Vattenfall present at the 10th International Conference on Greenhouse Gas Control Technologies

On 19 September, the 10th International Conference on Greenhouse Gas Control Technologies opened in Amsterdam, the same city as the conference was first held in 1992. At that time, the CCS concept was new and fairly unknown. Nevertheless, 250 delegates attended. This year, more than 1 500 people gathered from all over the world to both share and hear about the latest news and the most recent research and, not least, to meet new acquaintances within the CCS community. The theme of the conference was "From research to reality", in many ways reflecting where Europe is right now on issues concerning CCS, not least for Vattenfall, which is developing demonstration projects in both Germany and the Netherlands.

The GHGT conference is the largest conference in the world with a CCS focus. Around 1 000 papers were accepted this year, 250 of them were presented at the eleven technical sessions and at the two poster sessions where participants could discuss among 750 posters with their authors. The entire CCS value chain was covered during the four-day conference.

Public perception, a hot topic

A topic that attracted increasing attention this year compared to earlier conferences was public acceptance. Beside posters and technical sessions, panel debates and keynotes were also dedicated to this subject. In the panel of one of the discussions, called *Public Perception and Acceptance – Lessons Learnt*, Professor Niels Peter Christensen shared some of the experience Vattenfall has gained from CCS activities in Germany and Denmark. Niels Peter emphasised the importance of onshore storage and local storage locations (see also article on page12) and presented the issues that should be given priority when developing suitable geological storage sites. For example, the safe storage of CO2 was mentioned as a prerequisite and as an issue of great importance to the local population. Emphasis was given to the importance of, and opportunities for, creating local benefits in the area of the storage site. This can be done by forming alliances with local business, creating activities or jobs and so on.

Vattenfall's contributions

Vattenfall presented results and conclusions from its research and development projects and studies. A selection of these is described below.

One of the papers by Vattenfall was *Flue Gas Cleaning for CO_2 Capture from Coal-fired Oxyfuel Combustion Power Generation* (Yan, J. et al). The paper presented current progress in the area of flue gas cleaning for Oxyfuel combustion and significant improvements in understanding the characteristics of SO_x, NO_x, particulate matters (PMs) and non-condensable gas components in flue gas cleaning processes. In Post-combustion and Pre-combustion for coal-fired power generation, CO_2 is selectively captured from the flue or fuel gases. In Oxyfuel combustion, on other hand, CO_2 capture is a CO_2 enrichment approach, where the main purpose of flue gas cleaning is to control the non-CO_2 components for both the CO_2-capture process and the boiler operation. Based on conceptual development, fundamental understanding and practical tests at the Schwarze Pumpe Oxyfuel Pilot Plant (OxPP), it has been proved that flue gas-cleaning systems have reached the performance level that can be considered achievable. The paper also concluded that there are generally no

technical bottlenecks for most of the flue gas-cleaning technologies. Finally, it was suggested that further research should focus on comprehensive optimisation of the flue gas cleaning-processes combined with boiler and downstream CO_2 compressing processes. The knowledge obtained from the Oxyfuel Pilot Plant will be transferred and further proved in large-scale demonstration plant applications.

Dynamic simulations for transport and storage

The two papers *Dynamic simulations of a carbon dioxide transport pipeline for analysis of normal operation and failure modes* (Liljemark, S. et al) and *Simulating rapidly fluctuating CO2 flow into the Vedsted CO2 pipeline, injection and reservoir* (Klinkby, L. et al) described studies of load variations in energy production and captured CO2 amounts and the effects on transport and storage systems.

In February 2008, Vattenfall announced plans to build a full-scale Postcombustion CCS demonstration plant for the capture and storage of CO2 from the power plant Nordjyllandsværket. However, Vattenfall decided in 2009 to postpone the project and Nordjyllandsværket has instead been developed as an early commercial CCS project. Nordjyllandsværket is a modern power plant designed such that the electricity output can be varied in accordance with market prices for electricity. This is increasingly necessary in Denmark, where 20% of the electricity is now generated by wind turbines with a highly-fluctuating market contribution. These daily and hourly load variations need to be handled by the entire CCS system, from the capture plant to the reservoir. Therefore, in 2009, Vattenfall performed two studies in which the rapidly-fluctuating CO2 flows into the Vedsted CO2-pipeline, injection well and reservoir were simulated along with the response of such transient variations in the pipeline, well and near the wellbore reservoir. One focal point was the occurrence of two-phase flow, i.e. the liquid CO2 becomes gaseous due to pressure reductions. Phase changes will have implications for transport capacity and challenge the technical design of the entire system.

The results of the study that relates dynamic reactions in the pipeline with those in the storage reservoir (*Simulating rapidly fluctuating CO2 flow into the Vedsted CO2 pipeline, injection and reservoir)* indicate that high loads as well as shutdowns and shorter periods without flow can be handled by the modelled system. In the case of long periods of very low rates of CO2 injection, problems arise with maintaining high CO2 saturation in the near well reservoir and with phase changes in the pipeline and well. For low injection rates it will therefore be necessary to optimize phase conditions along the pipeline and at the well head.

In the transport study *(Dynamic simulations of a carbon dioxide transport pipeline for analysis of normal operation and failure modes)* the simulations demonstrate that preventive measures are required to help avoid and handle two-phase flow. For example, quick shutdowns and load changes led to the occurrence of two-phase flow. However, by controlling the flow through the final control valve, the two-phase flow was restricted to the vertical section of the pipeline (i.e. the injection pipe).

Risk assessment and methodology development

In the paper *Risk analysis methodology for CO2 transport including quantified risk calculation* (Nyborg, M. et al) a Geographic Information System (GIS)-based route selection process was used to narrow potential alternatives pipeline routes into one final alignment. The route-selection process was based on construction costs as well as important non-technical issues. The risks associated with the selected pipeline route were analyzed using a GIS-based risk analysis system developed within the Vattenfall CCS project. In this tool, the consequences of a leak somewhere along the pipeline are calculated, together with the probability of the leak

occurring. By doing this for the whole pipeline the total societal risk can be calculated, simplifying the communication with authorities demands.

The next GHGT conference

The GHGT conferences are held every two years in IEAGHG's member countries and the conference series rotates between North America, Europe and Asia. The 11th International Conference on Greenhouse Gas Control Technologies will be organised by RITE & IEAGHG. This conference will take place in Kyoto, Japan in November 2012.

For further reading about the conference and the papers presented at GHGT10, please visit www.ghgt.info.