WELL BURNED MEANS CLEANLY BURNED

Wood heating is making a growing contribution to the substitution of fossil fuels and is thus contributing to a sustainable energy supply. Wood burning is CO₂-neutral, but produces dust that is potentially unhealthy. Aerosols can now be controlled with appropriate equipment and correct behavior—an international conference in mid-June at ETH Zurich made that clear.

Investigation in a wood-buring stove in the laboratory at the University of Lucerne - Engineering and Architecture. Photo: HSLU

Particulate matter has many sources. Tiny particles in the micro and nanometer scale (PM10) are produced during combustion of oil or coal to generate heat and electricity in power plants, industrial enterprises or residential buildings. Fine dust additionally arises from diesel engines in road and rail transport, in agriculture, forestry and construction sites (combustion processes, abrasion). Also when fires are blazing in cozy domestic wood stoves, fine dust is produced that can be inhaled by humans and that can attack the lungs. Particulate matter is a complex mixture to which secondary particles...
Well Burned Means Cleanly Burned

Ve 70 kW. “Switzerland has made enormous progress in the fight against fine dust in the past two decades and today in international comparisons has first-class air quality. The current review of the OAPC will bring further improvements,” says Daniel Binggeli, SFOE expert on bioenergy.

Fine Dust from Small Wood Furnaces

The burning of wood and other types of biomass has growing importance—it contributes to a sustainable energy supply, since the combustion of renewable resources is CO2 neutral. Wood heating, however, contribut approximately 10 to 30% to annual man-made particulate matter pollution, depending on the location. Automatically operated wood chips furnaces today operate relatively cleanly thanks to the
use of high combustion temperatures. Although particulate matter is formed during this high-temperature combustion processes too, it is in the form of inorganic ash that in large furnaces is retained by separators.

In addition to the approximately 8,000 such modern wood furnaces in Switzerland, there are still 56,000 wood-fired central heating systems and 539,000 fireplaces and wood stoves in operation. Many of them release more fine dust into the environment as some operators think. “In many small wood-fired systems, the wood is not burned completely, thereby collecting soot and other forms of particulate matter with sizes measuring less than 10 microns (PM10) too,” says Prof. Thomas Nussbaumer, combustion expert at the University of Lucerne and owner of the consulting firm Verenum (Zurich). “We must focus technical improvements on allowing complete combustion of wood. In addition, operators must be trained and the particulate emissions be subject to consistent control,” said Nussbaumer.

International Exchange of Experience

In mid-June 2016, Nussbaumer was a keynote speaker at the 20th Conference on ‘Combustion Generated Nanoparticles’ at ETH Zurich, helping engineers and physicians find new solutions for the fine dust problem. The conference module on biomass combustion was co-organized by ‘32 IEA Bioenergy Task’, a working group of experts from 14 countries under the umbrella of the International Energy Agency (IEA) that is concerned with technical and economic aspects of biomass combustion (see p. 5). The panel enables Switzerland – represented by the Swiss Federal Office of Energy – to exchange ideas with neighboring countries Germany, Austria, Italy and Scandinavian countries such as Sweden and Norway, which like Switzerland have high standards for combustion technology and strict limits.

This international exchange in Zurich was shown by Dr. Hans Hartmann from TFZ Competence Centre for Renewable Row Materials (TFZ-Kompetenzzentrum für nachwachsende Rohstoffe) in Straubing near Munich. Hartmann reported his findings of small wood-burning stoves and fireplaces: In order to minimize emissions, the wood must not be too moist, but also not completely dry. Also important is to correctly load the furnace and to light the fire from above and not from below, as is still practiced by many fireplace-friends. The diameter of wood logs also has a significant impact on dust production: If the diameter is too small, the level of particulate dust can be three times higher than if the wood is optimally sized.

“The user actually has a greater impact on the particulate matter load than the technology used” concluded Hartmann at the conference.

Novel Test Methods

Other speakers in Zurich addressed the chemical and physical properties of fine dust particulate matter and also the procedures and standards that are used to detect particulate matter and other emissions from wood combustion. Becau-
se of the “Diesel scandal” at VW and other carmakers, the reliability of existing test methods is a hotly debated today. For example, Dr. Christoph Schmidl of the Austrian Bioenergy 2020+ presented in Zurich a test method that is able to depict the emission behavior of wood heating by simulating comparatively realistic load cycles. The conference contributions to “Session 2: Biomass Combustion (co-organized by task 32 of IEA Bioenergy)” are available through the following link: http://www.nanoparticles.ch/2016_ETH-NPC-20.html

Information on IEA Bioenergy Task 32 and the conference theme wood-fired emissions are available from Dr. Sandra Hermle (sandra.hermle[at]bfe.admin.ch), head of the SFOE-research program bioenergy.

Technical papers on research, pilot, demonstration and flagship projects in bioenergy are available here: www.bfe.admin.ch/CT/biomasse.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Load cycle</th>
<th>Real life</th>
<th>Load cycle</th>
<th>Real life</th>
<th>Load cycle</th>
<th>Real life</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>[mg/m³STP]</td>
<td>272</td>
<td>343</td>
<td>434</td>
<td>368</td>
<td>415</td>
<td>447</td>
</tr>
<tr>
<td>NOx</td>
<td>[mg/m³STP]</td>
<td>110</td>
<td>135</td>
<td>158</td>
<td>151</td>
<td>128</td>
<td>120</td>
</tr>
<tr>
<td>OGC</td>
<td>[mg/m³STP]</td>
<td>9</td>
<td>7</td>
<td>24</td>
<td>7</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Dust</td>
<td>[mg/m³STP]</td>
<td>37</td>
<td>26</td>
<td>30</td>
<td>32</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Efficiency</td>
<td>%</td>
<td>78.2</td>
<td>75</td>
<td>75.2</td>
<td>83.6</td>
<td>81.1</td>
<td>83.2</td>
</tr>
<tr>
<td>Annual Efficiency</td>
<td>%</td>
<td>-</td>
<td>72.4</td>
<td>-</td>
<td>78.8</td>
<td>-</td>
<td>81.4</td>
</tr>
</tbody>
</table>

The table compares the measured values (load cycle) during this load cycle test for carbon monoxide (CO), nitrogen oxides (NOx), organic gaseous hydrocarbons (OGC, commonly also known as volatile organic compounds (VOC)) and total dust (Dust) with “in a field” (real life) measured test values, for three wood-pellet burning furnaces (STP is Standard conditions for Temperature and Pressure). The trained eye will recognize that the load cycle test is in relatively good agreement with the field test values – much better than with the classical bench test measurements that use unrealistic values. Table: Bioenergie2020+

INTERNATIONALLY CONNECTED

Working groups (“Tasks”) of the International Energy Agency (IEA) are an important tool with which Switzerland promotes international exchanges in the field of energy technologies. The IEA currently has 39 programs (“Technology Collaboration Programs” / TCP) that are each dedicated to a specific energy area—Switzerland participates in 20 of these programs. To concretely implement international cooperation, each program has a number of Tasks in which experts from various countries work on a specific theme.

One of the IEA programs with Swiss participation is Bioenergy. Under this program, ten working groups are active and Switzerland participates in three: Task 32 (Biomass Combustion), Task 33 (Gasification) and Task 37 (Fermentation). Each working group will work on specific questions that will be defined during a three-year program under the strategic guidelines that were previously formulated by the Executive Committee of the program. Switzerland is represented in all relevant Executive Committees of the IEA programs with an expert from the SFOE.

“The experts within the Tasks prepare scientific publications that give each country an important impetus for the development and use of particular energy sources,” says Dr. Sandra Hermle, who represents Switzerland in the Executive Committee of the Bioenergy Program of IEA. “The working groups serve for mutual exchange and thus provide the framework to determine, in collaboration with professionals from other countries, specific energy technologies that will address future national issues.” BV