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# Modeling of a pyrolysis batch reactor using COMSOL Multiphysics

*Shawki Mazloum*<sup>1, \*</sup>, *Sary Awad*<sup>1</sup>, *Youssef Abou Msallem*<sup>2</sup>, *Nadine Allam*<sup>2</sup>, *Khaled Loubar*<sup>1</sup>, and *Mohand Tazerout*<sup>1</sup>

<sup>1</sup>IMT Atlantique, DSEE Department, 44307 Nantes cedex 3, France

<sup>2</sup>Lebanese International University, MENG Department, P.O. Box 5 Khiara, Lebanon

**Abstract.** Plastic Pyrolysis is a thermal degradation process; it offers an important alternative energy. The aim of this study is to model a batch reactor to be used for plastic pyrolysis. Consequently, four experiments with different heating and cooling cycles are done using an empty pyrolysis batch reactor and four temperatures are measured at different locations on the reactor. On the other hand, the empty reactor is modeled and several simulations are done, using COMSOL Multiphysics software, under the same experimental conditions. By comparing the temperatures obtained from simulation to those measured experimentally, it is noticed that the results are very close with a maximum error of 4%, hence the model is validated.

## 1 Introduction

Nowadays after the depletion of fossil energy reserves, which are the essential source of energy worldwide, seeking for alternative renewable energy became a crucial issue and subject for many researchers and academic institutions. On the other hand, there is a serious problem facing humanity, which is the enormous growth of the accumulated plastic waste every year. A statistic shows that 25 million tons of plastic waste were generated in Europe in 2012 and about 38% of the plastic waste are still treated in the landfill, while only 36% were utilized for energy recovery [1]. A solution of plastic waste accumulation and an alternative source of energy is plastic pyrolysis which converts waste plastic into a wide range of fuels and chemicals. Plastic pyrolysis is a thermal decomposition of large chain polymers into shorter ones by heating plastic to a given temperature, where an endothermic reaction occurs in the absence of oxygen [1].

In order to study the pyrolysis process, a batch reactor used at IMT Atlantique laboratories will be modeled using COMSOL Multiphysics software. The model will be validated by comparing the simulation of heating and cooling cycles of the empty reactor to the experimental results.

\* Corresponding author: [shmazloum93@gmail.com](mailto:shmazloum93@gmail.com)

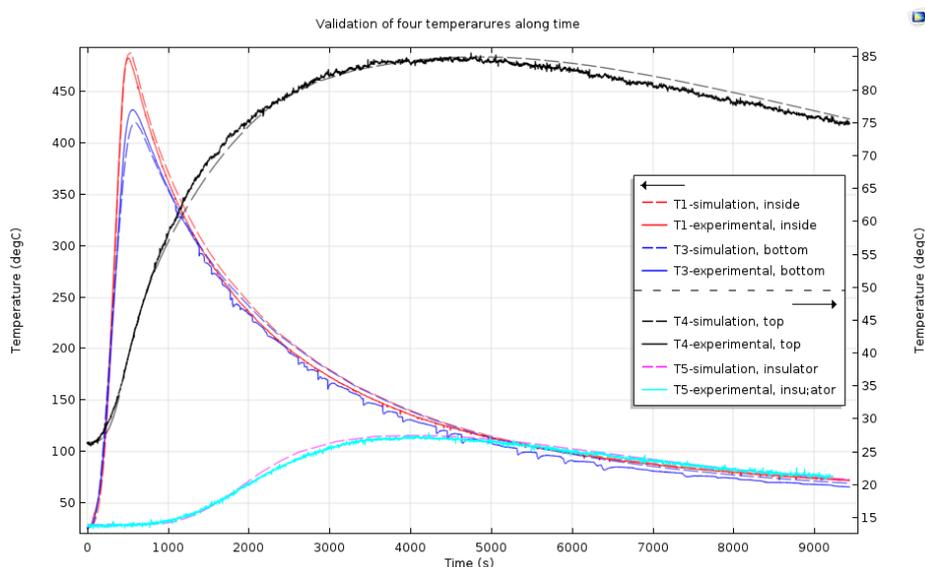
## 2 Experimental study



stainless steel and ceramic fiber are respectively: for the thermal conductivity 22 and 0.2 (W/K.m), for the heat capacity 440 and 1200 (J/K.kg) and for the density 8000 and 190 (kg/m<sup>3</sup>) [3].

## 4 results

Figure 2 presents the results of one of these experiments where heating of the reactor is done, with full load (1500 W), during 7 minutes proceeded by a cooling for 157 minutes. As it is obvious in this figure, the simulated and experimental curves are approximately coincided for the four temperatures with an error varying between 1 and 4%. The simulation is also compared to other experiments; this validate the modeling of the batch reactor for different heating process.



**Fig. 2.** Comparison between experimental and simulation results for three temperatures along the reactor.

## 5 Conclusion

Using COMSOL, the batch reactor for plastic pyrolysis is modeled and validated by comparing experimental and simulated results with a maximum error of 4%. After the validation of the model, the future work is to study and simulate different phenomena occurring during pyrolysis process, i.e. heating of feedstock, phase change and cracking, before proceeding to the full study of plastic wastes pyrolysis in the batch reactor.

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