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Press Release – 05/09/2013

FIELD DEMONSTRATION CONFIRMS VIABILITY OF OXY-FIRING FOR CO_2 CAPTURE FROM OIL REFINERIES

Oxy-firing has been confirmed by CCP as a viable technology from a technical and economic standpoint for capturing CO_2 from the main emitting component of refinery operations, the Fluid Catalytic Cracking (FCC) unit. This comes as a result of the completion of CCP's first capture field demonstration, which took place at a Petrobras research facility in Paraná state, Brazil.

The successful test has brought closer a more cost-effective technology capable of capturing up to 95% of FCC CO_2 emissions, potentially equating to some 20-30% of emissions from a typical refinery. The project tested start-up and shut-down procedures and different operational conditions and process configurations – allowing the CCP partners to gain reliable data for scale-up.

The refinery is a challenging environment for capturing CO_2, with many different operations producing emissions. The FCC unit converts heavy, lower-value hydrocarbon feedstock into lighter, more valuable products and is often the largest single source of CO_2 emissions. Traditionally, air is used to regenerate the catalyst, by burning the coke deposited on the surface. In the oxy-combustion mode, air is replaced by pure oxygen, which is diluted with recycled CO_2 to maintain thermal balance and catalyst fluidization.

Nigel Jenvey, CCP Chairman said: "This is a significant moment for CCP and the advancement of CCS. Our first demonstration project has successfully met its objectives and proved that oxy-firing is a viable way of reducing CO_2 emissions from oil refineries. This project has shown the real value of collaboration by those within the oil and gas industry in order to discover insights and develop technologies that can help cut our own emissions footprint."

Oscar Chamberlain, Petrobras General Manager of R&D in refining said: "Petrobras is thrilled to be part of this moment as a CCP participant and technology provider for oxy-firing in FCC units. The challenge of proving the technical viability of oxy-firing an FCC unit has been met thanks to the availability in Paraná of a unique demonstration scale FCC test plant. This is a great step in the efforts to bring forward a technology that could significantly mitigate the CO_2 emissions from oil refineries."

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The main results from the demonstration are:

- Technical viability was proved with different feed qualities (VGO, ATR) and in two extreme operating conditions (Same Heat Balance, Same Inert Volumetric Flow Rate), with the same or higher product yields
- The purity of captured CO_2 reached the target 93-95% under oxy-firing conditions
- Smooth and fast switch between air and oxy-firing through effective monitoring of excess CO_2 in the flue gas
- A significant gain in operational flexibility was achieved, meaning the cost of CO_2 capture can be somewhat mitigated. This flexibility allows either higher carbon throughput (10% higher flowrate with same conversion) or the processing of lower cost heavier feedstock with the same results
- Catalyst entrainment rates compared to combustion in air varied from lower (Same Heat Balance) to higher (Same Inert Volumetric Flow Rate). An interim condition – Same Solid Entrainment – was also tested delivering the same entrainment as in air operation
- Increase in oxygen partial pressure did not lead to increased catalyst deactivation, thus indicating there will be no need to increase catalyst make-up in full-scale operating conditions. However greater catalyst replacement rate may be needed where higher entrainment rates lead to higher cyclone loading and catalyst loss (most notably when the CO_2 recycling rate is above that of the Same Solid Entrainment condition)
- Potential corrosion issues were identified early in the testing due to the presence of NO_x and SO_x impurities in the flue gas. These are fully understood and are manageable through proper design.

A factsheet with more information about the demonstration is available at
http://www.co2captureproject.org/reports/FACTSHEET_FCC.pdf

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Notes to Editors

Report: A version of the CCP paper presented at the GHGT-11 conference in Kyoto, Japan, in September 2012 (*Oxy-Combustion Technology Development for Fluid Catalytic Crackers (FCC) – Large Pilot Scale Demonstration*) is available to editors at http://www.co2captureproject.org/reports/PAPER_FCC.PDF

FCC Overview:
The FCC is often the largest single source of CO_2 emissions from a refinery. The pilot FCC unit used in the CCP demonstration has the capacity to process up to 33 bbl/d of hydrocarbon feed (emitting 1 ton/day of CO_2). It consists of an adiabatic riser, stripper and regenerator, which allows simulation of a commercial FCC unit, including the energy balance.

The CCP is a partnership of major energy companies, working to advance the technologies that will underpin the deployment of industrial-scale CO2 capture and storage. Since its formation in 2000, the CCP has undertaken more than 150 projects to increase

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understanding of the science, economics and engineering applications of CCS. Currently in its third phase of activity (CCP3) its members are BP, Chevron, Eni, Petrobras, Shell and Suncor.

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