

1. Research project objectives

At present taking into account the fact that renewable sources of energy are covering more and more space the stability becomes very crucial factor. Especially when speaking of RSE, one considers wind turbines, and photovoltaic cells where the availability of wind and of solar energy can be very unpredictable. Thus stable sources, discerning with high flexibility are of key essence in order to be able provide stable electricity production and security in case of wind and sun shortage. Solid fuels like coal or biomass that are stored outside of the power plants are in fact an immense source of chemical energy, ready to be transformed into a useful form energy, whenever the opportunity arises. What is more, innovative ways of energy transformation, such as the gasification process can turn out to be a much better choice than combustion, owing to many potential advantages, along with the environmental impact. The high temperature environment that is present during coal gasification and which is related to very complex and simultaneously occurring physical and chemical phenomena makes it very problematic to describe it applying only experimental techniques. That is why computer simulations can help understand and optimize the process. One of such methods can be a Computational Fluid Dynamics. It allows to avoid costly mistakes, before committing resources towards building large-scale units.

In order to be able to predict the behavior of such complex process accurately complex CFD models are required which can lead to computationally expensive simulations. One of the main objective of the project relies on developing the algorithm which will be based on the calibration technique of kinetic parameters of simple models basing on the results from advanced and complex models. Thus it will be possible to preserve the accuracy of the advanced models and the low computational cost of the empirical ones. Another objective but also a consequence of such calibration will be an inclusion of fuel properties and operating conditions into these calibrated parameters.

2. Research project methodology

The project applies many techniques, that already exist. CFD simulations of the gasification process have been studied since many years. Some of them have used widely, some of them scarcely Yet, combining these techniques together makes it a consistent methodology. Work carried out in this project will combine those widely and scarcely applied modelling techniques including some experimental measurements. At first, a fuel of interest – coal will used for further investigation. There will be basic fuel analysis performed which will result in determination of calorific value, moreover experiments with drop tub furnace and thermogravimetric analyser will be carried out to estimate kinetic parameters of the examined process.

Subsequently obtained parameters will be used to carry out complex numerical simulations. Results of these complex simulations will then be used to calibrate simplified models, which will allow to obtain final results.

Finally, CFD results will be validated by the experiments performed in an entrained flow gasifier. It will allow to determine, how good is the agreement between the simulation results and the measured values.

3. Reasons for choosing this topic

The main reasons for choosing this topic is the impact of the research on the development of the science because there is a scarce amount of works attempting to model pyrolysis and char conversion taking into consideration specific properties of coal and gasifier's operating conditions. Moreover a database of obtained parameters accounting for fuel properties and operating conditions, prepared for the studied coal and obtained calibration algorithm can be applied by other scientists for their models. It will be possible to draw many important conclusions out of these results.