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# Oil Heavy Residues Oxy-combustion with $CO_2$ Capture

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**Abstract**

Saudi Aramco and General Electric have been jointly developing oxy-combustion technology with $CO_2$ capture for difficult to burn liquid fuels. The technology enables direct combustion of such fuels while addressing $CO_2$ emissions concerns in a cost effective way. A 15 MW thermal testing campaign was performed in Windsor, CT firing heavy asphalt in air and oxy mode. The testing campaign results show a significant improvement in fuel combustibility in oxy mode compared to air firing in addition to 50% reduction in $NO_x$ emissions. The test results were used to validate a CFD model enabling simulation of various configuration for scale-up studies. The test results were considered in the basis of design for a 2800 MW OHR oxy-fired power plant with $CO_2$ capture. The technology is ready for demonstration at a larger scale in a refining environment where it can synergistically be integrated with the refinery optimizing its operation and performance.


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*Keywords:* Oxy-combustion; Gas Processing Unit; $CO_2$ capture; liquid fuels; Oil

## 1. Introduction

Saudi Aramco is conducting pioneering research in Carbon Capture, Utilization and Storage and efficient combustion technologies to help reduce fuel and carbon intensity in support of the global quest for reducing $CO_2$

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emissions. Low value fuels combustion is a high priority in the context of Saudi Arabia for the purpose of optimizing the energy mix.

GE Power's Steam Power Systems (SPS) Environmental Control Solutions (ECS) has developed Carbon Capture technologies in general and in the area of oxy-fired boilers in particular, including several comprehensive large pilot developments.

Saudi Aramco and SPS have been jointly developing oxy-combustion technology with $CO_2$ capture for difficult to burn liquid fuels with the goal to provide technical solutions for $CO_2$ emissions reduction from refineries and power plants in the most cost effective way.

Current techniques for the combustion of heavy fuels, like OHR, feature the use of costly chemicals or blending of the fuel with light ends (cutter stocks) to achieve the process conditions required for use as fuel in power plants or utility boiler applications.

Oxy-combustion with $CO_2$ capture was identified as one of the promising first generation $CO_2$ capture technologies and was heavily developed for coal and gas applications; it was demonstrated at semi-industrial scale in many pilot projects across the world: i.e CCS pilot at Schwarze Pumpe with Vattenfall [1] and at Lacq with Total [2].

The oxy-combustion technology for OHR applications offers an alternative to the before described proceedings. The basic concept is to use oxygen instead of air to burn the oil heavy residues which would yield a better combustibility, lower emissions and higher efficiency while producing a highly concentrated $CO_2$ stream that would be easy to process for $CO_2$ removal through cooling, drying and purification in a Gas Processing Unit (GPU).

Saudi Aramco and GE collaboration aims at

- Demonstrating the technical feasibility of combusting efficiently OHR in a semi-industrial scale facility
- Gathering operating data points that can validate the CFD models and scale-up the oxy-combustion technology to industrial scale
- Performing a basic engineering and cost estimate for a 2800 $MW_{el}$ OHR oxy-fired power plant with $CO_2$ capture.

**Nomenclature**

| | |
|---|---|
| ASU | Air Separation Unit |
| CAP | Chilled Ammonia Process |
| CCS | Carbon Capture and Sequestration |
| CFD | Computational Fluid Dynamics |
| ESP | ElectroStatic Precipitator |
| FCC | Fluid Catalytic Cracking unit |
| FGC | Flue Gas Condenser |
| GPU | Gas Processing Unit |
| ISBF | Industrial Scale Boiler Facility |
| OHR | Oil Heavy Residues |
| SWFGD | Sea Water Flue Gas Desulfurization |

Subscripts

| | |
|---|---|
| th | Thermal |
| el | electrical |
| v | Volume |
| wt | Weight |