3rd Oxyfuel Combustion Conference

GPU Pilot Operation and Energy Consumption

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1. Introduction
Alstom has a comprehensive program for developing the Oxy-combustion technology with the intermediate aim of designing and building a large scale demo plant before full commercialization. Within this program the development of efficient GPU solutions is one major focus. To support this development, a mobile GPU pilot plant has been designed and constructed. This pilot plant has now been operated for over two years and the first part of this presentation will describe its design features and present results from the operation.

In the second part of the presentation the impact of operating conditions on the design and the energy requirement of the GPU will be discussed. Examples of conditions that will be analyzed are the required CO2 product purity, the inlet flue gas CO2 content and the effect of cooling media temperature.

2. Mobile Pilot GPU
The GPU pilot has been designed as a mobile unit with the Compression section and the Purification section arranged in two specially designed containers. In addition equipment for Gas Analysis and other Auxiliary systems

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are arranged in a third container. The GPU has been designed for real flue gas operation but, as an option for special tests, a mobile synthetic flue gas unit has been arranged in a fourth container. The container arrangement will allow for fairly easy re-location of the pilot between different site locations as well as modification and extension with additional sub-units.

The main purpose of the GPU pilot is to provide a tool for investigating first of all the CO2 separation from the inert gases, but also the behaviour of other gas components typically present in an oxy-combustion flue gas. Therefore, the pilot includes all necessary systems for the flue gas processing: a direct contact cooler for water condensing, a four stage compressor, gas purification and dryer units and, finally, low temperature cooling and CO2 separation systems. The flue gas capacity of the unit is 65Nm3/h. For process operation, super vision and data recording an industrial PLC system has been installed.

The tests started in 2011 at the Alstom Technology Center in Växjö, Sweden, using synthetic flue gases of typical Oxy-combustion composition. The test program was continued in 2012, now with real Oxy-combustion flue gases produced in Alstom’s 15MWth Oxy-combustion Boiler Simulation Facility (BSF) in Windsor, USA. During the presentation results from these tests will be discussed.

3. GPU Design Concepts vs. Energy Consumption
The required CO2 product purity will impact the design of the GPU. For the more relaxed CO2 purity envisaged for storage in saline aquifers (SA quality), low temperature flash separation is normally sufficient to remove sufficient amounts of the inert gases at acceptable CO2 recovery rates. However, for the product purities required for e.g. Enhanced Oil Recovery (EOR) low temperature distillation will be necessary to reduce the residual oxygen content to an acceptable level and to reach the close to 100% CO2 purity level. The latter process will of course use more energy, however usually both variants may still be auto-refrigerated, which means that the required cooling capacity for driving the CO2 condensation process may be provided by CO2 expansion only, at least at typical inlet flue gas product purities.

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Decreasing inlet flue gas CO2 level may lead to a decreasing CO2 recovery rate at maintained product CO2 purity. To keep up with the CO2 recovery rate in this situation, the addition of an external refrigeration unit might be a solution, however at an increased operating cost.

The auto-refrigerated GPU processes where the cooling is provided by expanded CO2 will normally result in a CO2 product in gaseous form. If a liquid CO2 product will be required, a GPU design including the use of an external refrigeration cycle may provide a solution. Complexity may increase with the introduction of a refrigerant media which may impact the overall plant design.

Depending on local conditions, e.g. ambient temperature and cooling water availability, a refrigerated process may be beneficial also from an energy point of view. At increased cooling media temperature a GPU incorporating a refrigeration cycle may show lower specific energy consumption per ton CO2 product than an auto-refrigerated process. In the presentation these and other aspects influencing the design of the GPU will be further discussed.