Numerous forms of corrosion have been found on steel equipment used in the manufacture or transport of biogas. Three corrosion degradation modes are presented here based on events that occurred in France. It seems that corrosion should be taken into account from the design stage of the installations.

1st case, 18/01/2012, Bacterial corrosion and rapid deterioration of a digester (ARIA 41671):

A liquid digestate leak was discovered on a 20 m tall digester unit at a plant manufacturing frozen French fries. The effluent, flowing down along the wall, entered the sewer and was conveyed to the site’s treatment plant where it was processed. The liquid in the digester was at a height of 18 m. The upper part contains the biogas which is used as fuel for the site’s boilers. The operator stopped supplying the digester with potato waste and set up a process for its elimination (300 t/d). The digestate was extracted and the level of liquid inside the tank dropped to 15 m, thereby effectively stopping the leak.

The 7,000 m³ cylindrical digester has a diameter of 21.5 m. Its thermal insulation is designed to maintain the digestate at an optimum temperature for biogas production. It should be noted that the system was filled with water in the summer of 2007, but wasn’t put into service until April 2009. It was at this time that the plant began using its waste to produce biogas. The digester is made of stainless steel. The shell, on the other hand, is carbon steel. The digester was built using sheeting of varying thickness: 12 mm at the bottom, and 3 mm at the top, with intermediate thicknesses of 10, 8, 6, 5 and 4 mm.

After draining and inerting the system, the operator removed the roof, the insulation and a series of sheets along a vertical generatrix. Widespread corrosion of the internal walls was observed. Thickness measurements revealed an average loss in thickness of 2.6 mm, with maximum losses up to 4 mm.

As a result of this premature wear, it is assumed that the presence of sulphate-reducing bacteria was responsible for the corrosion of the steel sheeting. A technical evaluation was conducted to better understand the phenomenon.

Following the event, the operator rebuilt the digester using glass-lined steel.

Biogas is a mixture of methane (55-70%), CO₂ (20-40%), steam and often corrosive gas residue. Production is optimised by maintaining the temperature in the digester at approximately 40 °C, with a pH of between 5.5 and 8.5.

Corrosive compounds, such as H₂S, are also present in the biogas, which requires it to be purified for use as fuel or to be transported.

All the metallic elements in digestion tanks (agitators, piping, etc.) or transport pipes are thus subjected to corrosion.
2\(^{nd}\) case, 11/12/2012, Impact of the biogas circulation rate (ARIA 43522):

A biogas leak was detected at around 11:45 am in the sludge digestion zone of an urban wastewater treatment plant containing underground piping connecting 2 biogas storage spheres. A safety perimeter was set up at 11:55 am. At 2 pm, the piping was isolated using a "line blind" device placed upstream and by closing a manual valve downstream. Around 3 pm, a trench was opened up to inspect the pipeline, thus making it possible to locate the leak on a flange at around 6:30 pm. Upon analysis, the loss of integrity was due to slow internal corrosion caused by the excessively slow flow velocity of the biogas. The operator replaced the cast iron piping with smaller diameter plastic (HDPE) piping to increase the flow velocity of the fluid.

3\(^{rd}\) case, 03/10/2013, Influence of moisture and H\(_2\)S contained in the biogas (ARIA 44662):

At around 4:30 pm, a biogas detection alarm was being triggered intermittently in the control room at an urban wastewater treatment plant. The control operator forwarded the alert to the safety station. Thinking that a faulty sensor may be to blame, a security agent went to an inspection chamber on the underground piping supplying the digesters and confirmed that a pocket of biogas was present (100\% of the LEL). The stand-by crew was alerted at 5:30 pm and, suspecting a leak on buried piping, decided to shut down the sludge mixing booster and then ventilate the contaminated inspection chambers. The process was halted at 6:30 pm even though the leaky pipe had not been located due to the high density of underground piping in the area.

The search was resumed 72 hours later, and measures were taken to reduce the leakage rate and secure the area. After 60 hours, at a depth of 4 m, a 4 cm hole was found on a cast iron pipe connecting 2 digesters to the gasometers. As a result of the leak, 24,000 m\(^3\) of biogas was lost [...]

Slow internal corrosion of the cast iron pipe would be at the origin of the incident. The biogas exiting the digester is very humid. Moreover, the biogas produced in this unit has a higher concentration of H\(_2\)S than in the other units because the sludge contains less ferric chloride (H\(_2\)S neutraliser). Finally, the piping is among the oldest on the site, thus having been subjected to corrosive agents for the longest period of time.

A few questions to be asked in order to limit the risks of corrosion

**Design:**
- Does the choice of steel used take into account the corrosion problems specific to biogas? Is steel ultimately the most suitable material?
- Are all forms of corrosion examined? Has the choice and nature of the protective coating been made accordingly? Have purging systems been put in place to trap the condensation of biogas in the gas pipes?
- Will the equipment be easily accessible for maintenance and inspection?
- Is there any feedback from facilities similar to the project?

**In-service monitoring of installations:**
- Have inspection plans been developed for steel equipment in contact with biogas? Are thickness measurements performed on the walls of the equipment? How often?
- Does the biogas produced present particular characteristics (moisture, H\(_2\)S content)? Is this data taken into account in the inspection plans?
- Is "ATEX" zoning of the installations determined? Is it properly indicated?
- Is the quality of the sludge used monitored? Is their ferric chloride content monitored?
- Are equipment shut-down periods subject to special measures (corrosion monitoring)?