PhD thesis

Numerical modelling of solar pyrolysis process of the waste biomass

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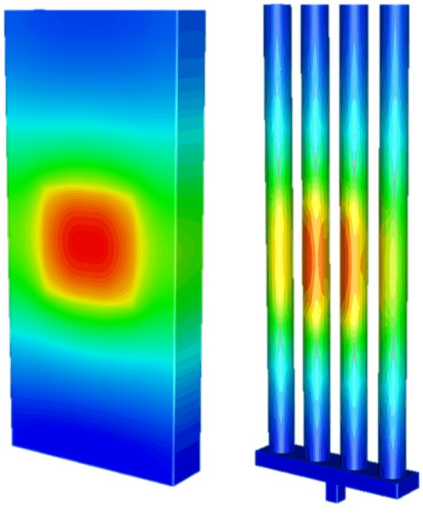
Zuzanna Kaczor



Gliwice 2021

Silesian University of Technology

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Submitted in the field of engineering and technical sciences in the discipline of environmental engineering, mining and power engineering

Faculty of Energy and Environmental Engineering
Silesian University of Technology
Gliwice, Poland

2021

Author:
Zuzanna Kaczor, M.Sc. Eng.
Silesian University of Technology
Department of Thermal Technology
Konarskiego 22, 44-100 Gliwice, Poland
e-mail: zuzanna.kaczor@polsl.pl

Supervisor:
Sebastian Werle, Ph.D., D.Sc. Eng.
Associate Professor at Silesian University of Technology
Department of Thermal Technology
Konarskiego 22, 44-100 Gliwice, Poland
e-mail: sebastian.werle@polsl.pl

Co-supervisor:
Zbigniew Buliński, Ph.D., D.Sc. Eng.
Silesian University of Technology
Department of Thermal Technology
Konarskiego 22, 44-100 Gliwice, Poland
e-mail: zbigniew.bulinski@polsl.pl

Polish title:
Modelowanie numeryczne procesu solarnej pirolizy biomasy odpadowej

Abstract

The dissertation presents an analysis of the solar pyrolysis of waste biomass process with the use of numerical tools and methods. In the first place, the ecological and political conditions, which have recently resulted in high interest in biomass, have been introduced. Issues related to the origin of biomass are presented as well as its composition and the way in which solar energy is stored in it. The use of biomass for energy purposes and the related problems were discussed. The methods of biomass processing to eliminate its disadvantages and obtain substances easier to apply were summarized and the pyrolysis and its accompanying phenomena were discussed. Then, a laboratory system is presented on which the pyrolysis is being experimentally carried out. The issues of numerical modelling of this process is analysed, the most important factors and component phenomena of the process influencing its actual course and the results of numerical simulations were identified. The individual publications present the subsequent stages of numerical analyses of the individual problems related first to the design of the laboratory rig and the determination of the final operating parameters, and then related to the process itself carried out on the finally obtained laboratory rig. Therefore, the process of focusing Sun's rays with mirror of different curvatures was examined in the context of its application in Polish conditions. Then, the pyrolysis process itself, carried out in a pyrolysis reactor of the first concept, was analysed in order to verify the design of the system, the operating parameters and the impact of material properties adopted in the simulations on the calculation results. In the next step, the available publications were reviewed in terms of methods, assumptions, simplifications and data adopted in mathematical modelling of biomass pyrolysis by other researchers, so as to select the most relevant approach for the process studied in this work. Finally, the inverse analysis was conducted in order to determine the most important boundary conditions for the model of the process carried out in the final pyrolysis reactor. In this way, the most important problems were solved and the main issues related to numerical modelling of biomass solar pyrolysis were analysed.

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