CCP PROJECT FACTSHEET

OXY-FUEL DEMONSTRATION PROJECT

Results: Pilot testing in once through steam generators (OTSG)

Oxy-Fuel Combustion to Reduce OTSG Emissions

Once-through steam generators (OTSGs) burn large amounts of natural gas, and are the primary source of GHG emissions from the in-situ production of bitumen from Canada's Athabasca oil sands. OTSGs are used in steam-assisted gravity drainage (SAGD) operations; these types of operations will be the primary source of growth in heavy oil activities for the foreseeable future, as upwards of 85% of bitumen resources in Canada can only be extracted through in-situ production methods. This is an important area of development that could help significantly reduce the greenhouse gas emissions of these operations.

The CCP identified oxy-fuel combustion as a candidate for OTSG boilers. Oxy-fuel technology uses nearly pure oxygen instead of air for combustion. By eliminating nitrogen, a flue gas with concentrated CO_2 is produced, which requires minimal clean-up prior to compression and transport to long-term geological storage.

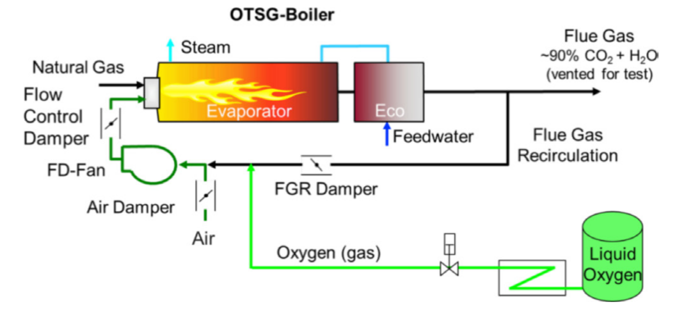

Figure 1. Main features of OTSG retrofit

OVERVIEW

The CCP (CO_2 Capture Project) has completed piloting of oxy-fuel combustion technology in an OTSG (once through steam generator) – the primary source of CO_2 emissions from in-situ production of heavy oil. The test was successful and showed that a conventional OTSG could be retrofitted for oxy-firing with minimal changes and retain the ability to operate in standard air-firing mode.

The pilot took place at Cenovus' Christina Lake oil sands production facility in Alberta, Canada. The pilot was the second phase of the retrofit project and was completed in April 2015.

The key results were:

- Boiler performance was nearly identical for air-fuel and oxy-fuel operation
- The fuel flow was reduced with oxy-fuel combustion by approximately 5% at the same load and steam quality as air-fuel combustion
- A small, oxy-fuel pilot burner is essential for improved flame stability of the main burner
- Transitions are best performed at low boiler load at moderate flows for air and oxygen
- Mass-based oxy-fuel NOx emissions were on average only 15% of those measured with air-fuel combustion; no CO emissions were measurable for either combustion method
- The retrofit of the boiler used common components that are available in industry

THE PROJECT

Goals

The main goals of the project were:

- Identify changes in heat transfer pattern and flame length between air-fuel and oxy-fuel combustion
- Find the best combustion solution for oxy-fuel operation with respect to heat transfer emissions, oxygen concentration and flame stability
- Determine the volumes of flue gas recirculation for oxy-fuel operation
- Establish safe and reliable operating procedures, interlocks and control methods.

Two Phase Project

The project was carried out in two phases:

PHASE I

The first phase, completed in 2010, involved establishing the design basis for a commercial scale boiler system as well as a test sized boiler.

PHASE II

The second phase focused on modifying a 50MMBtu/hr OTSG unit for oxy-fuel combustion and operating for three weeks. The operation tested the feasibility of a retrofit and would provide essential data to design a full-scale system. Since the planned operation period was of limited duration, the oxygen for the test was supplied by trucked-in liquid oxygen from an existing air separation plant. Construction for Phase II of the project was completed in 2014, and commissioning was completed during the first quarter of 2015. The pilot testing work was completed in April 2015.

BOILER MODIFICATIONS

To enable oxy-fuel combustion, a flue gas recirculation system was added to the boiler (Figure 1). The flue gas recycle was routed from the economizer outlet plenum at the base of the stack via a new duct to the windbox. Oxygen was mixed into the recycled flue gas prior to the existing air-fuel burner. Two louver-type air dampers were installed at the combustion air inlet. One damper was designed as a low leakage damper and the other worked as an opposed blade control damper. Similar to the air dampers, two dampers were installed to control flow in the flue gas recycle duct. The forced draft fan was replaced with a larger model to handle the larger volumetric flow rates produced during oxy-firing. A small oxy-fuel burner to support flame stability was installed in the center of the existing air burner, which was essentially unchanged.

SCALE-UP CONSIDERATIONS

Although the demonstration boiler is smaller (50 MMBtu/hr) than typical full-scale SAGD boilers (250 to 300 MMBtu/hr), the findings can be applied to larger boilers. There are no technical scale-up barriers to implementing oxy-fuel combustion commercially for carbon capture in this application.

PROJECT PARTICIPANTS

The project participants included CCP, Devon Energy Canada, Cenovus Energy, Statoil, MEG Energy, Praxair, and the Climate Change and Emissions Management Corporation (CCEMC). Cenovus Energy hosted the test at their Christina Lake in-situ site, and Praxair was the prime technology provider. Suncor was the project manager.

ABOUT THE CCP

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

To find out more visit www.co2captureproject.org