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Ch0C: whole CCU chain 3MW$_{th}$ demonstration project with detailed NO$_X$ measurements

Romain Béard[a*], Laurent Mariac[a], Sarah Juma[a], Frédéric Fallot [b], Giampaolo Maio[b], Livia Tardelli[c]

[a]*TotalEnergies OneTech, 2 Place Jean Millier, La Défense, Courbevoie, 92400, France*

[b]*ENGIE Lab CRIGEN, 4 rue Joséphine Baker, Stains, 93240, France*

[c]*NaTran, 6 Rue Raoul-Nordling, Bois-Colombes, 92277, France*

Abstract

The "Ch0C" project (meaning "low carbon oxy-fuel boiler") is a French industrial pilot initiative and collaborative effort to apply oxy-fuel carbon capture to mid-sized industrial boilers (1-25MW$_{th}$) to decarbonize industrial steam production. The Ch0C pilot comprises different technological modules: an ultra-low NO_x oxy-fuel burner, a 3MW$_{th}$ fire-tube boiler and a CO_2 Purification and liquefaction Unit (CPU). This pilot project aims to demonstrate the operability of the whole CCU chain at industrial scale. The commissioning is intended in spring 2025 at an industrial chemical platform in Villers-Saint-Paul, North East of Paris.

NO_x emissions could be a technical and environmental concern for CCUS. After combustion (air or oxygen-blown), NO is almost ten times more present than NO_2. However, NO conversion into NO_2 is promoted by high pressure and can be expected to occur in the liquefaction unit due to chemical equilibrium shift. In the presence of condensed water, NO_2 forms aqueous nitric acid, which can cause corrosion of metallic equipment. In the prior Pilot CO_2 Lacq project (2009-2013), operated by TotalEnergies, high NO_x emissions (400 ppm at 3% dry O_2) were observed in an oxy-fuel combustion retrofit 32MW boiler. Corrosion from NO_2 dissolution was observed in the third stage of compression (in carbon steel) due to acidic water carry-over from gas/liquid separators to the compressor.

NO_x emissions reduction is an issue that needs to be faced for all CCUS technologies that recover CO_2 from combustion fumes. In fact, NO_x creates troubles on the equipment of the capture unit (either oxy-combustion or post combustion), for CO_2 utilisation and for its transport in the pipeline. To ensure non-corrosivity of the CO_2 under normal, transient and upset transport conditions, specifications for NO_x in CO_2 are required. For instance, in Northern Lights® and Aramis® projects, the total concentration of NO_x species is limited at 1.5 ppm (1) (2). Therefore, analysis and monitoring of NO_x will be required in CCS.

To confirm the performance of the Ch0C pilot, NO_x species will be continuously monitored at key points of the process during the 8-month test campaign. NO/NO_2 ratio will be measured thanks to dedicated instruments.

* Corresponding author. Tel.: +33695782210
E-mail address: romain-rb.beard@totalenergies.com

Figure 1 : Carbon purification and liquefaction unit installed in Villers-Saint-Paul plant

In addition, an intermediate 2-week mapping campaign will be performed to strengthen the analysis of NO_x species (total NO_x, NO, NO_2, N_2O) throughout the entire process, including flue gases and condensates as shown in Figure 2. Analysis of condensate samples will be conducted during the test campaign to quantify NO_x dissolution.

All the analytical measurements will be carried out on a CO_2 matrix (new measurements standard for CO_2 transport and storage) rather than an N_2 matrix (standard measurements for air quality control), notably for the CO_2 capture and purification process. Nevertheless, a short dedicated study will be implemented during the parametric tests to ensure the consistency between measurements in the CO_2 and N_2 matrix. This step will avoid potential derivation generated by unmastered or inappropriate calibration.

A wide range of operating parameters will be tested (O_2 factor, Natural Gas quality, Oxygen purity, Fuel Biogas type composition, Boiler load…) to characterize the performances of the innovative system (boiler/burner/CPU) and to understand the NO_x evolution at each stage of the process.
Measurement results as well as their analysis will be presented at the conference.

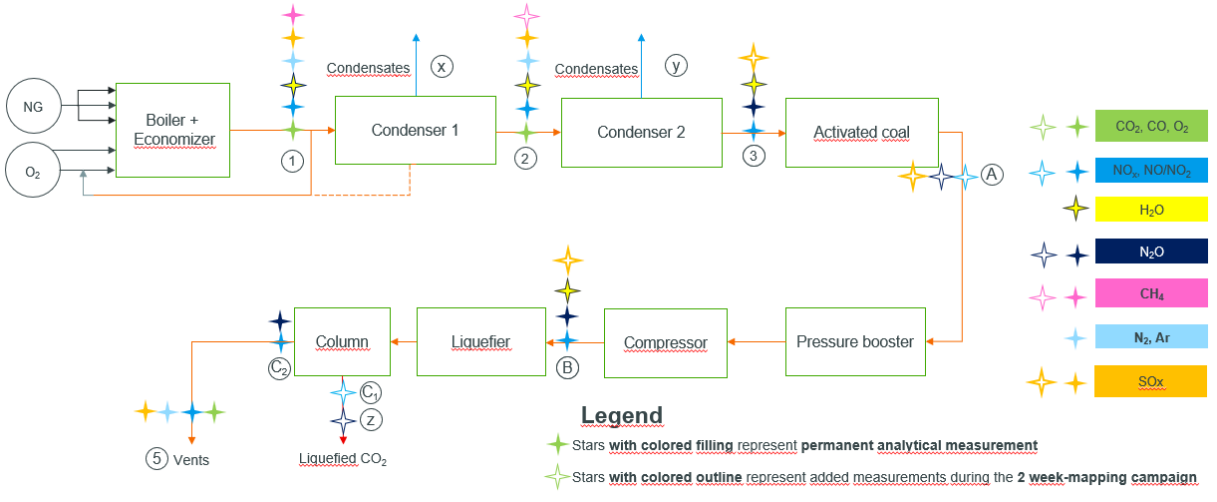

Figure 2 : Components analyzed in Ch0C pilot during permanent analytical measurements and during the 2-week mapping campaign

Keywords: CCU ; Ch0C pilot ; NO_x monitoring ; corrosion

References

1. NorthernLights-GS-co2-spec2024.pdf [Internet]. [cité 19 mars 2025]. Available at: https://norlights.com/wp-content/uploads/2024/06/NorthernLights-GS-co2-spec2024.pdf

2. Aramis CCS [Internet]. [cité 13 mars 2025]. CO_2 specifications for Aramis transport infrastructure. Available at: https://www.aramis-ccs.com/news/co2-specifications-for-aramis-transport-infrastructure/