Scientific tools for fuel characterization for clean and efficient biomass combustion SciToBiCom

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Objective

To develop experimental and theoretical tools to support use of various biomass based solid fuels in different technologies

- **Fuels**
  - Standard wood pellets, Wood chips, Bark, Straw, Miscanthus, Arundo Donax, Residues from bio-ethanol production, Waste wood, Fuel blends
- **Technologies**
  - Grates, Fluidised bed, Pulverised

Project information

Project leader and coordination
Technical University of Denmark
Department of Chemical and Biochemical Engineering

Project duration
2010-2012

Funding
National funding

Partners

Denmark
Technical University of Denmark
Department of Chemical and Biochemical Engineering

Finland
Åbo Akademi University
Process Chemistry Centre

Norway
Norwegian University of Science and Technology (NTNU)
Department of Energy and Process Engineering

Austria
BIOENERGY 2020+ GmbH (BE2020+)

Project build-up

Topic 1 Modeling of the combustion process	**WP1** **Generic models for NOx formation** **DTU, NTNU**	**WP2** **Generic models - Ash formation/ deposition and formation of small particles** **AAU, BE2020+/ TUG, DTU**	**WP3** **Combustors – Technology dependent models** **BE2020+/TUG, AAU**
Topic 2 Advanced characterization of biomass fuels	**WP4** **Advanced characterization – NOx related issues** **NTNU,** AAU	**WP5** **Advanced characterization – Ash related issues** **BE2020+/TUG, AAU, NTNU**	**WP6** **Advanced characterization – Fuel pretreatment** **DTU, AAU**

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WP1: Generic models for NO_x formation

Partners: DTU, NTNU
WP leader: Professor Peter Glarborg, DTU Chemical Engineering

Objectives

- Develop simplified scheme to describe gas-phase NO formation from volatile combustion (for use in CFD)

- Develop predictive model for NO formation during biomass char combustion

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WP2
Generic models - Ash formation/ deposition and formation of small particles

Partners: AAU, BE2020+/ TUG, DTU
WP leader: Åbo Akademi University Process Chemistry Centre

Objectives

- **To model ash formation and release of heavy metals leading to particle and aerosol emissions or deposit formation in a full scale boiler**
- To develop new characterization method based on thermodynamic equilibrium calculations in order to describe the release behavior of ash forming elements and heavy metals
- To develop a thermodynamic model for ash formation and ash melting in fixed-bed combustion
- To develop simplified models concerning the formation of aerosols for use in CFD.

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WP3: Combustors – Technology dependent models

Partners: AAU, BE2020+
WP leader: BE2020+

Objectives

- Transformation of the generic models developed in other WPs into a form that can be used for modelling of combustion devices (fixed bed combustion, pulverised combustion and fluidized bed combustion)
- Model development for grate furnaces
- **Model development for FBC plants**

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WP4
Advanced characterization – NOx related issues

Partners: NTNU, AAU
WP leader: Norwegian University of Science and Technology
Department of Energy and Process Engineering

Objectives

- State the important relations between fuel characteristics, process conditions and the role of precursors for NOx formation
- **Determine the parameters that describe pyrolysis and char conversion based on thermally large biomass particles**

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WP5: Advanced characterization of biomass fuels – ash related issues

Partners: AAU, BE2020+, NTNU
WP leader: BE2020+

Objectives

- **Advanced characterisation of biomass fuels according to fuel indexes and chemical fractionation**
- **Determination of the association of ash forming matter in biomass fuels with emphasis on volatile alkali compounds and heavy metals**
- Advanced characterization of biomass fuels by TGA/DSC and XRD analysis of ashed fuel samples
- Advanced fuel characterization of biomass fuels by µTGA and macro-TGA coupled with FTIR, MS and GC
- Performance of lab-scale combustion tests as innovative method for fuel characterisation and to gain basic data concerning the release behaviour of alkaline metals, S, Cl and heavy metals
- Determination of release curves for alkaline metals and heavy metals
- **Establishment of an advanced fuel database for conventional and new biomass fuels investigated within the project**

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WP6: Fuel Pretreatment

Partners: DTU, AAU
WP leader: Associate Professor Peter Arendt Jensen, DTU

Objectives

- **Provide the fundamental fuel characterization data needed for the design of an integrated pretreatment reactor**

- Provide data on chlorine release during pyrolysis for different biofuels as a function of pyrolysis conditions

- Provide data on heat transfer and grindability at pyrolysis conditions

Outcomes

- Models for
  - gas and char nitrogen chemistry
  - release of ash forming species
  - aerosol formation

- Characterization of
  - fuels (based on various techniques)
  - ashes (melting behavior)
  - release of NOx precursors, alkali and heavy metals
  - pyrolysis and char conversion
  - fuel properties important for pretreatment