The Newsletter

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A SAFER CORROSION PROTECTION

by Cyriane Fournier

DOWN-HOLE CASING INSPECTION

by Philippe Gergaud and Nizar Aouina

GEOSTOCK

A safer corrosion protection

Géosel, one of the largest European operational and strategic petrol product sites with thirty salt caverns, has switched to a corrosion inhibitor that is more effective and compatible with end-users needs.

Cyriane Fournier, *Corrosion and water quality engineer*

Photo : Géosel

Géosel is circulating liquid hydrocarbons in carbon steel pipelines since 1969. These pipelines connect the oil port of Lavera to the underground salt caverns storage located at Manosque in the south of France. About 100 km of metallic pipelines link the two locations. Different liquid hydrocarbons can pass through these pipelines such as crude oil, condensates, naphtha, fuel, diesel and gasoline.

In order to inhibit internal corrosion, a mixture of sodium nitrite and soda were injected from the Lavera pumping station in the direction to Manosque. This chemical has been shown to be effective towards the metal (passivation of its surface to avoid corrosion), but users at the outstream of the storage highlighted a safety risk with regards to its use. As a matter of fact, sodium nitrite is susceptible to form nitrogen oxide (NOx) in steam cracker, which generates explosion risk.

To eliminate this risk, GEOSTOCK launched a study to replace sodium nitrite injection by a corrosion inhibitor that could have the same efficiency, with the minimum necessary concentration, without any safety risk.

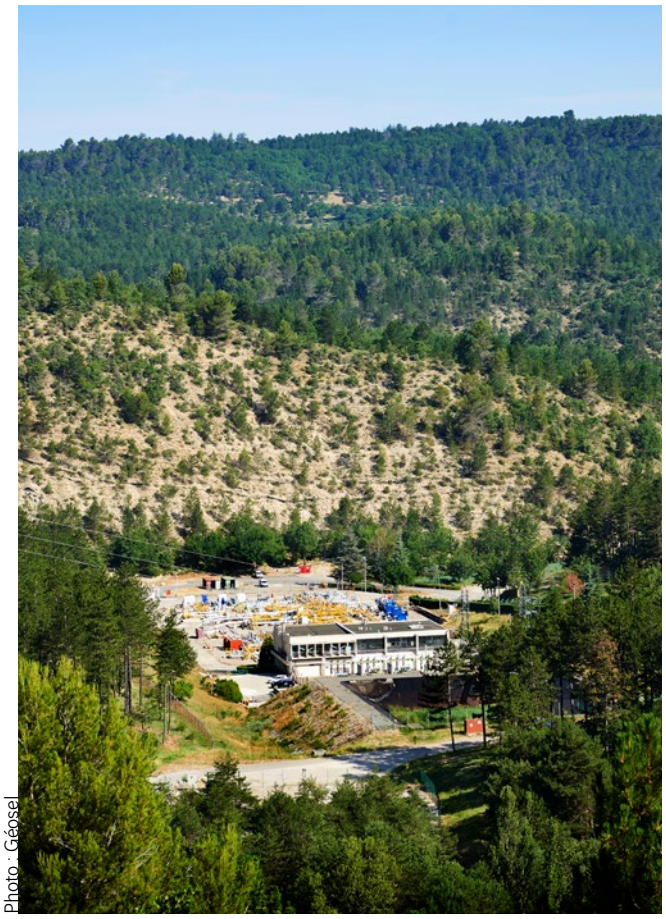


Photo : Géosel

GÉOSEL

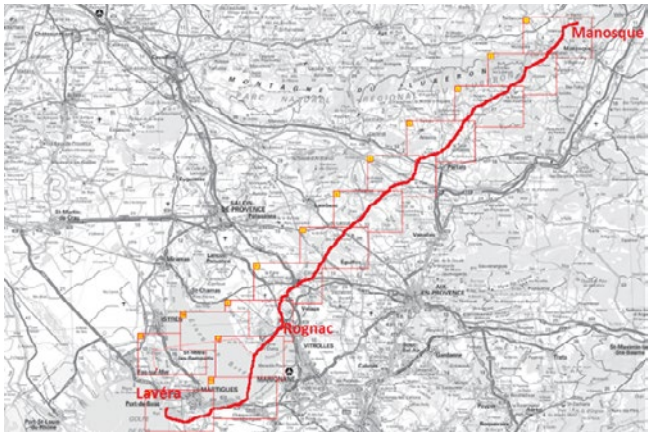
- One of the 1st European storage sites in size,
- A storage capacity in excess of 9 million m^3,
- 30 salt caverns,
- 40% crude oil and 60 % refined products,
- Almost 3.5 million m^3 of refined products transferred per year,
- Over 50 years experience in strategic and operational stock management.

At first, an investigation with several suppliers of corrosion inhibitors was launched. It was complex to find chemicals that fits with the scope of work, as many corrosion inhibitors contain nitrogen, as amine derivatives.

After listing appropriate chemicals, comparative tests between the current inhibitor and potential candidates were carried out. NACE TM-0172-2001 methodology was followed to validate the efficiency of the chemicals. This protocol was developed from standard ASTM D665; it is suitable for oils containing a part of water. It involves immersing a standard steel bar in the tested solution and observing its surface condition after 4 hours of stirring at 1000 revolutions per minute. Each chemical was tested with fuel, crude oil, diesel, naphtha and condensate solutions.

These tests allowed to prove that the initial inhibitor containing soda and sodium nitrite was efficient in diesel while it lost a part of its efficiency in the other oils.

The tests highlighted that an organic acid inhibitor containing xylene and ethylbenzene (called α inhibitor in the following) was more efficient than previous inhibitor and eliminates the risk of NOx formation, as it did not contain nitrogen.



GÉOSEL pipelines route

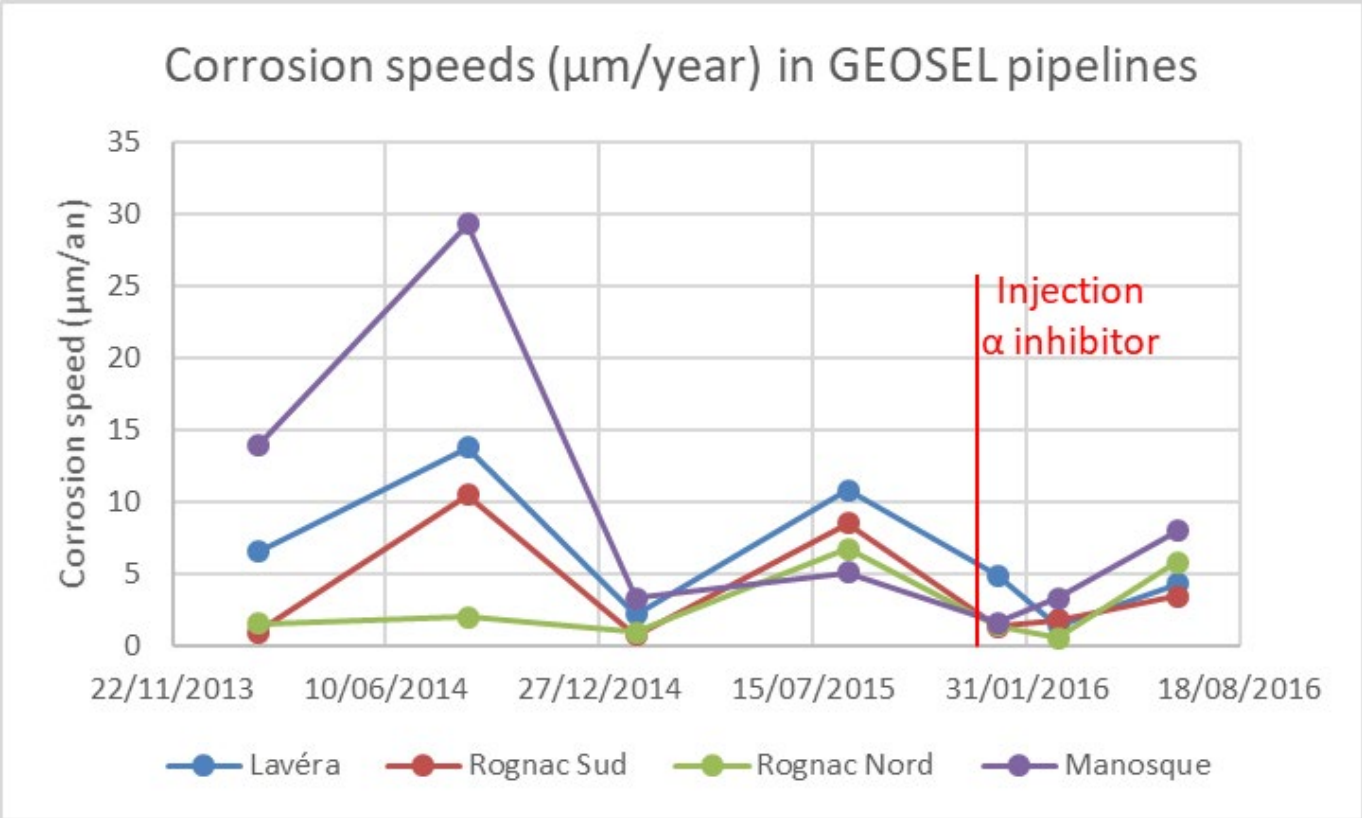
After this laboratory phase, a field test in line was set up to confirm the good compatibility and effectiveness of the new inhibitor. This period consisted in monitoring the injection of α inhibitor through GÉOSEL pipelines for nine months. During this time, samples were taken to check the good compatibility of the additive with the hydrocarbons. In parallel, the corrosion speeds were recorded with corrosion coupons and probes in order to compare them with the values measured with the previous chemical. Finally, the residual α inhibitor contents were analyzed at different levels of the process in order to verify that the dosage was optimized.

At the end of this testing period, no compatibility issues were identified. In addition, the corrosion speeds observed are satisfactory as they are similar or even lower than those observed with sodium nitrite containing inhibitor. The dosage of α inhibitor was therefore deemed optimal to allow the protection of GÉOSEL's hydrocarbon pipelines and eliminating safety issues. This inhibitor is still injected nowadays, and no issues have been reported.

Photo : Innospec

Steel bar after NACE TM-0172-2001 test with naphtha. From left to right: without any inhibitor, with sodium nitrite at 25 ppm; with new corrosion inhibitor organic acid with xylene and ethylbenzene at 12 ppm.

Similar methodology could be employed to change and optimize corrosion inhibitor dosage or injection points in other facilities. ♦



Corrosion Speeds in GÉOSEL pipelines before and after the testing phase

Down-hole casing Inspection
LPG rock cavern storage under Donges Total refinery

Periodic down-hole casing inspection is recommended by Geostock to complete and confirm the information collected during regular controls, such as the analyses of the water in the shafts and the regular control of the cathodic protection and corrosion coupons.

Philippe Gergaud, *Foreman, Product movement service, Total*

Nizar Aouina, *Corrosion and water quality engineer, Geostock*

Total Donges' refinery has an 80.000 m³ underground cavern storing liquefied propane. This cavern, which has been dug at -112 m in the Gneiss within the perimeter of the refinery, is connected to the surface via two shafts (extraction shaft and operation shaft). These shafts allow the passage of the casings that are necessary for the operation and monitoring of the storage. Since the storage was commissioned in 1977, four decennial maintenance and inspection operations were conducted to check these casings and maintain their integrity. The last operation took place in 2018. Its program was established taking into account the results of previous inspections, the level of urgency of corrosion and the technical evolution of inspection tools. It was carried out as follows:

- Hydraulically securing the cavern,
- Removal, cleaning and maintenance of the tubings and pumps which are in the casing to be inspected,

Photo : Total

Instalaltion of an A-frame above the operation shaft platform

- Cleaning of the internal wall of the casings to be inspected with a high-pressure water jet. The purpose of this operation was to eliminate deposits that could disrupt the inspection,

- Videography inspection of the 20″ product casing, 8″ seepage water casing, 8″ extraction casing and 4″ vent casing. The inspection of the 4″ vent, which ends in the gaseous phase of storage and whose hydraulic safety is unfeasible, was carried out under pressure control equipment,

- Inspection by ultrasonic logging of the 20″ product casing, 8″ seepage water casing and 8″ extraction casing. This inspection is made possible in the air part of the casing by moving a column of water along with the sensors using watertight discs. The discs are then flipped over to allow the ultrasonic tool to enter the immersed part of the casing,

- Caliper inspection of the 4″ vent casing. The Caliper tool used has 24 fingers that retract or deploy depending on the variation in the internal radius of the casing. It is a high-performance tool when it comes to detect internal corrosions and determine the minimum internal diameter of the casing.

- Electromagnetic inspection of the 4″ vent casing. A 2″1/4 electromagnetic tool was used for its ability to pass easily through the restrictions of the vent pipe. The tool allows to measure average thicknesses and is less accurate than ultrasonic tools to distinguish external corrosions from internal corrosions.

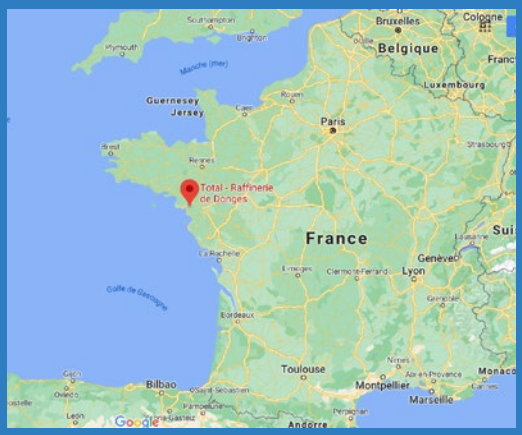
The entire planned program has been completed. The preparatory work carried out upstream of this decennial inspection, in collaboration with the refinery support services, Geostock and the involved companies, allowed to carry out this inspection in optimal safety conditions.

Installation of BOP (Blow out preventer) above the 4″ vent casing

Photo : Total

Inspection tools detected and sized internal and external metal losses on the product, seepage, extraction and vent casings. The decennial inspection and maintenance operation allowed to ensure the integrity of the cavern-to-surface casings and equipment and to identify areas requiring reinforced monitoring.

Based on these results, Geostock recommended an action plan to improve the corrosion protection of the cavern-to-surface casings of the Total Donges storage. Today, the refinery is implementing the resulting recommendations. ♦



Located on the Loire estuary in France, the Total Donges refinery processes around 11 Mt / year of crude oil. The underground propane cavern is an integral part of the refinery process which allows:

- storage of propane coming from the refinery's units,
- receiving and shipping propane by sea,
- feeding the LPG filling center.

View of the refinery from the other bank of the Loire River.

Photo : Romain Chaffin