Seven new orders for bioenergy plants

Wärtsilä Biopower has gained orders for seven biofuelled energy plants during the first few months of 2003. Wärtsilä will supply both complete bioenergy plants and process equipment to Sweden, Russia and the Baltic countries. These new orders are an important step in Wärtsilä's strategy of becoming the first global supplier of small-scale biopower plants.

Demand for small power and heating plants for decentralized energy production is growing fast and the use of biofuels in electricity generation is rising in Europe.

Plants to Sweden

Two of the new orders are for Sweden. District heating company **Vilhelmina Värmeverk AB** has ordered a 10 MW_{th} process equipment package to meet local district heating and sawmill needs.

Tekniska Verken i Linköping AB, a heating utility owned by the city of Linköping, has placed a turnkey order for a 3 MW_{th} bioenergy plant and a 5 MW_{th} oil-fired boiler plant to produce energy for the local district heating network. Wärtsilä has previously supplied the same customer with a combined heat and power plant based on gas-diesel engines.

Bioenergy for Russia and Estonia

The Finnish-Russian joint venture **ZAO Pestovo Novo** has ordered a turnkey 10 MW_{th} bioenergy plant for the town of Pestovo in the Novgorod region, where Finnish UPM-Kymmene will supply a sawmill in co-operation with a Russian timber company.

Wärtsilä has also been contracted to deliver three bioenergy plants to Estonia; two plants for sawmills and one for district heating.

AS Näpi Saeveski, part of Estonia's largest sawmill company Sylvester Group, has ordered process equipment for a 6 MW_{th} bioenergy plant in Lääne-Virumaa. The new plant, which will replace an old plant, will burn sawmill waste.

AS Sauga Saeveski has ordered a 6 MW_{th} bioenergy plant for a sawmill in Sauga. This plant will produce heat from bark, chippings and sawdust for the sawmill's drying process. **OÜ Pogi** has ordered a turnkey 8 MW_{th} bioenergy plant for the town of Paide.

Lithuania's first

UAB Sylvester Alytus in Lithuania has ordered a turnkey 8 MW_{th} bioenergy plant for the town of Alytus, Wärtsilä's first power plant order in Lithuania and therefore a breakthrough in this market. ■

As NO_X emission limits become increasingly stringent Wärtsilä has successfully tested the compatibility of selective catalytic reduction (SCR) with gas and dual-fuel engines for extremely low emission levels.

Parallel with the first commercial installations of the Ultra Low Emissions (ULE) Solution with Wärtsilä SG gas engines, Wärtsilä has continued development of the ULE solution for dual-fuel engines. In a dual-fuel engine, ignition of the lean air-fuel mixture is initiated with injection of a small amount of LFO as the pilot fuel. The engine can also be run in pure liquid fuel mode.

During the tests, the compatibility of the SCR solution with the specific features of the DF engine were confirmed and further optimized. Apart from pushing the limits for NO_X abatement, this was also an excellent opportunity to collect extensive information on other emission components and their abatement in the selective catalytic reduction (SCR) system.

The near future can be expected to generate projects where NO_X and other emissions need to be reduced to even lower levels. In these projects, an in-depth knowledge of emission technology will certainly be a great asset.

SCR Theory

The catalyst elements in the SCR lower the activation energy between NO_X molecules in the exhaust gas and injected ammonia (NH_3). Harmless nitrogen (N_2) and water (H_2O) are formed as a result of reactions (1) and (2) below.

$4\ NO + 4\ NH_3 + O_2 \rightarrow 4N_2 + 6\ H_2O$ (1)

$6\ NO_2 + 8\ NH_3 \rightarrow 7\ N_2 + 12\ H_2O$ (2)

Reducing NO_X emissions close to zero ppm-v without NH_3 slip puts high demands on the design of the SCR system:

- For the NO_X and NH_3 molecules to get into contact with each other, the reagent (NH_3) needs to be well mixed with the exhaust gas before entering the catalyst.
- The retention time of the reagents in the SCR must be long enough for all NO_X and NH_3 molecules to have time to react on the catalyst surface. That is, the catalyst volume needs to be large enough.
- A delicate balance between the NO_X in the exhaust gas and the injected NH_3 is needed. Too little NH_3 will not allow all NO_X to be reduced. Conversely, a surplus of NH_3 will lead to emissions of NH_3, usually referred to as NH_3 slip.

Apart from their ability to catalyse the reduction of NO_X, the SCR elements have many other interesting properties, including their activity towards oxidation of higher hydrocarbons. There also exist modified SCR elements with additional

The Ultra Low Emissions Solution for dual-fuel

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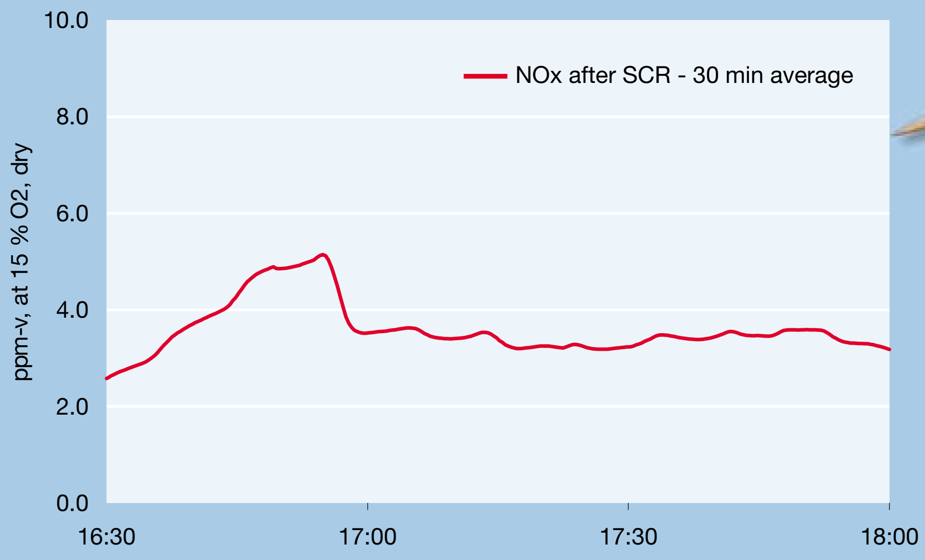

Figure 1 Measured NO_X after the SCR

properties such as a high activity towards oxidation of CO and organic compounds as well as activity towards oxidation of excess NH_3 to harmless N_2.

Test set-up

The test was performed at full scale by upgrading an existing SCR system. The SCR was installed after a Wärtsilä 32DF engine with an electrical output of 5.8 MW_e. The upgrading included more than doubling the catalyst volume and optimizing the NH_3 injection system.

During the test campaign, a NO_X analyser was connected to the SCR control system to enable feedback control of the NH_3 injection. To comply with local CO legislation, the original SCR system already included an SCR catalyst layer with enhanced oxidation ability.

After the system was upgraded, extensive testing was performed on the fresh catalyst. The measured components included NO_X, NH_3, particulate matter, polycyclic aromatic hydrocarbons (PAH), hydrocarbons and more exotic components. Follow-up testing was performed after one year (6000 running hours) following a similar measurement plan.

During the campaign, SCR performance was tested with different sets of catalyst element loading. Items such as pressure drop, control system performance, and catalyst performance drop with time were monitored to ensure problem-free long-term operation in commercial installations.

Test results

Simultaneous measurements of both NH_3 and NO_X verified that it is possible to achieve both the targeted NO_X emissions and NH_3 slip. Figure 1 shows recorded NO_X emissions after the SCR and a calculated 30-minute average. The 30-minute average stayed below 5 ppm-v, 15% O_2, dry, during the measurement period.

Simultaneous sampling of NH_3 showed that the NH_3 slip was well below the targeted 5 ppm-v, at 15% O_2, dry. With better settings, especially for the control system, even higher performance was indicated. The follow-up measurements confirmed the same high performance after one year of running.

The measurement campaign also provided interesting results for many other emissions components than NO_X and NH_3. This included both uncontrolled and controlled emissions, thus also indicating the abatement efficiency of these emissions in the SCR. From a long list of test results, the efficient abatement of formaldehyde and PAH in the SCR, as well as the oxidation of NH_3 slip in the special SCR elements can be highlighted.

Conclusions

The R&D project has further verified the SCR design for an Ultra Low Emissions Solution for gas and dual-fuel engine installations. Apart from proving the NO_X abatement, the test added valuable information on a broad range of emissions, both engine emissions and the effect of the SCR on these emissions.

The project also provided a lot of insight into the critical design issues for low-emission gas plants and further enhances Wärtsilä's ability to offer gas power plant solutions for even stricter emission requirements in the future. ■