Biomass Pyrolysis and Combustion – From Experimental Measurements to Numerical Modeling

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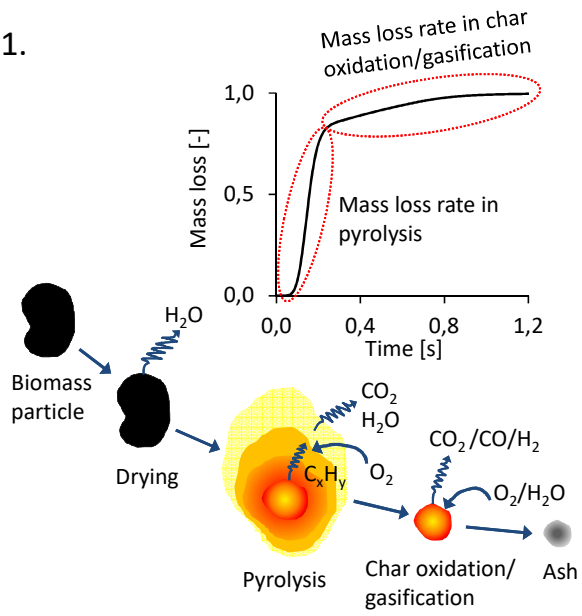
When biomass is used as an alternative resource to fossil fuels in energy industries, it is important to know the exact fuel properties of the biomass. When these properties are determined, the biomass conversion technologies can be designed such that the biomass fuel is used as efficiently as possible, ultimately ensuring the economic and environmentally sustainable use of the resource.

During the Sustainable Bioenergy Solutions for Tomorrow (BEST) project, Tampere University of Technology (TUT) and Valmet Technologies Oy have developed new and more accurate methods to experimentally characterize the fuel properties of different biomass feedstocks. In addition, efficient computer models have been developed that can aid in the design process of various biomass conversion technologies, such as combustion, gasification and pyrolysis reactors.

1.



- In combustion, pyrolysis and gasification processes the fuel particles go through different thermochemical decomposition stages.
- Different biomass materials have highly varying fuel properties which affect how fast the particle goes through these stages.
- The BEST research at TUT has developed experimental and numerical methods to determine the fuel properties for different biomass feedstocks.

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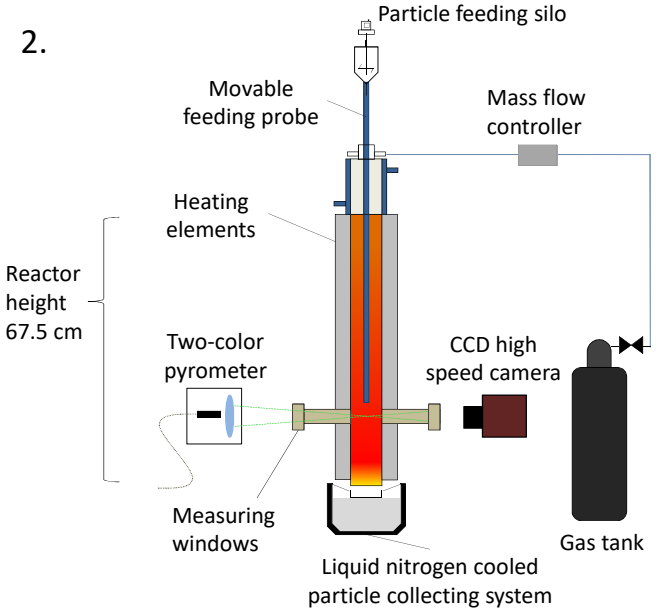
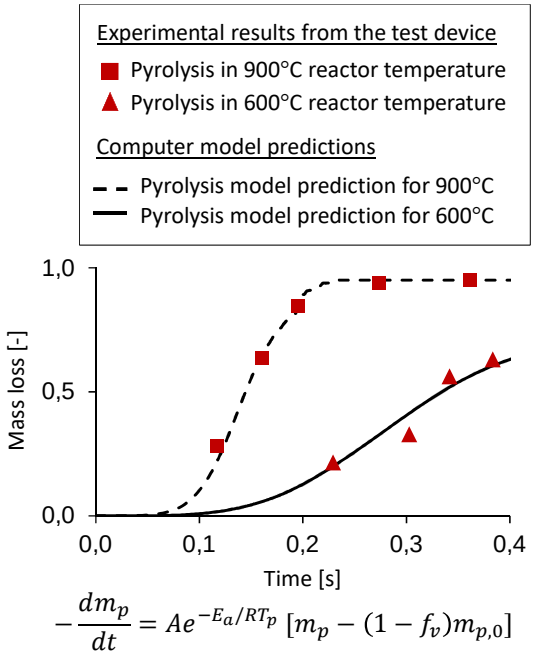
[1] H. Tolvanen, *Advanced solid fuel characterization for reactivity and physical property comparison*, Doctoral Dissertation, Tampere University of Technology, Publication 1359, 2016, 66 p.
[2] H. Tolvanen, L. Kokko, R. Raiko, *Fast pyrolysis of coal, peat, and torrefied wood: Mass loss study with a drop-tube reactor, particle geometry analysis, and kinetics modeling*, Fuel 111, 2013, pp. 148-156

2.



- The Drop-Tube Reactor at TUT is the main experimental test device for measuring the pyrolysis and combustion properties for different biomass feedstocks (see references [1, 2] for further information).
- The reactor is electrically heated and it can reach temperatures of over 1000°C.
- The reactor measures how quickly the biomass particles lose their mass in different high temperature gas environments.

3.



$$-\frac{dm_p}{dt} = Ae^{-E_a/RT_p}\,[m_p - (1-f_v)m_{p,0}]$$

- The experimental data from the Drop-Tube-Reactor is used is used to develop computer models that can aid efficient and fuel economic design of biomass energy technologies.