Advances in European cord wood testing and policy

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Presentation abstracts

Abstracts of Presentations
At the 20016 Pellet Stove Design Challenge

Speakers provided abstracts of their talks and their powerpoint presentations will be added following the event. These are the abstracts submitted as of March 31. Bios of all the speakers can be found here and descriptions of the panels can be found here.

Team Presentations

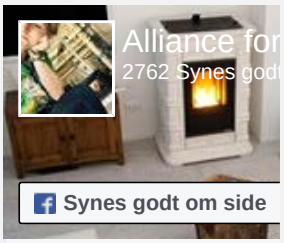
Wittus – Fire by Design (PEWOS-stove)
Representative/s: Niels Wittus & René Bindig
DBFZ and partners developed the PEWOS-stove, which is a combination of a down draft stove and a newly developed two stage pellet burner. The first stage is gasification/pyrolytic decomposition of the wood pellets, second stage is combustion/oxidation of the burnable gases. The complete burn-out takes place in the down draft stove, as well as the heat transfer to the surroundings. In addition, a catalyst converter on the basis of metal oxide foam has been integrated to minimize carbon monoxide, volatile organic compounds and soot. The heat output of the PEWOS-stove is between 13 kW (45000 Btu/h). PM values is lower than 10mg/m^3 and CO is 20mg/m^3.

Noble Metals Recovery (VibraStove)
Representative: Stephen Spevak
The VibraStove took it's inspiration from the popular Rocket Stove. My approach includes a gravity feed system and gasification. There would be no sensors, computer, or electronic controls. In addition I wanted a stove that could operate completely off-grid. All of these objectives have been reached, plus an unexpected bonus of having a stove that burns exceptionally clean, and efficiently. In reaching the objective it seems that a new type of burner was invented. This burner uses what I have termed "close coupled combustion". This method of combustion concentrates various processes into a very compact area. Co-mingled there is gasification, charcoal production, burning of the gases, and intense combustion of the charcoal caused by the velocity of the airstream being forced through the glowing embers. All this is accomplished by means of a sealed system except for a single point of entry for the outside air to enter into the blast furnace like conditions.

SUNY Buffalo
Representative: Dr. Joseph Mollendorf
The University at Buffalo design team has purchased and set-up a commercially available pellet stove as part of a NYSERDA funded project for the Alliance for Green Heat Pellet Stove Design Challenge. A Quadra Fire Classic Bay 1200 pellet stove was selected based on references from trusted sources. The first year of the project required the team to create an experimental setup to define the baseline emission level and combustion efficiency of the pellet stove without using any available specifications provided by the manufacturer. Therefore, by using a combination of undergraduate knowledge and engineering judgment in conjunction with the equipment selected, the team is confident in the accuracy of the experimental setup.

Repeatability in Pellt Stove Testing

Norbert Senf, Masonry Heater Organization
The author has conducted several experimental studies on particulate matter (PM) repeatability using the Condar portable dilution tunnel. In a recent study using cordwood in a masonry heater, a coefficient of variation of 25% was obtained, using 12 fuel loads matched for moisture, weight, sizing,



stacking and ignition. A previous study was conducted using pairs of matched dimensional lumber fuel cribs, and a CV of 10% was obtained. Recently, as part of the Pellet Stove Design Challenge, the Condar was operated simultaneously with an EPA Method 5G-3 sample train on short repeat runs of 1 – 1.5 hours on 3 stoves at 3 different burn rates. Over 18 test runs, the CV with the Condar was 3.1%, indicating that pellet stoves and the Condar itself can have very good repeatabilty in PM testing. The higher variation seen with cribs and cordwood in a batch burning stove was likely almost entirely due to the fueling. With the short pellet tests, the M5G-3 train showed higher variability, possibly due to difficulty in resolving the low PM catch weights with 2" filters as opposed to 6" filters.

Air Quality and Pellet Stoves

Andrea Ferro and Philip Hopke, Clarkson University

There are two aspects to indoor air quality arising from pellet stoves. First are the emissions from the stove itself and their impact on indoor air quality. Even a properly functioning, well vented stove will have some impact on the room and the house in which it is located. In addition, the pellets will also have an impact on air quality. Stored pellets emit both carbon monoxide and volatile organic carbon compounds with the amounts dependent on the type of wood in the pellets and their age. A discussion of the issues related to pellet stoves and fuels will be presented.

The European Stove Market

Jytte Boll Illerup, Technical University of Denmark

Wood stoves have the potential of providing CO2-neutral energy without transmission loss—but with the significant drawbacks of high emissions of pollutants and particulate matter at low altitude close to private homes, and with an uneven heat release profile, which produces non-optimal heating comfort. A collaboration project between the CHEC research centre at DTU Chemical Engineering and the stove manufacturing company HWAM A/S has led to development of an automatic control system for wood stoves, and the first version of an automatically controlled wood stove was launched on the market in 2012. The automatic control system developed for wood stoves in this project ensures optimal combustion conditions, thereby minimizing the emissions throughout a complete wood log combustion cycle. This improved performance has been verified by field tests in private homes.

Ricardo Luis Teles de Carvalho, SBi/Alborg University, Denmark

This presentation will focus on the aspects regarding the usage of residential wood-burning stoves in Europe, including the growing adoption of pellet stove technologies in Mediterranean regions. Some results from research work carried out in Denmark, Norway, Portugal and Spain will be presented and analyzed in this session. Experimental results regarding the performance of biomass combustion stoves and the effects of real-life practices in terms of thermal efficiency, particulate and gaseous emissions will be addressed. This research is based on the development of a new testing approach that combines laboratory and field measurements established in the context of the implications of the upcoming eco-design directive. The communication will cover technical aspects concerning the operating performance of different types of biomass stoves and building envelopes, in order to map the ongoing opportunities for the development of proper interplays between advanced technologies and future buildings in the region.

Marius Wöhler, BeReal, Germany

Existing test standards for biomass room heating appliances (pellet and firewood stoves, and inset appliances) have supported technology development tremendously in past decades. Due to today's changing and more demanding requirements, however, there is the obvious need for refined testing procedures in order to differentiate between poor and excellent products. Such differentiation should take into account operating conditions as they are found in real life installations. Offering such information to customers will create substantial competitive advantages to innovative SMEs providing high quality products and may provide a reliable guideline for future standards or regulations.
The key objectives of BeReal are:

- Development of advanced testing methods for room biomass heating appliances to better reflect real life operation
- Development of a centralized standard evaluation tool for quality assurance purposes
- Validation of methods at an early stage of development
- Proof of real life impact of advanced products by field test demonstration

- Proof of reliability and reproducibility of testing methods and evaluation tools through a Round Robin test
- Development and introduction of a quality label based on the novel testing methods

Determining Pellet Stove Efficiency

Gael Ulrich, Biocombustion Institute

If flue gas temperature and composition are known, one can calculate the efficiency of a biomass combustor using the so-call "stack loss" technique. This presentation explains in detail why that is possible and how to do it. Fortuitously, during the preparation of this bulletin, the Alliance for Green Heat published data from their testing of six pellet stoves this past September.1 Test equipment used in the AGH study delivered composition, temperature, and efficiency numbers. Investigators declined to report the efficiency numbers for various reasons, although they do mention a range of 60 to 75%. Using the AGH temperature and concentration data, I made independent calculations and found one of the six stoves operating at 51% efficiency, three in the low 60s, and the remaining two operating at 71 and 76%. I also conclude that some of these units use "dilution as the solution to pollution." If we consider actual emissions in grams per hour or milligrams per MegaJoule of heat delivered instead of parts per million in flue gas, the rating is rearranged with one stove deemed second dirtiest becoming the cleanest and that ranked third cleanest becoming the dirtiest. Factors that influence efficiency and cleanliness and how to improve these important performance properties will be discussed.

Development of Ultra-Clean Cord Wood Stoves

Taylor Myers and Ryan Fisher, MF Fire

We have seen a tremendous interest in innovation in the wood stove space— excited press coverage, enthusiastic regulatory agencies, and most importantly, eager customers. We believe that there is a strong demand for cleaner, more efficient, and easier to use wood stoves. But there are barriers to innovation, faced by small and large companies alike. Design and regulatory expenses make it difficult for a new company to enter the space. Regulatory tests methods are improving but are not designed for automated devices. In this talk we discuss the promise and challenges of innovation in wood stoves.

Jake Lindberg, SUNY Stony Brook

We will show the progress we have made in designing a next generation woodstove. We have identified segmented combustion, air intake control and an afterburner as the most promising systems to reduce concentration of Carbon Monoxide (CO), Volatile Organic Compounds (VOCs), and particulate matter (PM) in wood stove exhaust. By incorporating these systems into our stove design we hope to mitigate the effect of unseasoned wood, control air flow to facilitate complete combustion and reduce emissions caused by incomplete combustion. The preliminary results are promising.

Commercial Boiler Efficiency Protocol Report

Ben Bell-Walker, BTEC

The United States currently lacks an accepted testing protocol for the seasonal thermal efficiency performance of commercial sized boilers that are designed to run on solid biomass fuels (pellets, chips, briquettes, and cordwood among others). The Biomass Thermal Energy Council (BTEC) and its project partners have been engaged for the past few years in an effort to create a voluntary industry standard. One of those project partners is Brookhaven National Laboratory. Prior to validating the protocol by using it in a laboratory setting, BTEC has recently released a draft of that protocol for stakeholder feedback. Attendees of the Pellet Stove Design Challenge are invited to review the draft protocol (available from BTEC) and provide comments and ask questions in person based on their expertise in biomass fuels, combustion, testing and efficiency.

The Retrofit Challenge

Jeff Hallowell, Biomass Controls

In 2010 Biomass Controls, formerly ClearStak, noticed a growing need for a device that could reduce harmful pollutants being emitted from biomass appliances. To meet this need they invented the Pollution Control Device, a product that can be attached to the stack of a biomass appliance. Based on testing performed as part of the Puget Sound Clean Air Agency's Woodstove Retrofit Challenge, the Pollution Control Device can produce CO reductions of over 90%, VOC reductions between 77-92% and PM reductions of over 90%. The Pollution Control Device can be integrated with Biomass Control's patented Intelligent Biomass Controller (IBC). When connected to wireless the IBC offers a

user friendly platform that helps the user to operate the product more efficiently. Simple and easy to follow directions can be displayed on the IBCs display or an Android or iPhone mobile application. The data provided from the testing in addition to the data we are able to capture from our with our Kelvin software application have proven that installing the PCD on existing biomass appliances is a cost-effective way to reduce the harmful effects of woodsmoke and easily allow the user to manage and/or monitor their furnace.

Ultra-fine particles from bark and wood

Dr. Barbara Panessa-Warren

Is bark the primary variable that Determines Combustion Emission Nanoparticle production, and the potential for Health/Environmental Risks? This presentation shows the differences in composition and types of nanoparticle emissions from cord wood (with bark) fired- and wood pellet (no bark)-fired stoves/ boilers to see if the absence of tree bark altered nanoparticle production/composition, reducing potential health risks. We examined the morphology and composition of combustion emission nanoparticulates and their aggregates, released from oak cord wood-fired (conventional and new technology) stoves/ boilers; and the nanopartices from wood pellet-fired new technology stoves/ boilers. Although the cord wood-fired stoves/ boilers produced more carbon nanoparticulates and soot, the advanced technology appliances and those operating with catalysts reduced or eliminated metals and numbers of carbon particulates. The wood pellet-fired stoves/boilers produced fewer graphitic and graphene nanoparticles, and no high atomic number metals, when compared to the cord wood-fired appliances. However nanoparticle production and elemental composition, were also altered by operational conditions, the use of catalysts, and burn cycle/operational phases.