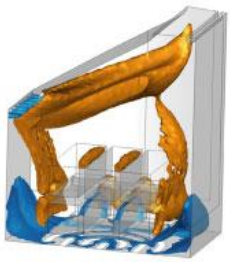
WoodCFD

Clean and efficient wood stoves through improved batch combustion models and CFD modelling approaches



Newsletter 1-2016

Introduction

The WoodCFD project is proceeding as planned, focusing on achieving the overall objective, which is development of clean and efficient wood stoves through improved batch combustion models and CFD modelling approaches through:

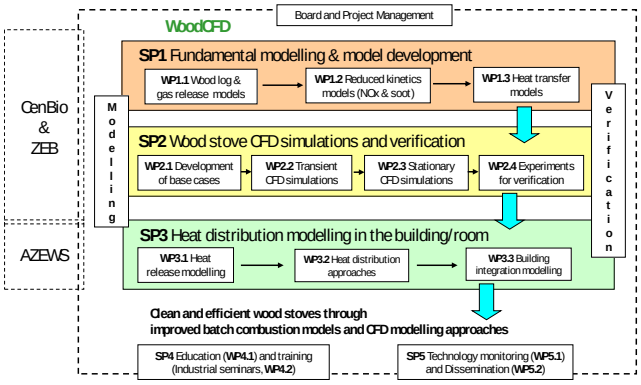
- Model development: improved transient wood log and gas release models, transient heat transfer and storage models, reduced kinetics models (NOx and soot), and transient models and approaches for heat distribution in the building; and verification of these
- Simulations: transient and stationary CFD simulations of wood stoves, and room and building integration simulations; and verification of these

The sub-objectives are:

- Develop improved sub models to be included in the CFD simulations
- Develop a numerical tool that is suitable to study concept improvements for wood stoves and to recommend new improved concepts with respect to high energy efficiency and low emissions based on simulation results
- Develop improved transient heat distribution models - giving reliable prediction of the effect of various heat transfer concepts in buildings and providing design guidelines for optimum wood stoves for tomorrows (energy efficient) buildings
- Education of highly skilled candidates within this area and training of industry partners
- Monitoring of activities and state-of-the-art within this area and dissemination of knowledge to the industry partners, and other interested parties when applicable

The anticipated results of the project are clean and efficient wood stoves through improved batch combustion models and CFD modelling approaches. Improved models and modelling approaches, in combination with targeted experiments, are keys in the development of future's downscaled clean burning and energy efficient wood stoves. This will have a potentially huge impact on the most important bioenergy value chain in Norway today, targeting key bottlenecks in the value chain, i.e. reducing today's still relatively high emissions from wood stoves and improving their energy efficiency, especially in low load wood stoves, as well as ensuring optimum room and building integration.

The Work Breakdown Structure of WoodCFD is:



WoodCFD will run for four years (2015-2018) and has a total budget of 17.5 million NOK which is 80% financed by the Research Council of Norway through the ENERGIX program and 20% financed by the industrial partners Jøtul AS, Dovre AS, Norsk Kleber AS, Morsø Jernstøberi A/S.

Progress in 2016

In 2015 the scientific focus was on initial studies and establishment of sub-models for use in transient CFD simulations, as well as modelling of heat transfer in stoves and analysis of heat distribution to other rooms in a building. The work with the sub-models, also for stationary CFD simulations, is continued in 2016. The

- a Knowledge-building Project for Industry (KPN) co-funded by the Research Council of Norway through the ENERGIX-programme.
Contact: oyvind.skreiberg@sintef.no

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employed PhD candidate in the project focus on development of a decomposition model for wood logs.

WoodCFD in the Journal of Building Performance Simulation

A WoodCFD work, Simple Modelling Procedure for the Indoor Thermal Environment of Highly Insulated Buildings Heated by Wood Stoves, has been published in the Journal of Building Performance Simulation. The abstract is given below:

Space heating using wood stoves is a popular solution in many European countries. The nominal power of the state-of-the-art stoves is oversized compared to the needs of highly insulated buildings, leading to a risk of overheating. A modelling procedure is here developed in order to investigate the indoor thermal environment generated by wood stoves in such buildings. This procedure is kept simple to perform all-year detailed dynamic simulations (e.g. using TRNSYS) at an acceptable computational cost. A specific experimental set-up has been developed for validation, essentially regarding the interaction between the stove and the building. The largest source of error appears to be the thermal stratification in the room where the stove is placed. The experiments prove that the model gives a fair insight into the global thermal comfort. Therefore, it is possible to investigate the conditions required for a stove to be properly integrated in a highly insulated building.

WoodCFD at 24th European Biomass Conference & Exhibition

A WoodCFD work, Computational Fluid Dynamics as an Efficient Design Tool for Wood Stoves, was presented by Øyvind Skreiberg at the 24th EUBCE conference in Amsterdam, 6-9 June 2016.

WoodCFD at CLIMA 2016

Joanna Polak, a master student connected to the WoodCFD project, presented a paper with the title "Experimental study of the airflow distribution inside and between two zones with temperature differences with an air curtain system" based on her master thesis work at the conference CLIMA 2016, 22-25 May 2016, Ålborg, Denmark.

WoodCFD at Indoor Air 2016

Guangyu Cao will present a joint CenBio and WoodCFD paper with the title "An experimental study on how a wood stove affects the indoor air quality when used as the main source of heating in two representative Norwegian dwellings, one modern and one old, at the conference Indoor Air 2016, 3-8 July 2016, Ghent, Belgium.

How to operate your wood stove

The firing season has ended, but each year the same subject is coming up in the media, i.e. how to operate your wood stove in the best way. We therefore here points towards popular science articles published in connection with last year's heating season, providing information that might make even you a better wood stove operator, before the next heating season starts. The articles are:

Her er "vedfyringens ABC"

Ja, dette fjerner sotet fra peisen (February 6, 2016)
Så mye bedre er nye vedovner (January 28, 2016)
Vil forby disse ovnene (January 23, 2016)
Foreslår å forby gamle vedovner (January 22, 2016)
Vil forby gamle vedovner (January 22, 2016)
Ekspertenes beste vinterråd (January 21, 2016)
Nå kan vedfyring være helsefarlig (January 21, 2016)
Nå kan dette være helsefarlig (January 21, 2016)
Her ser du hvorfor du IKKE skal brenne juletreet i peisen (January 4, 2016)
Farlig å fyre med juletreet (January 3, 2016)
Ikke brenn juletreet – og hvordan du blir kvitt det (January 2, 2016)
Slik tar du helsesjekk på vedovnen (December 29, 2015)
Her er forskerens tips til sikker og miljøvennlig vedfyring (October 21, 2015)
Sjekk om du bør ha feier på besøk (October 20, 2015)
Sjekk om du bør bytte vedovn (October 15, 2015)

These articles are in Norwegian, but good advices in English can be found in the Guidebook Effective and environmentally friendly firing of firewood.

In a nutshell:

1. Plain and simple, as the operator and control system, you significantly influence the performance of your wood stove, with respect to both emissions and efficiency. Become a more educated wood stove user, and by that also contribute to reduced environmental impact from your stove.

2. If you have an old wood stove, pre 1998, replacing this with a new one will be very wise both from an emissions and efficiency point of view. Why? Because the new wood stoves implement measures for improved combustion that do not exist in the old stoves.

PhD work

The PhD work "Numerical simulations of the transient behavior of wood log decomposition and combustion"

is progressing. The candidate, Inge Haberle from Austria, has started her research work, focusing on establishing the framework needed for further detailed studies.

Collaboration with ZEB

As in the StableWood project, the predecessor to WoodCFD, there is an active collaboration with The Research Centre on Zero Emission Buildings (ZEB).

WoodCFD publications

Guangyu Cao, Laurent Georges, Øyvind Skreiberg, Morten Seljeskog. An experimental study on how a wood stove affects the indoor air quality when used as the main source of heating in two representative Norwegian dwellings, one modern and one old. Accepted for presentation at Indoor Air 2016, 3-8 July 2016, Ghent, Belgium.

Morten Seljeskog, Alexis Sevault, Birger Rønning, Magnus Rishaug, Asbjørn Østnor, Øyvind Skreiberg (2016). Variables affecting particulate emissions from residential wood combustion – simultaneous sampling on hot and ambient filter. 20th ETH-Conference on Combustion Generated Nanoparticles, 13-16 June 2016, Zurich, Switzerland.

Øyvind Skreiberg, Mette Bugge, Morten Seljeskog, Nils Erland L. Haugen, Inge Haberle, Laurent Georges (2016). Computational Fluid Dynamics as an Efficient Design Tool for Wood Stoves. 24th European Biomass Conference and Exhibition, 6-9 June 2016, Amsterdam, The Netherlands.

Joanna Polak, Guangyu Cao, Laurent Georges, Øyvind Skreiberg (2016). Experimental study of the airflow distribution inside and between two zones with temperature differences with an air curtain system. Proceedings of CLIMA 2016, 22-25 May 2016, Ålborg, Denmark.

Laurent Georges, Øyvind Skreiberg (2016). Simple Modelling Procedure for the Indoor Thermal Environment of Highly Insulated Buildings Heated by Wood Stoves. Journal of Building Performance Simulation.

Joanna Lazar, Nils Erland L. Haugen, Jonas Kruger, Andrzej Szlek (2016). Numerical Study of Hydrogen Inhibition of Char Gasification Using Detailed Hetero- and Homogeneous Chemical Kinetics. Energy & Fuels 30(6):4411-4418.

Philipp Betchart (2015). Viscosity measurements. NTNU Project thesis. Main supervisor: Erling Næss, Co-supervisor: Kolbeinn Kristjansson

Eivin Sellevold (2015). Modelling the indoor thermal environment in passive houses heated by wood stoves. NTNU Project thesis. Main supervisor: Laurent Georges, Co-supervisor: Øyvind Skreiberg

Joanna Polak (2015). Experimental study of the airflow distribution in a room with heating equipment. NTNU Master thesis. Main supervisor: Guangyu Cao, Co-supervisors: Laurent Georges, Øyvind Skreiberg

Laurent Georges, Morten Seljeskog, Øyvind Skreiberg (2015). En balansert kombinasjon av stråling og konveksjon gir best komfort. Varmenytt 4-2015, p. 22.

Øyvind Skreiberg, Mette Bugge, Morten Seljeskog, Nils Erland L. Haugen, Laurent Georges (2015). CFD as an efficient design tool for wood stoves. Expert workshop on Highly efficient and clean wood log stoves, IEA Bioenergy Task 32, 29 October 2015, Berlin, Germany.

Laurent Georges, Øyvind Skreiberg (2015). Wood stoves for future's energy efficient buildings. Expert workshop on Highly efficient and clean wood log stoves, IEA Bioenergy Task 32, 29 October 2015, Berlin, Germany.

WoodCFD in the media

Benjaminsen, Christina; Skreiberg, Øyvind; Seljeskog, Morten. Her er "vedfyringens ABC". Gemini 3 desember 2015. Reprodusert på forskning.no. NRK radio intervju med Morten Seljeskog.

Benjaminsen, Christina; Skreiberg, Øyvind. Cheaper heating using environmentally-friendly wood-burning stoves. Gemini 9 February 2015.

Benjaminsen, Christina; Skreiberg, Øyvind. Miljøvennlig vedfyring gir deg billigere varme. Gemini 3 februar 2015. Reprodusert på Adresseavisen nett.

Skreiberg, Øyvind. Vi skal gjøre det mer effektivt og miljøvennlig å fyre med ved. blog.sintefenergy.com 2 februar 2015.

Selected **StableWood** modelling publications:

Øyvind Skreiberg, Morten Seljeskog, Laurent Georges (2015). Solutions and technologies for wood stoves in future's energy efficient residential buildings. Oral presentation at 23rd European Biomass Conference and Exhibition, 1-4 June 2015, Vienna, Austria. (Co-presentation with ZEB).

Mette Bugge, Øyvind Skreiberg, Nils E. L. Haugen, Per Carlsson, Morten Seljeskog (2015). Predicting NOx emissions from wood stoves using detailed chemistry and computational fluid dynamics. Energy Procedia 75:1740-1745.

Øyvind Skreiberg, Morten Seljeskog, Laurent Georges (2015). The process of batch combustion of logs in wood stoves - Transient modelling for generation of input to CFD modelling of stoves and thermal comfort simulations. Chemical Engineering Transactions 43:433-438. (Co-publication with ZEB).

Laurent Georges, Øyvind Skreiberg (2014). Simulation of the Indoor Thermal Environment in Passive Houses heated using Wood Stoves: comparison between thermal dynamic simulations and CFD. 1st International Workshop on CFD and Biomass Thermochemical Conversion, 30th September, 2014, DBFZ, Leipzig, Germany, pp. 57-61. (Co-publication with ZEB).

Laurent Georges, Øyvind Skreiberg, Vojislav Novakovic (2014). On the proper integration of wood stoves in passive houses under cold climates. Energy and Buildings 72:87-95. (Co-publication with ZEB).

Laurent Georges, Øyvind Skreiberg, Vojislav Novakovic (2013). On the proper integration of wood stoves in passive houses: Investigation using detailed dynamic simulations. Energy and Buildings 59:203-213. (Co-publication with ZEB).

Other news

IEA Task 32 Biomass Combustion and Co-firing

An IEA Bioenergy Task 32 meeting was arranged in Switzerland in connection with the 20th ETH-Conference on Combustion Generated Nanoparticles, 13-16 June, where Morten Seljeskog gave a presentation on the topic "Variables affecting particulate emissions from residential wood combustion – simultaneous sampling on hot and ambient filter". This was the first meeting in the new triennium (2016-18). For more information about IEA Bioenergy Task 32 activities, see this newsletter, and for IEA Bioenergy news, see this newsletter.

EERA Bioenergy - Stationary Bioenergy

The effort this year has been focused on arranging workshops in Brussels connected to issue papers, on bioenergy and biofuels, and coordination of efforts to establish joint EU proposals. For more info on EERA Bioenergy, visit the website, and see the newsletters.

RHC technology platform

The activity level of the RHC platform is picking up, after a period where new financing solutions have been sought and the originally planned strategy documents have been delivered. The "new" European Technology and **Innovation** Platform on Renewable Heating & Cooling (RHC-ETIP) brings together stakeholders from the biomass, geothermal and solar thermal sector - including related industries such as District Heating and Cooling, Thermal Energy Storage, Hybrid Systems and Heat Pumps - to define a common Research, Development and Innovation strategy for increasing the use of renewable energy technologies for heating and cooling. Two workshops will be arranged 27 and 28 June. The first one is an industry workshop while the second one is a technology workshop. The aim is to support to key activities of the RHC-ETIP and to discuss the successful contribution of the RHC-sector to the fifth dimension of the Energy Union.
See the RHC newsletters for other news.

Links (click on the links or logos to get there)

StableWood
SKOG22
Energi21
Renewable Heating and Cooling technology platform
EERA Bioenergy
IEA Task32 Biomass Combustion and Cofiring