figure 2: Velocity profile through ohmic heater

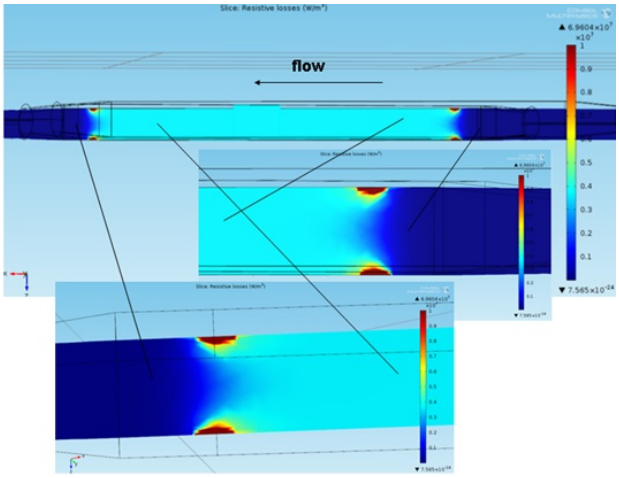

Figure 3: Power density distribution across a single heater section

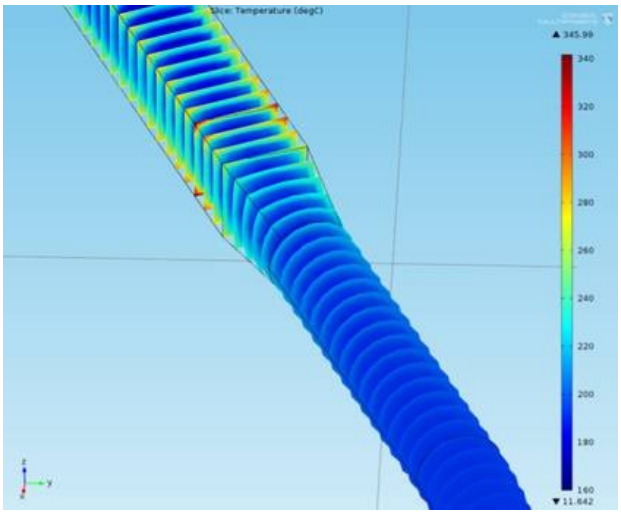

Figure 4: Temperature profile at final heater section