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Modelling of CO_2 pipelines in dynamic CCS systems

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The growing rate of renewable energies contributing to the power supply in Germany is starting to influence conventional thermal power plants. As a particular example, the state of Brandenburg in the eastern part of Germany has an installed capacity of 4.4 GW wind power [DEWI 2011] and 6.1 GW fossil fueled large-scale power plants (including the site in Boxberg, north-east saxony) [Vattenfall 2011] respectively. This ratio is disadvantageous, as the local thermal power plants have to provide all the balancing power to control the load of the power grid in the region. As long as there are bottlenecks in the grid, preventing the extra load from wind energy to be transported as well as a lack of technologies to store electrical energy, almost all load changes have to be balanced by the large fossil fueled power plants.

The ability to provide balancing power will also be an essential criterion for new large-scale CCS (**c**arbon dioxide **c**apture and **s**torage) power plants to be permitted. But this of course will influence the overall performance of the power plant and the connected peripheral systems. It is obvious that the additional equipment to capture, transport and store the CO_2 and all related extra process steps will lower the flexibility and the speed of load changes that can be applied to the CCS system if no special measures are applied. All changes in load that are demanded from the power grid will be transferred to the capture and transport system, finally resulting in changes in mass flow and pressure of the CO_2. These changes will also influence the performance of the storage reservoir.

The presentation at the GeoEn session at the EGU 2012 will cover a look at a CCS system consisting of a coal fired Oxyfuel power plant, a pipeline to transport the CO_2 and a saline aquifer as a storage reservoir. It is obvious that all parts of this system will influence each other due to the direct connection via pipeline and the physical limitations in mass flow and pressure deviations from design values.

To track the effects of load changes on the system, the software program OLGA® [SPT 2011] is used. The software will give as simulation results detailed information about the dynamic changes of pressure, temperature and mass flow within the pipeline from the power plant down to the injection well and even is able to account for influences from the reservoir.

The example which will be presented includes a power grid situation wherein high load changes due to fluctuating wind power induce changes in the CCS power plant load and all associated systems, especially the CO_2 mass flow in the pipeline itself.

Results will be discussed with regard to the design criterions of such CCS systems and the safe operation of a pipeline under high load changes to prevent critical situations that would force a stop of power plant and injection operation or other measures like a blow down of the pipeline.

References

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