	Name of the PhD: **Victor POZZOBON** Title of the PhD thesis: **Biomass gasification under high solar heat flux** Dates (start/end): 10/2012 – 11/2015
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Other contributors	Co-funding Labex SOLSTICE & IMT Mines Albi

Context and objectives

Concentrated solar energy appears as an alternative energy source to power the thermochemical conversion of biomass into energy or materials with high added-value. Production of syngas from lignocellulosic biomass is an example, as well as the production of carbonaceous residues with controlled properties.

Approach

This work focuses on the study of the behaviour of a thermally thick beech wood sample under high solar heat flux (higher than 1000 kW/m2). Two approaches have been undertaken at the same time: an experimental study and the development of a numerical model.

Main results

Experiments have highlighted a specific behaviour of beech wood under high solar heat flux. Indeed, a char crater, symmetrical to the incident heat flux distribution, forms in the sample. This study has also shown that biomass initial moisture content has a strong impact on its behaviour. Dry sample can achieve an energetic conversion efficiency of 90 %. While, high initial moisture content samples produce more hydrogen, at the price of an energetic conversion efficiency around 59 %. Furthermore, the temperatures reached (higher than 1200 °C) and the presence of water enable tar thermal cracking and steam reforming. Finally, wood fibers orientation has been shown to have only a minor impact on its behaviour.

At the same time, a modelling of the coupled reactions, heat and mass transfers at stake during solar gasification was undertaken (Figure 1). The development of this model has highlighted the necessity to implement innovative strategies to take into account radiation penetration into the medium as well as its deformation by gasification. Numerical model predictions are in good agreement with experimental observations. Based on the model predicted behaviour, further understanding of biomass behavior under high solar heat flux was derived. In addition, sensitivity analyses revealed that Arrhenius type models are not fitted for precise intra-particular water behavior description and that the choice of the pyrolysis scheme is key to properly model biomass behaviour under high solar heat flux.

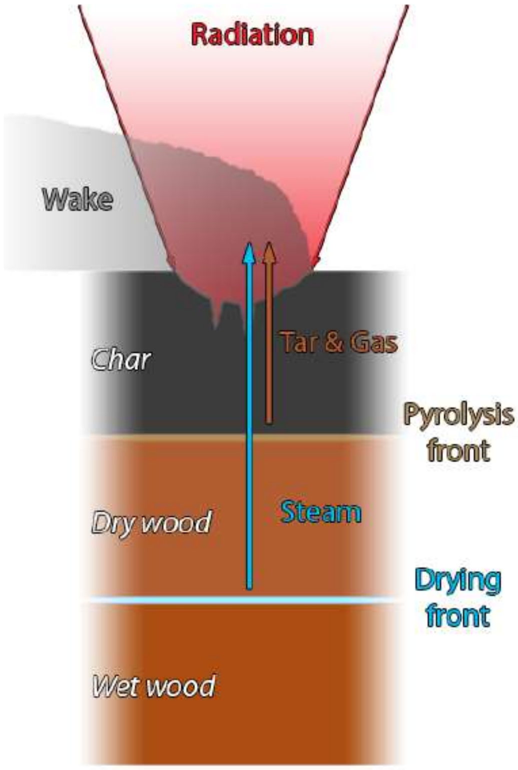

Figure 1. Various mechanisms occurring during gasification of a thick beech wood sample

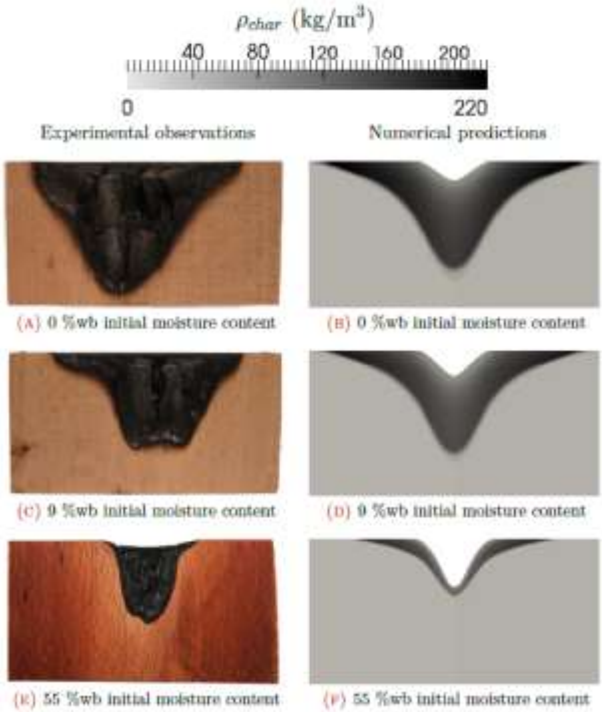

Figure 2. Comparison of experimental (left) and numerical results (right).

Publications in scientific journals

V. Pozzobon, S. Salvador, J. J. Bézian, M. El-Hafi, Y. Le Maoult, G. Flamant "Radiative pyrolysis of wet wood under intermediate heat flux: Experiments and modeling." Fuel Processing Technology (2014), 128, 319–330

V. Pozzobon, S. Salvador, "High heat flux mapping using inverse methods: an application to solar concentrating systems." Solar Energy (2015) 117, 29-35

V. Pozzobon, S. Salvador, J. J. Bézian, "Biomass gasification under high solar heat flux: experiments on thermally thick samples." Fuel (2016), 174, 257-266

V Pozzobon, S Salvador, J-J Bézian, "Biomass gasification under high solar heat flux: Advanced modelling." Fuel (2018), 214, 300-313.