2nd Oxyfuel Combustion Conference

CO_2 Capture Project Phase 3 – Oxyfuel Large Scale Pilot and Demonstration Projects

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1. Introduction

The CO_2 Capture Project (CCP) is an award-winning partnership of seven major energy companies working to advance the technologies that will underpin the deployment of industrial-scale CO_2 capture and storage (CCS).

Harnessing the unique expertise of its members, the CCP has worked in collaboration with government bodies and more than 60 academic institutions, industry and leading environmental groups. Initiated in 2000, the overall objective of CCP is to deliver major cost reductions for CO_2 capture and demonstrate that geological storage is efficient, verifiable and secure.

Phase 3 of The CO_2 Capture Project (CCP3), which began in late 2009 and is scheduled to run until 2013, is absolutely critical in preparing the ground for widespread deployment of the next generation of CCS technologies. Thus much of CCP3's work will be focused upon moving from theory to commercial application in refining, in-situ extraction of bitumen and natural gas power generation scenarios, with at least one full scale demonstration planned in CCP3.

2. CCP3 Oxyfuel Projects

Capture technologies for application in oil refineries, extraction of heavy oils and in power production from natural gas are included in the portfolio of CCP3. Demonstration of the next generation technologies is a key aspect of this phase. Three oxyfuel projects are being planned by CCP: two demonstrations projects and one research and development Project (R&D). The demonstration project currently in the most advanced stage of construction, is the oxy-firing on a FCC Prototype unit located at the Petrobras' research complex in São Mateus do Sul, Paraná state,

Brazil, the second demonstration is planned for 2012, oxy-firing on a Once Through Steam Generator (OTSG) in Alberta, Canada, the final project is the R&D project which will undertake an assessment of the use of oxyfuel on process heaters, focusing on modify existing burners and/or the design of new burners for oxy-fired operation so as to understand the impact of flue gas recirculation on burner design and operation.

2.1 The oil refinery scenario

The regenerator of the fluid catalytic cracking (FCC) process is the single most significant emitter in a refinery, accounting for more than 30% of total emissions (mainly CO2). A study in CCP2 showed that oxy-firing may result in lower costs than post-combustion processing and pilot test results showed this technology was ready to be developed at a larger scale.

Based on this, the CCP joined Petrobras in the organization of a demonstration in a large scale FCC pilot unit located in the Petrobras research complex of São Mateus do Sul, Paraná, Brazil. Petrobras is currently retrofitting this large scale pilot FCC unit for operation at oxy-combustion conditions.

The large scale FCC pilot unit was originally built for research and development of FCC-related technologies and has a capacity of processing up to 33 bpd of feedstock, emitting about 1 ton per day of CO2. For the demonstration the unit will process 200 kg/h of vacuum gasoil (VGO) or 100 kg/h of atmospheric residue (ATR), operating with 300 kg of catalyst inventory.

The retrofit of this FCC pilot unit includes a CO2 recycle system and an oxygen supply system. The recycle system includes a flue gas scrubber, which will promote an alkaline removal of SOx with a caustic soda solution, a washing tower to remove traces of caustic soda from the flue gas, a recycle compressor and a chiller to adjust water content as well as a pressurized recycle gas storage tank, which will serve mainly to absorb oscillations in the system and will also be used to accelerate the start-up of the oxy-combustion operation.

The oxygen supply system includes a liquid oxygen tank with atmospheric vaporizers, an oxygen distribution network, a flow and pressure control panel and skid and an oxygen injector.

The tests will be conducted at standard FCC testing conditions with the regenerator operating in the full combustion mode. The recycle rate will be varied between 75 to 85 wt%, thus producing oxygen concentrations at the inlet of the regenerator from 21 to 28 mol%. Depending on the condition tested, the flue gas flow rate may vary from 160 to 300 kg/h. The tests are programmed to occur by the end Q1 2011 and the main interest is to evaluate stability of operation, transition between air and oxygen, impacts on catalyst regeneration and feed conversion, impact on unit thermal balance and catalyst circulation rate. Catalyst characterization during the tests will also be undertaken.

The demonstration will provide data including non-proprietary design on the retrofit of the unit, description of plant star-up, shutdown and upsets as well as energy and mass balance data on the oxy-combustion operation (including CO2 purity of recycle stream at stable operation).

2.2 The SAGD scenario

Extraction of heavy oils or oil sands requires considerably more energy than conventional fossil fuels. SAGD is the most advanced extraction technique for heavy and ultra-heavy oils [1] injecting steam into the reservoir to soften and displace hydrocarbons. Steam is typically produced in once-through-steam-generators (OTSG) fired with natural gas and using oily water from the reservoir as the water source. The CCP scenario considers a set of large OTSGs (4 x 250 MMBTU/hr), causing emissions of about 500,000 metric tons per year of CO2. Evaluations performed in the previous phases of the CCP point to oxy-firing as a promising option for this scenario, though pre- and post-combustion alternatives will also be studied. The CCP, in collaboration with Praxair, Devon Canada, Cenovus and StatoilHydro and with co-funding by the government of the province of Alberta (Climate Change and Emissions Management Corporation Programme), has organized the retrofit to oxy-firing and demonstration of a

commercial OTSG boiler used in oil sands operation in Canada. Praxair performed the feasibility study to establish the design basis and costs for retrofitting both a large scale boiler (duty of 250 MMBTU/hr) and a test boiler for the demonstration (duty of 50 MMBTU/hr). The retrofit of the test boiler, including installation of different types of oxy-fuel burners and the necessary piping for oxygen supply, as well as a demonstration testing three different burners, will take place in 2012.

2.3 Acknowledgements

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2.4 Cited references

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