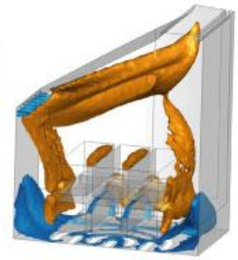


WoodCFD

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

Newsletter 2-2015

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:

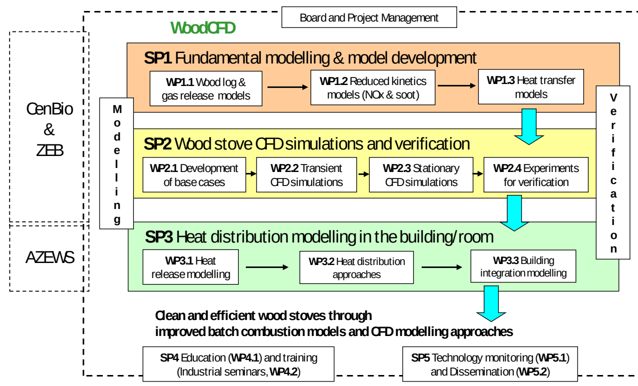
- Model development: improved transient wood log and gas release models, transient heat transfer and storage models, reduced kinetics models (NOx and soot), and transient models and approaches for heat distribution in the building; and verification of these
- Simulations: transient and stationary CFD 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 2015

In 2015 the scientific focus has been 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, continues in 2016.

- a Knowledge-building Project for Industry (KPN) co-funded by
the Research Council of Norway through the ENERGIX-programme.
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SINTEF

How to operate your wood stove

A new firing season has started, and 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 selected popular science articles and web articles that provide information that might make even you a better wood stove operator. Recommended articles are:

Her er "vedfyringens ABC"

Hvordan oppnår du optimal trekk og riktig fyring i vedovnen?

Sjekk om du bør bytte vedovn

Sjekk om du bør ha feier på besøk

Disse tingene må du huske å gjøre før du fyrer i peisen

Tre tips gir skikkelig fyr i peisen

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.

Radiation or convection stove?

Many, more or (usually) less qualified, opinions regarding the preferred stove type with respect to optimum heat transfer mode, radiation or convection, exist. WoodCFD has therefore written a small popular science article on this subject. The conclusion is that there is no general preference, and that **a balanced combination of radiation and convection gives the best heat comfort**. See the article attached to this newsletter (in Norwegian).

PhD position filled

The announced PhD position within "Numerical simulations of the transient behavior of wood log decomposition and combustion" has been filled. A number of applications were been received. After completion of the applicant evaluation process and carrying out interviews, Inge Haberle from Austria was nominated and accepted the PhD position.

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).

New WoodCFD publications in 2015

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: Del 1 og Del 2.

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.

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). Modeling of the Indoor Thermal Comfort in Passive Houses heated by Wood Stoves. Proceedings of System Simulation in Buildings 2014 (SSB2014), 10-12 December, Liege, Belgium. (Co-publication with ZEB).

Øyvind Skreiberg (2014). Biofuels of the future, and modelling implications. Keynote presentation at the 1st International Workshop on CFD and Biomass Thermochemical Conversion, 30th September, 2014, DBFZ, Leipzig, Germany. (Co-presentation with CenBio).

Mette Bugge, Nils E. L. Haugen, Øyvind Skreiberg, Morten Seljeskog (2014). CFD modelling of NOx emissions from wood stoves. 1st International Workshop on CFD and Biomass Thermochemical Conversion, 30th September, 2014, DBFZ, Leipzig, Germany, pp. 51-56.

Morten Seljeskog, Øyvind Skreiberg (2014). Batch combustion of logs in wood stoves – Transient fuel models and modelling of the fuel decomposition and products composition as input to CFD gas phase calculations. 1st International Workshop on CFD and Biomass Thermochemical Conversion, 30th September, 2014, DBFZ, Leipzig, Germany, pp. 39-44.

Øyvind Skreiberg, Morten Seljeskog, Laurent Georges (2014). Batch combustion of logs in wood stoves – Transient modelling for generation of input to CFD modelling of stoves and thermal comfort simulations. 1st International Workshop on CFD and Biomass Thermochemical Conversion, 30th September, 2014, DBFZ, Leipzig, Germany, pp. 45-50. (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 (2014). Simulation of the Indoor Thermal Environment in Passive Houses heated using Wood Stoves. BUILDSIM-NORDIC, 25-26 September 2014, Espoo-Finland. (Co-presentation with ZEB).

Mette Bugge, Nils E. L. Haugen, Øyvind Skreiberg (2014). NOx emissions from wood stoves – A CFD modelling approach. Proceedings of 22nd European BC&E, 23-26 June 2014, Hamburg, Germany, pp. 674-679.

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 Integration of Wood Stoves in Norwegian Passive Houses: Investigations Using Dynamic Simulations. Proceedings of Clima 2013, Prague, 16-19 June 2013. (Co-publication with ZEB).

Øyvind Skreiberg, Morten Seljeskog, Laurent Georges (2013). Transient wood-log stove modelling integrating detailed combustion physics. Oral presentation at 21st European Biomass Conference and Exhibition, 3-7 June 2013, Copenhagen, Denmark. (Co-presentation with ZEB).

Kolbeinn Kristjansson, Erling Næss, Øyvind Skreiberg, Marie Seltveit Haugen (2013). Stable heat release and distribution from batch combustion of wood. Proceedings of 21st European Biomass Conference and Exhibition, 3-7 June 2013, Copenhagen, Denmark, pp. 568-572.

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).

Morten Seljeskog, Øyvind Skreiberg (2012). Transient fuel models for wood log combustion. Oral presentation at 20th European Biomass Conference and Exhibition, 18-22 June 2012, Milan, Italy.

Morten Seljeskog, Øyvind Skreiberg (2012). Transient fuel elemental composition models for wood logs. Renewable Energy Research Conference 2012, 16-17 April, Trondheim, Norway.

Other news

IEA Task 32 Biomass Combustion and Co-firing

An IEA Bioenergy Task 32 meeting was arranged in Berlin in connection with the IEA Bioenergy Conference 2015, October 27-29. Final planning of activities for the next triennium (2016-18) was on the agenda. An Expert workshop on Highly Efficient and Clean Wood Log Stoves was also arranged by Task 32. Also in the new triennium wood stoves will receive significant attention, and a workshop dedicated to wood stoves is planned, as well a wood stove session on the upcoming Combustion Generated Nanoparticles conference June 13-16 in Switzerland. For more information about IEA Bioenergy Task 32 activities, see the recent newsletter, and for IEA Bioenergy news, see this recent newsletter.

EERA Bioenergy - Stationary Bioenergy

After arrangement of the EERA Bioenergy - Stationary Bioenergy Sub-Program workshop ECN in the Netherlands June 15-16, where the goal was to align efforts towards joint proposals, to e.g. H2020, within the stationary bioenergy area, the effort now is focused on selection of topics and coordination of efforts to establish joint proposals. For more info on EERA Bioenergy, visit the website, and see the most recent newsletter.

Seminar in Copenhagen: Real-world emissions from residential wood combustion

SINTEF Energy participated in a seminar in Copenhagen December 3, arranged by the University of Aalborg in Copenhagen, where SINTEF had been invited together with several European and not at least Danish woodstove "experts". The seminar focused on the challenges in determining and minimizing real-world pollutant emissions from residential wood combustion, keeping in mind that test bench results cannot simply be considered representative of actual emissions. The seminar was also intended as a catalyst for idea development and possibly later project development among the participants. The seminar should stimulate networking and participants were encouraged to contribute to discussions. Following the seminar, a blog has been launched, with links to all the presentations.

Further plans for a new competence building project on indoor air quality/stove emissions, administered by NTNU, will seek collaboration with several of the participating parties.

RHC technology platform

The activity level of the RHC platform has been limited this year, as new financing solutions have been sought and the originally planned strategy documents have been delivered. However, the activity level is expected to pick up in 2016, see the recent newsletter for more information.

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

SINTEF NTNU JØTUL Dovre morsø NORSK KLEBER 1893 The Research Council of Norway

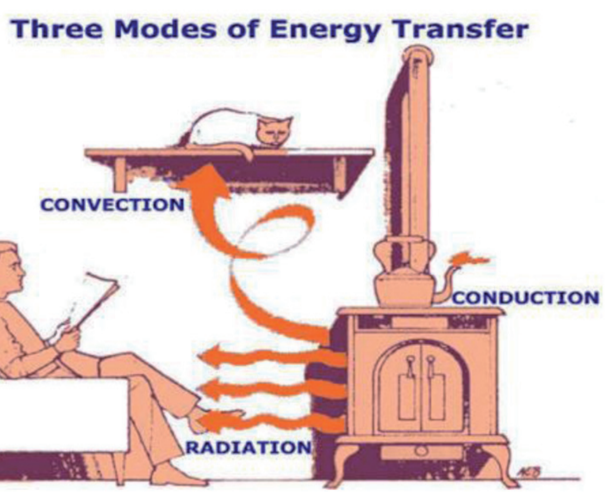
De «lærde» strides om hvorvidt energi avgitt som strålingsvarme eller som konveksjonsvarme gir best opplevelse av varmekomfort i oppholdsrom. Udokumenterte påstander svirrer rundt på nettet og leverandører av konveksjonsovner går i strupen på leverandører av stråleovner (støpejernsovner) med udokumenterte utsagn om at konveksjon er bedre enn stråling for opplevelse av komfort. Leverandører av støpejernsovner svarer at strålevarme gir best komfort! Sett fra et uhildet vitenskapelig ståsted finnes det ikke belegg for å si hverken det ene eller det andre per i dag. Det eksisterer ingen dokumentasjon hvor man har kunnet beregne seg fram til hvilket prinsipp som på et generelt grunnlag gir den mest komfortable varmeopplevelsen. Alle påstander om hvilken metode som er best er slutninger trukket dels på «erfaring» og dels på fakta om den enkelte oppvarmingsmetodes ytterste form. I sine ytterste former har nemlig begge oppvarmingsmetodene sine fordeler og ulemper.

For stråleovner kan det enkelt beregnes at overflatetemperaturen på disse er vesentlig høyere enn for konveksjonsovner ved lik vedomsetning. Eksisterende matematiske korrelasjoner basert på forsøk viser at selv for det som oppfattes som rene stråleovner så er andelen avgitt varme som konveksjon/stråling i området 40%/60%. Imidlertid monteres det ofte strålingsskjold på en eller flere sider av disse for å kunne oppnå «nær veggen opplevelser» noe som øker konveksjonsbidraget ytterligere, gjerne over 50%/50%. Hvis en stråleovn står inntil en brannmur på en eller flere sider vil også konveksjonsbidraget stige ytterligere. Fordelen med stråleovner i sin ytterste konsekvens er at de leverer all varmen som stråling til omgivende flater, noe som fordeler varmen relativt jevnt i rommets høyde men ujevnt i rommets lengde. Siden omgivende flaters masse er mye større enn massen til omgivende luft vil disse kun få en mindre temperaturøkning, som dermed resulterer i sakte bevegelse av romluften som følge av konveksjon grunnet temperaturdifferanse mellom omgivende vegger og luft.

For «rene» konveksjonsovner, dvs. alle vertikale flater unntatt fronten dekket med strålingsskjold, kan det beregnes at selv disse har en viss mengde varme som avgis som stråling, gjerne i et forhold opp mot 90%/10% som konveksjon/stråling. Fordelen med denne typen ovner er at man får en rask bevegelse av oppvarmet romluft gjennom en sirkulerende luftstrøm igangsatt av oppdriften mellom strålingsskjold og brennkammervegger. I praksis vil selv rene konveksjonsovner avgi mer enn 10% av varmen som stråling delvis gjennom vindusarealet og delvis fra andre flater som ikke er dekket av strålingsskjold. Akkurat hvilket forhold som gjelder er avhengig av den enkeltes ovns konfigurasjon. Konveksjonsprinsippet har og den egenskap at det genereres større vertikale temperaturgradienter enn ved oppvarming som stråling fordi den oppvarmede luften transporteres raskere mot høyden og horisontalt langs høydelagene enn varmen fordeles nedover. Denne temperaturgradienten øker med økende takhøyde.

Ingen vedovner kan per i dag kategoriseres som rene strålings- eller konveksjonsovner og faktum er at alle produsenter leverer ovner som er en blanding av begge typer, avhengig av vindusareal og andel ovnsflater dekket av strålingsskjold. NTNU og SINTEF vil framover ta i bruk nye simuleringsverktøy og kombinere dette med målinger for å kunne gi mer informasjon til ovnsprodusenter om fordeler og ulemper ved begge oppvarmingsmetodene under ulike forhold. Vi håper på denne måten å bidra til mer optimale konsept som i det lange løp vil gagne alle produsenter av vedovner og bidra til at vedovner vil ha en funksjon også i framtidens boliger.

Så vår konklusjon blir: Ja takk, begge deler! Så får fremtiden vise, basert på harde fakta, om mer av den ene eller den andre er å foretrekke under spesifikke betingelser.



Vennlig hilsen,
NTNU, Laurent Georges, Førsteamanuensis & SINTEF, Morten Seljeskog, Forsker og Øyvind Skreiberg, Sjefsforsker