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INSPECTION AND IMPROVEMENT OF SOIL/AIR WELL INTERFACE

by Cyriane Fournier

DEVELOPMENT OF STRATEGIC BIOFUELS NEGATIVE CARBON FOOTPRINT RENEWABLE FUELS PLANT IN CENTRAL LOUISIANA

by Daisy Gallagher

INSPECTION AND IMPROVEMENT OF SOIL/AIR WELL INTERFACE

As part of the maintenance plan of its Loenhout underground gas storage facilities, FLUXYS carries out regular inspections to monitor the corrosion evolution of the soil/air well interface in the cellar outputs and trigger repairs when necessary. This contributes to ensuring the integrity of the wells and more broadly of the storage facility.

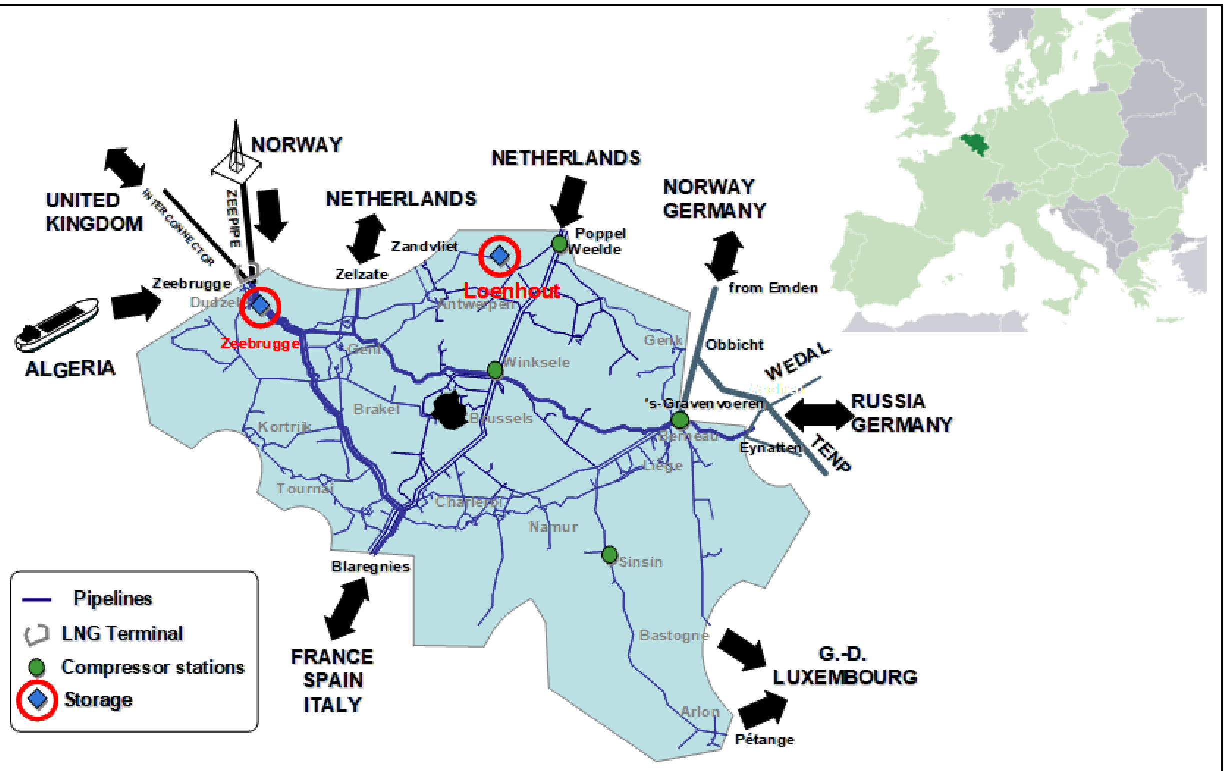
Cyriane Fournier, Corrosion and water quality engineer & Innovation manager

Loenhout Underground Gas Storage, Central Station

The Loenhout underground natural gas storage facility is located in Wuustwezel, in the Campine region, about 25 km north Antwerp (Belgium). It was developed in an aquifer system and is in operation since 1985.

Since 2012 and based on the results of an extensive Well Integrity Management study, FLUXYS has built a Long-Term Plan to suitably anticipate and manage the integrity of its underground facilities.
As part of this maintenance program, FLUXYS conducted in 2014 a comprehensive inspection campaign on the 36 wells ranked with the highest criticality for the storage, with a specific focus on the cellar well outputs, known to be sensitive zones because of the presence of stagnant water, oxygen gradient and restricted access.

In these cellars, the soil/air interface of the storage wells is a sensitive area in terms of corrosion. As a matter of fact, it can be subject to atmospheric corrosion, water corrosion or soil corrosion. This corrosion will depend on the humidity for atmospheric corrosion, the oxygen content and the salinity for water corrosion and the type of soil and oxygen content for soil corrosion. The integrity of the surface casing in this area is essential to maintain the tightness of the storage (even if this casing is a second barrier and is not in direct contact with the stored fluid).



Location: Onshore, North Belgium

Project status: Natural gas storage operation since 1985

Reservoir: highly karstified and fissured limestone, with shale cap-rock

Structure: Anticline (top 1100 m, height 200 m), surface area: 19 km^2

Total gas capacity: 1 500. 10^6 Nm^3

Working gas capacity: 820. 10^6 Nm^3

Injection / withdrawal rates: 325 000 Nm^3/h / 650 000 Nm^3/h

Construction: 1975 – 1985

Capacity / flowrate increase: 1985 – 2017

Most of the well outputs were found in good state and simply needed a repainting. Nevertheless, despite the cathodic protection and painting that were applied on all the wells, more significant corrosions were observed on some well interfaces. These corrosions were for example due to a painting system that was not adapted to immersed areas. Some others were due to guide tubes that were acting as screens to external cathodic protection, which prevented the surface casing to be protected in this area. Moreover, the annular space between guide tube and surface casing was conducive to water retention, which accelerates corrosion in tidal area.

Figure 1 : Example of corroded well at soil/air interface

For those specific wells, a repair program was set up. First of all, it was necessary to check that the remaining thickness of the surface casing was still acceptable considering the maximum operating pressure. For that purpose, a part of the guide tube was cut to inspect the external surface of the surface casing that was degraded. It was cut until a depth at which degradations were not visible anymore. The casing was then sand blasted and inspected with ultrasonic probes to collect some thickness references and with a 3D scanning laser to get the whole external profile.

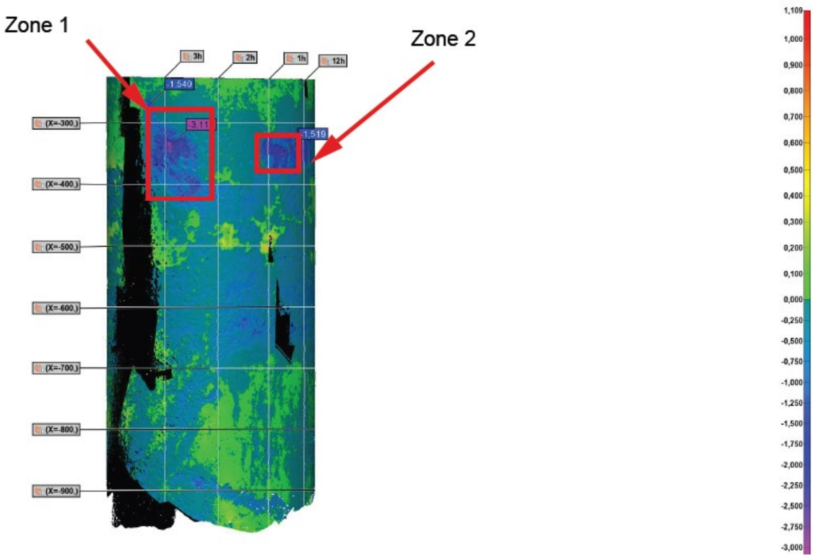


Figure 2 : 3D representation of one face of surface casing

Calculations based on API5C3 and ASME B31G revealed that corroded casings could still be considered as tight barriers at the considered pressure.

It was then recommended to repair the casings with a specific painting system adapted to humid and immersed environments and to apply anticorrosion bands additionally. Moreover, the risk of corrosion due to water retention was eliminated by creating a conical solin around the surface casing. All the annular spaces were filled-in with expansive materials. Last, the metallic pieces between the guide tube and the surface casing which limit vibrations were replaced by insulated materials to avoid any screen effect of the cathodic protection.

Several trials were made to find the optimal solin for these well interfaces with concentric casings. Some of these solins were not resistant to the immersive conditions. In 2022, GEOSTOCK and FLUXYS were able to verify that the selected solin configuration was still effective 5 years after its creation

Figure 3 : Inspection of a solin 5 years after its creation

Since 2015, GEOSTOCK has been performing visual inspections of FLUXYS cellar outputs on a yearly basis to monitor the corrosion evolution of the soil/air well interfaces, trigger repairs or adaptations when necessary, and finally guarantee the integrity of the wells and more broadly of the underground storage.

Development of Strategic Biofuels negative carbon footprint renewable fuels plant in central Louisiana

Geostock Sandia is involved in the development of Strategic Biofuels Louisiana Green Fuels Plant that will produce clean, renewable diesel fuel using waste wood from local sustainable forestry.

By Daisy Gallagher, Senior geologist - Underground Injection Control & Carbon Capture and Storage, Geostock Sandia LLC

Since 2020, Geostock Sandia (GKS) assisted Strategic Biofuels (SB) in developing their negative carbon footprint renewable fuels plant in central Louisiana. The project will produce clean, renewable diesel fuel using waste wood from local sustainable forestry and supply all power from internal green processes. The carbon will be converted into fuels and will be sequestered permanently deep beneath the subsurface. The SB project has been designed to sequester over 1.4 million metric tons of CO_2 and will be one of the world's most carbon negative facilities.

In the US, Class VI UIC Injection wells are designed to be used in carbon capture and storage, with a focus on depleted gas fields and saline aquifers reservoirs. The US Gulf Coast is an attractive location for the industry and investors alike due to the proximity to emitters and the favourable geologic suitability for injection and confinement. However, stringent federal requirements must be met, and a demonstration must be made the governing bodies, that the sequestering of CO_2 will not impact underground sources of drinking water or impact local communities. To date, only one facility in the US is currently operating with a Class VI Permit.

Since project inception, GKS has been involved with the initial site feasibility selection, followed by a Test Well designed to acquire data that is critical to making this demonstration. The Class VI UIC application for SB culminated in over 15,000 pages of highly technical data and analysis, future model projections over 100-year timeframes, CO2 injection well designs and completions, subsurface monitoring programs, project safety and response, and long-term project development plan and was submitted to the US federal government in March 2023. What sets this project apart, is that GKS took the site-specific data and developed long-term model with refined analysis information to predict the pressure and plume behavior of the injected carbon dioxide over time.

SB's COO Bob Meredith commented "Rigorous subsurface research, data collection, and advanced engineering and software modeling have demonstrated that we can safely and permanently sequester all of the carbon dioxide generated during renewable fuel and green power production at our Louisiana Green Fuels Project in Caldwell Parish. Completing this application for the EPA Class VI Permit accomplishes another major milestone for our Project. The application is massive, and its submission is the culmination of nearly two years of relentless dedication of our outstanding LGF Project team of experts and that of our valued partners at Geostock Sandia."

FOCUS ON CLASS VI UIC INJECTION WELLS

In the US, Underground injection wells have been divided into six different classes depending on the well type, the injection depth and the potential for the injection activity to result in endangerment of an underground source of drinking water.

Class VI wells are used to inject carbon dioxide (CO2) into underground subsurface rock formations for long-term storage or geologic sequestration. Geologic sequestration refers to technologies to reduce CO2 emissions to the atmosphere and mitigate climate change. Stringent requirements have been designed for Class VI well in order to protect underground sources of drinking water. These requirements are described on the United States Environmental Protection Agency website (https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide).