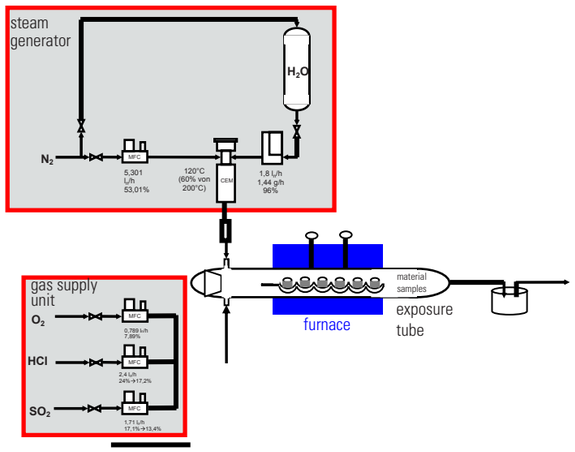
MPIE tests the corrosion resistance of materials

The "High Temperature Reactions (HTR)" group at MPIE focus its research on high temperature reaction phenomena of metals in the presence of gases, solid particles and melts, in particular on High Temperature Corrosion processes in waste and biomass incineration plants where the fireside corrosion by combustion gases and ash deposits is the major limiting issue for the application of steels as heat transfer surfaces.

In the EC-funded project NextGenBioWaste the MPIE takes part in WP2.3 where it is mainly involved in investigating the potential of newly developed laboratory materials, basically FeCrSiAl alloys and iron aluminides, as well as commercial used alloys. Therefore the long-term performance will be investigated of model alloys covered with laboratory prepared synthetic deposits and exposed in gas atmospheres simulating the conditions in incineration plants. A schematic scheme of the High Temperature Corrosion lab-scale facility including a gas supply unit, a steam generator and an exposure tube inside an electric furnace where the material samples are tested is shown below.



Schematic scheme of the lab-scale exposure facility

One of the results of the laboratory tests is that the reaction of solid and especially molten salts on the metal surface is responsible for most of the corrosion phenomena. The 'active oxidation' mechanism plays a special role of alloying elements. This is a chlorine catalysed reaction cycle leading to enhanced oxidation via volatile metal chlorides as intermediate products.

Contact: Max-Planck Institut für Eisenforschung GmbH ,
Markus Schmitt, Schmitt@mpie.de

Retrofit of the grate incinerator at AVR

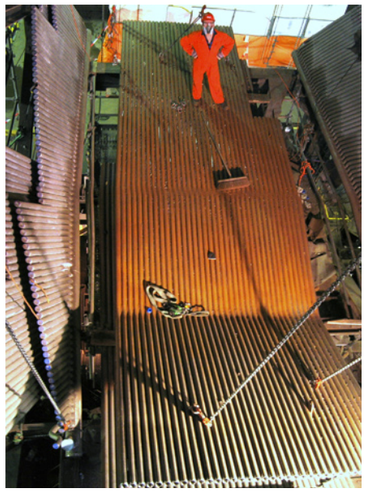
AVR is specialised in solutions for waste and environmental problems and is now the largest waste processing company in the Netherlands.

At the production site in Rozenburg, near Rotterdam, AVR has six grate incinerators in operation. The grate incinerators process more than a million tons of household waste annually. This process results in a production of about 110 MWel, sufficient for approximately 295,000 households.

In the NextGenBioWaste project, AVR is successfully retrofitting one of the six counter flow WtE-line to a more effective 'current flow concept'-incinerator. The oxygen level will also be reduced to 4-6%, and additional advantages are expected:

- Increase waste throughput and steam production
- Decrease boiler fouling
- Increase operation time
- Increase availability

AVR will demonstrate that it is possible to retrofit existing incinerators to state of the art efficient current flow system, leading to technical and environmental improvements. The work will be supported by new advanced measurement techniques and CFD calculations.



Wall modification to current flow

Contact: AVR - Afvalverwerking B.V., wim.roelofs@avr.nl

Other news

Annual meeting in Brescia

The annual General Assembly meeting and the semi-annual Executive Board meeting were arranged in Brescia, Italy in March 2007. Nearly all the participants were together during two days. A site visit at the ASM plant was also included. Thanks to ASM for an excellent arrangement.

The participants in front of the ASM plant

NextGenBioWaste conference

"The First International Conference on Biomass and Waste Combustion" will be arranged 8-10 October 2008 in Italy as a part of the NextGenBioWaste project. The conference will be technical and the progress beyond state-of-the-art on new technologies for retrofit and new combustion plants will be presented.

First announcement of the Conference with more specific information will be issued soon.

New bed bottom design installed in Nyköping

The new bed bottom has been installed on schedule in the Nyköping plant. Vattenfall Nordic Heat started up the plant in September. This is a BFB steam boiler for CHP production, and it is retrofitted to be adapted for operation with 100% waste wood.

Co-funded by the European Commission under the Sixth Framework Programme
Integrated project; research and demonstration - Contract No: TREN/05/FP6EN/S07. 56773/019809

Co-ordinator: SINTEF Energiforskning AS (SINTEF Energy Research), Senior Research Scientist Lars Sørum
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Newsletter

No 1 - 2007

NextGenBioWaste deals with waste and biomass feedstocks and covers the supply chain from fuel preparation, via conversion to ash treatment and use.

NextGenBioWaste is up and running

NextGenBioWaste is a huge and complex project with challenging targets to be reached by the end of the project in 2010. NextGenBioWaste has 17 partners from 7 countries working together to reach those targets.

Getting started "on the right foot" is very important in order to make this project run smoothly. The technical challenges to be met in the planning and engineering phase of this project are something each and every partner needs to deal with. In addition to all technical challenges, the challenges connected to managing the project needs special attention. The project manager Einar Jordanger together with the project management team (PMt) has put a lot of effort into creating a management and dissemination system which allows a smooth and effective day to day operation of the project. Given all technical and non-technical challenges to be met I am very happy to say that the Consortium as a whole are doing very well and delivering an impressive 21 out of 24 deliverables for the first year reporting.

You will read about several demonstration activities in this first newsletter which certainly can confirm that NextGenBioWaste "is up and running". Not only have several demonstration facilities been planned, engineered and built, but they are also producing their first results.

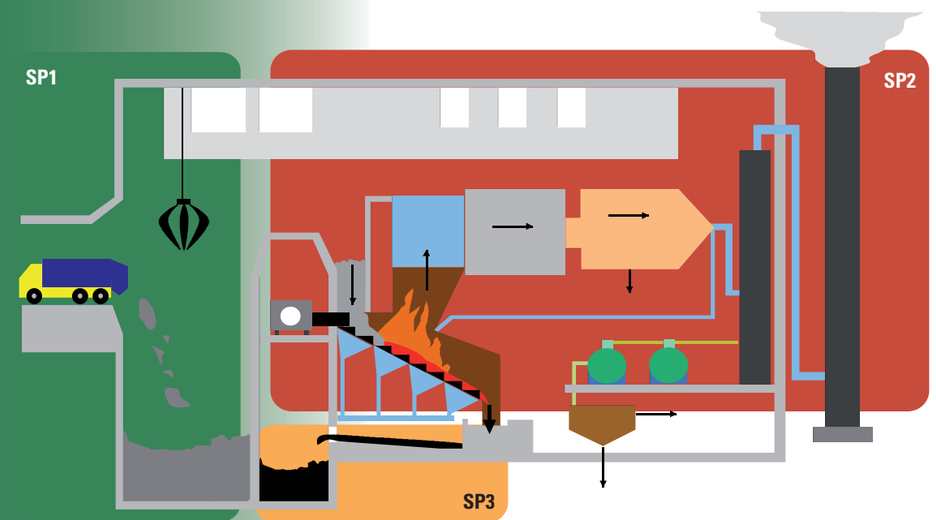
Dissimination of information from the project is another important and integrated activity in NextGenBioWaste, and a very strong foundation for promoting all innovative approaches in the project has been laid through several dissimination activities.

This is the first Newsletter from NextGenBioWaste, but make sure to read the ones that follow in order to get updated on the very latest news from a project packed with new innovative technology for the next generation of waste and biomass combustion plants.

Contact: Co-ordinator Lars.Sorum@sintef.no

The NextGenBioWaste project

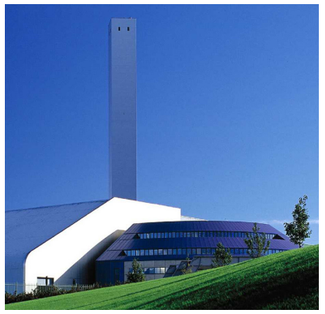
The NextGenBioWaste project is a four year integrated project within the EU sixth framework programme. The consortium comprises utility companies, technology providers, RTD providers and one consultant company.



NextGenBioWaste is targeting to perform innovative demonstrations of improvements to energy recovery and renewable electricity production from waste materials and other commonly used biomass feedstocks.

The overall objective of the NextGenBioWaste project is to improve the electric efficiency, reliability, performance and environmental compliance of waste and biomass combustion plants, which produce heat and electric power, and to reduce costs at a competitive level.

Innovative high-dust SCR system for NOx reduction



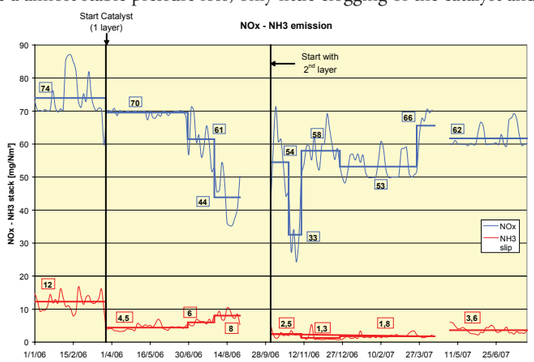
Brescia WTE plant

The main contribution of ASM to the NextGenBioWaste project is the installation and subsequent testing of an innovative system for NOx abatement in a WTE boiler. This boiler was already equipped with a flue gas recirculation system and with a SNCR system for NOx reduction, optimized during the past years of operation, which allowed the boiler to have about 80 mg/Nm³ of NOx concentration in the flue gas, well below the European limit of 200 mg/Nm³. The SNCR system consists of a series of nozzles that inject ammonia into the furnace where it reacts with oxygen and nitrogen oxides transforming them into gaseous nitrogen and water.

The new implementation at ASM is a high-dust Selective Catalytic Reduction (SCR) system. In practice it is a catalyst which helps the reaction between ammonia, oxygen and nitrogen oxides. In this way a lower concentration of NOx is achieved in the flue gas as well as a lower ammonia consumption and a lower concentration of residual ammonia (ammonia slip) in the flue gas. A similar type of catalyst is already known to the market but it is normally installed in the final part of the gas path, where flue gases have already passed through all the cleaning processes. Then the technology requires reheating of the gas, that is too cold for the catalyst to be effective, resulting in reduced plant efficiency and a more complex installation because additional heat exchangers are required.

In the ASM demonstration the catalyst is installed along the gas path where the temperature is already suitable for it to operate, and this is the first attempt for the technology in large scale industrial plant. The risks are mainly the possibility for the catalyst to clog (gases are still full of particles because they have not passed through the filters yet) and to poison because of the sulphates content of the gases not yet treated with lime.

The catalyst started its operation at the end of March 2006, in the first months of the NextGenBioWaste project, and worked with only one catalytic layer installed until September 2006 when, during the annual major overhaul of the boiler, it was checked and cleaned. A second catalytic layer was installed and the operation restarted at the end of September. After that the boiler and the catalyst operated for one year almost continuously. The results after more than one year of operation are a almost stable pressure loss, only little clogging of the catalyst and a rather good efficiency of the catalyst. The diagram shows the emissions of NOx and NH_3 slip of the unit. It could be seen that with the catalyst implemented both these emissions are reduced; furthermore it is clear that with aging and fouling of the catalyst the NH_3 slip increases slowly with a limited variation in NOx concentration, both however remains below the concentrations reached by the unit before implementing the catalyst.



The high dust SCR system has reduced the NOx emission and the ammonia slip.

These results need to be confirmed during a longer period, particularly for the problem of possible poisoning of the catalytic material. This material is very expensive, this is the reason why it needs to last several years for the technology to be competitive; if poisoning decreases the catalyst effectiveness too rapidly the technology will prove too expensive. Furthermore the system still needs to be tested at different conditions and to be improved in order to find its optimum working point.

Contact: ASM BRESCIA SPA, Lorenzo Zaniboni, Zaniboni@asm.it

Vattenfall is using additives to reduce corrosion and deposits in boilers burning household waste

Burning household waste efficiently in boilers to generate electricity is a huge technical challenge. The waste forms very corrosive gases and large amounts of corrosive ash. The ash forms deposits on critical components in the boiler, blocking the flue gas passage and causing components to corrode very quickly. This means that the efficiency of the process is limited and the boilers may need to be shut down for cleaning or maintenance. If the corrosion and deposit build-up problems could be solved it would be possible to increase the efficiency of the process and generate more electricity.

Three companies in the Vattenfall group have been working together to solve these problems. Vattenfall has developed and patented an additive which essentially neutralises the corrosive chlorine components in the gases. Therefore the additive is known as “ChlorOut”. The ChlorOut patent, which covers sulphate solutions that are sprayed into the flue gases, has previously been shown to work very well in wood-fired power station boilers, but not tested in waste-fired boilers. There are some similarities in wood and household waste (they both contain alkali chlorides), but there are also a lot of differences as waste contains more chlorides and other low temperature melting point metals like zinc and lead.

Within the NextGenBioWaste project the ChlorOut additive has now been tested in two waste-fired boilers. One was a grate boiler in Hamburg, Germany that burns mainly household waste and the other a fluidised bed boiler in Norrköping, Sweden that burns 50% household- and 50% industrial waste. In both boilers a marked reduction of the corrosive alkali chlorides was seen when the sulphate additive (ammonium sulphate) was injected. The amount of deposit build-up was halved and the corrosiveness of the deposits was reduced. There were also some environmental benefits to using the additive. The level of nitrous oxides in the flue gas was drastically reduced and a reduction in the amount of dioxins in the fly-ash was also detected.

The ChlorOut additive will be permanently installed in the boiler in Hamburg during the autumn of 2007. A long-term evaluation involving boiler operation and corrosion will then follow.

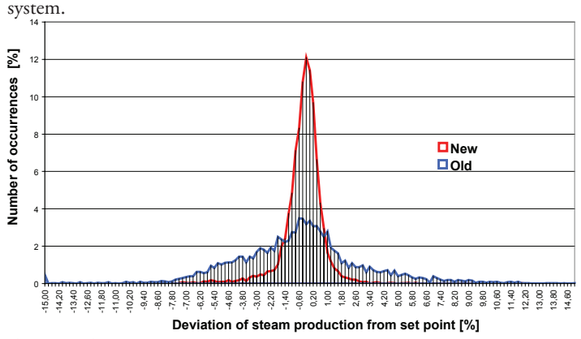
One of the goals is to halve the amount of corrosion caused by waste-fired boilers. It is thought that this can be achieved with the use of better materials and the use of additives.

Contact: Vattenfall, Pamela.Henderson@vattenfall.com

New trend-setting combustion control system

In the context of the NextGenBioWaste project, a new trend-setting combustion control system was installed and optimized at GKS in our waste to energy plant in Schweinfurt. The new combustion control system together with further technical measures along the flue gas way could increase the throughput performance of the plant by 10%.

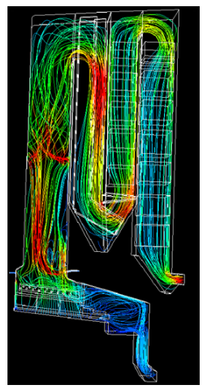
The main task of a combustion control system is to run the energy conversion (waste to steam) very stable at the maximum technical load. Furthermore the conditions of the combustion have to be as stable and suitable as possible, to avoid uncontrolled conditions which can force deposits in the boiler and corrosion at the boiler tubes. The achieved control accuracy with the new system shows a clear improvement compared to the previous system (see below). The control system is built up modular and structured. By integrated interfaces further innovative systems (e.g. GKS-combustion-chamber-model -which is another part of the project, see later) can be integrated. Next step in the project will be to validate an MPC (model predictive control) with this control system.



Deviation of steam production from set point; the red line is the new-, the blue line is the old combustion control

By means of CFD (computational fluid dynamics) simulations a reduction of the loss of pressure could be reached at critical components in the flue gas cleaning system, particularly at the scrubber. The results of the simulation are confirmed by the operation data measured in practice.

CFD simulations of the furnace and boiler have also been performed to investigate possibilities for futher optimisations. One weak point of such simulations till now, is that the boundary conditions, especially the release of volatiles from the grate bed, in CFD simulations are set as idealized. In the GKS-combustion-chamber-model the boundary conditions can be calculated 3-dimentional. More precise start conditions will lead to CFD simulations that are more efficient and support the future constructive and process measures to optimise the GKS process in order to reduce deposits and corrosion. On the other hand instationary conditions can be calculated with the GKS-combustion-chamber-model more than 100 times faster than real time. That gives the opportunity to run the model aside the real plant to deliver not measurable data for the above mentioned new control system.



CFD simulation of furnace and boiler

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Eco-probe to control acid dewpoint corrosion

The exit temperature of the flue gas from the recovery boiler has a detrimental influence on the energy efficiency of a Waste-to-Power (WtP) plant. The lower this temperature, the lower the stack losses and, therefore, the higher the recovery efficiency. However, the risk on acid dewpoint corrosion of the steel surfaces, due to condensation of sulphuric acid (H_2SO_4) formed from SO_3 and water vapour in the flue gas, limits the minimal boiler exit temperature. The same type of corrosion can occur when operating with low boiler feedwater temperature. Operating at low feedwater temperature increases the efficiency of the heat exchange, allowing a smaller economizer section of the boiler, which reduces investment and operational cost. Current designs of WtP plants use a conservative estimate of the acid dewpoint, resulting in suboptimal energy recovery rates and higher costs.

At present, no reliable direct measurement sensors for the determination of the SO_3-content of the flue gas or the acid dewpoint itself are available. Using a water-cooled ‘Eco-probe’, Keppel Seghers Belgium will perform indirect measurements of the acid dewpoint of the flue gas at the exit of a WtP boiler, and determine the correlation between the combustion parameters, the waste and dewpoint corrosion.

The probe, which consists of a double walled steel pipe end, will be inserted downstream of the economizer section of the boiler, and by means of a steady water flow with a controlled temperature, the skin temperature of the probe will be lowered systematically to temperatures between 80 and 130°C. In this way, the onset, progress and intensity of acid dewpoint corrosion of the probe can be studied.

The data will provide information on the minimal boiler exit and boiler feedwater temperature that can be used in the design of future plants. These temperatures are expected to be considerably lower than what is adopted today, and will lead to a significant increase in plant efficiency and a reduction of investment and operating costs.

Ecoprobe cooling circuit installed at ISVAG (Belgium).

The measurement campaign will be initiated at the ISVAG WtP plant in Wilrijk (Belgium). By August 2007 the installation of the Eco-probe was completed, and the actual measurement campaign started in September. It is likely that the set-up will be duplicated in other reference plants of Keppel Seghers to study the impact of the type of waste.

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