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GSE Position Paper on Gas Quality

Who is GSE?

GSE (Gas Storage Europe) is one column of GIE (Gas Infrastructure Europe), the European association of gas infrastructure operators. GSE represents the interests of storage system operators and has currently over 30 members which accounts for around 85% of the European gas storage market.

Introduction

Gas quality plays a crucial role for the interoperability of gas systems and thus the free flow and trade of gas. Currently, there exist different natural gas qualities across Europe depending largely on the different sources of gas.

This existence of disparate qualities has received increased attention in the recent years mainly due to the integration processes of the European gas market. Moreover, with the envisaged development of renewable energy sources, including those in gaseous form such as biomethane[1], synthetic natural gas[2] or hydrogen, the topic of gas quality will further gain in importance. It is worth noting in this context that biomethane is considered to have the highest potential to play a major part in the energy mix in the nearest future, largely thanks to the political support that it enjoys.

The need to develop gas quality standards in Europe to achieve market integration and ensure integration of renewable energy sources has been recognized by the European Commission, which has set off to pursue harmonization of gas quality parameters at EU level[3]. To this end, the Commission has launched two processes by issuing mandates to the European Committee for Standardization (CEN):

- CEN Mandate M/400 of 2007 to draw up standards in the field of gas qualities.
- CEN Mandate M/475 of 2010 to draw up standards for biomethane for use in transport and injection in natural gas pipelines.

Storage system operators grouped in GSE support the general objective of the work in the area of gas quality standardization. However, it ought to be stressed that this work should ensure that safety and integrity of the system are maintained, including for storage facilities. In particular, with regard to renewable energy sources, it is important to stress that their integration will rely on the existing gas infrastructure.

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[1] Biomethane: generic term used to refer to gases produced from both biological and thermochemical processes. The biological processes are based on upgrading biogas produced by anaerobic digestion of municipal waste streams, process residues, agriculture waste streams and energy crops such as various types of grasses as well as landfill gas by removing the carbon dioxide and other contaminants from the biogas. In thermochemical processes biomethane is produced by the catalytic treatment of synthesis gas downstream of biomass gasification processes

[2] Synthetic natural gas: gas produced from carbon-containing masses through gasification and methanation. This term may also mean gas produced from excess energy (e.e. surplus wind or solar energy) and water through a process of electrolysis and subsequent methanation (the concept of „power-to-gas“).

[3] It has to be mentioned that changes in gas quality would also require new standards for measurement devices and procedures

The aim of this paper is to raise awareness of the potential impact that changed gas quality may have on the operation of underground storage facilities**.**

Gas quality and underground gas storage

Gas quality plays a major role for the operability of underground gas storages. The proper operation of both surface and subsurface equipment of the facility as well as the underground reservoir itself depend largely on the properties of the gas which is injected into the facility.

In fact, underground gas storage facilities operate under specific conditions which differ greatly from those of transmission systems. This is because gas injected into a storage reservoir assimilates humidity which is caused by the presence of water in the immediate geological environment. Moreover, pressure and temperature conditions tend to be higher and geochemistry of the natural strata where the storage reservoir is embedded obviously differs from that of steel pipe. As these characteristics vary largely between storage facilities, depending on the local geological conditions, the storage technology applied as well as the type of storage itself (depleted field, aquifer, salt cavity), the impact of gas quality will not be equal for all storage facilities.

Nevertheless, while the behavior of storage facilities is well-known and proven in the case of injection of natural gas, the effects of the injection of renewable gas such as, biomethane, synthetic gas or hydrogen necessitate careful analysis. This is because such gas may contain certain components or critical concentrations thereof which can present considerable technical risks for a storage facility or including its installation hardwares and the reservoir itself. Although, as mentioned above, the extent of such impact will depend on a case by case basis, the development of standard parameters of such gas should not be prejudicial to the proper functioning and integrity of underground storage. In the same manner, the quality properties resulting from a mix of a renewable gas with natural gas will necessarily require an in-depth assessment against the possible effects on storage facilities.

As a consequence, given the complex processes involved in storage operations and the impact that changed gas quality may have on them, it is of utmost importance that the ongoing and future European work in the area of gas quality takes into account the specificities of underground gas storage. Failure to do so may both put at risk the operation of existing facilities as well as challenge the development of new ones thus impacting on the availability of storage capacity in the market.

Critical components of relevance for the operation of underground gas storage facilities:

While approaching the gas quality specification and its impact on gas storage, including in the context of the integration of renewable energy sources, a number of critical components or concentration thereof need to be taken into account.

The following section discusses various components whose presence or high concentration in the gas injected into a storage facility may exert a significant impact on both the subsurface or surface equipment.

A distinction needs to be made between components which can already be found (to a larger or lesser extent) in natural gas but whose concentration may vary significantly in other types of gas and components which are normally not found in natural gas but which may be present in other types of gas. For the purpose of this paper we will speak of “unconventional concentration” of certain “conventional” components in the first case and “unconventional components” in the second case.

- **Unconventional concentration of certain conventional elements:**

1. Oxygen

When extracted, natural gas is oxygen-free. This is because it is formed in underground strata under anaerobic conditions. Nevertheless, oxygen can be measured by TSOs at some interconnection points, albeit at very low concentrations, as a consequence of:

- quality adjustment (non-cryogenic nitrogen injection)
- desulfurization of gas with the use of processes requiring oxygen
- works on pipelines.

On the other hand, in the case of biomethane, the concentration of oxygen can be significantly higher than the levels which are currently found in natural gas. As a result, when injected into the high pressure transmission network or recompressed from the distribution grids biomethane can dramatically increase the oxygen content of gas with potential impact on storage facilities, in particular:

- increased corrosion of both surface and subsurface installations,
- iron(oxy)hydroxide precipitation with associated pH-reduction (corrosion enhancement, especially in combination with organic acids) and accompanied mineral weathering
- accelerated creation of elementary sulfur in the presence of H_2S, which may negatively affect the characteristics of the storage facility, leading to pore clogging of the underground or to sulfur deposit on valves, filters and turbines on the surface equipment.
- reaction with production chemicals (e.g. with glycols used in dehydration units to promote enhanced glycol-aging)

2. Sulfur components

Although sulfur components can be found in some cases in natural gas, their concentration is usually limited.

The presence of sulfur components within a storage reservoir may generate many different reactions with other substances (oxygen, hydrogen) for example to H_2S or cause changes of the pH-level and feeding of bacteria. This will ultimately depend on the geochemical and geophysical conditions of a facility.

With the increased concentration of sulfur components, the unwanted reactions described above can be exacerbated. This can be the case when injecting biomethane, which typically includes significantly higher concentration of these components.

As the usage of (sulfur containing) odorants is handled differently all over Europe, combined with the possible injection of biomethane from distribution to transmission networks the issue will require indepth assessment.

3. Carbon dioxide

Natural gas contains small amounts of carbon dioxide. However, carbon dioxide is one of the principal components of biogas. According to Marcogaz (WG Biogas-06-18), the concentration of carbon dioxide in biogas is around 40%.

Given the specific operating conditions of storage facilities, carbon dioxide can cause corrosion. This is due to the humidity in storage reservoirs which is generated by the presence of water in the immediate geological environment. With the elevated levels of carbon dioxide in biomethane as compared to natural gas, its injection can significantly exacerbate the process of corrosion.

4. Biological agents

Both natural gas and biomethane contain microorganisms. It is recognized that microorganisms are present in natural gas, but their nature can be different from those of biomethane, therefore this issue should be addressed.

Currently little is known about differences in microbial strains and quantities. Growth and reactions of microorganisms, especially under storage operating conditions (humidity, temperature, pressure, pH-factor etc.) are unpredictable and have to be carefully investigated further.

Nevertheless, it is clear that microorganisms and the products of metabolism (i.e. organic acids) may influence the quality of natural gas and impact on the storage facility in a number of ways:

- bio-clogging of natural reservoir strata
- bio-clogging of technical facilities (i.e. filters)
- damage to the reservoir rock due to change of the pH-factor
- corrosion
- contamination of processing fluids
- changes in gas quality (causing sour gas)

5. Hydrogen

In the context of the development of renewable energy sources the potential increased usage of hydrogen -and its possible injection into gas infrastructures- will need to be analyzed as it may have an impact on storage facilities. In particular the following technical limitations have to be assessed:

- stress cracking at steel installations, which might potentially occur under typical gas storage operations (cycle pressure loading)
- possible substrate for undesired bacteria
- possible production of organic acid or hydrogen sulfide
- possible undesired impact on gas engines

❖ Unconventional elements:

6. Siloxanes

Siloxanes are present in biomethane generated from solid waste or sewage treatment.

In the combustion process, siloxanes are oxidized to silicon dioxide which forms deposits on abrasive elements, in particular pistons and cylinder heads. This, in turn, damages gas fuelled engines and turbines and which are used by many UGS for the operation of the facility (e.g. compressor stations).

7. Ammonia

Ammonia is another component which can be found in biomethane and which presents a corrosion risk. This risk is of particular relevance in storage operating conditions characterized by the occurrence of humidity which exacerbates the corrosion process.

8. Halocarbons (Organo Halides)

Natural gas does not contain halocarbons. However, these are normally present in biomethane generated from solid waste treatment. The use of gas containing halocarbons for the processes associated with storage facility operation (e.g. to propel compression stations used by many UGS) may present a safety risk. This is because when combusted, gas containing halocarbons may generate dioxins and furans.

9. Poly aromatic hydrocarbons

As in previous cases, poly aromatic hydrocarbons may present a technical and safety risk for the equipment associated with the operation of a storage facility. In particular, they can cause damage to seals in valves and generate soot when combusted. Similarly to the other mentioned components, poly aromatic hydrocarbons can be found in biomethane.

10. Carbon Monoxide

Biomethane when generated from the thermal gasification of biomass amongst other processes contains a significant amount of CO, which is very toxic and whose release, especially in small confined spaces, can increase safety risks.

11. Trace components/Impurities:

Biomethane could bring additional dust and particles into gas systems, which can clog the filters that are used to protect the equipments as well as the valves and turbines.

Conclusions

Storage system operators grouped in GSE support the general objective of the work in the area of gas quality standardization, as gas quality plays a major role for the free flow of gas. At the same time, however due to the specific operation conditions of underground storage, the quality of gas which is injected into storage facilities presents a vital precondition for their proper functioning. Changed gas quality, if not compatible with certain limits, may therefore have a lasting negative impact compromising the use of storage. As mentioned in the present paper, this impact can vary between facilities and still needs to be analyzed in depth.

Given that underground gas storage facilities are mostly connected to transmission networks, changes to the quality of gas injected into the transmission network will, as a consequence, exert an impact on storage facilities. In this context, gas quality changes need to be approached with caution. This holds true in particular for biomethane whose use is expected to increase in the near future and which will rely on the existing infrastructure. This is important in that the influence on gas storage of some components which are present in biomethane can be significant. The way forward should be therefore to ensure that the quality parameters of renewable gas, such as biomethane, are adjusted upstream at the production stage so that the resulting product can be used without posing necessary technical or safety risks to the infrastructure on which it will rely.

Having said the above, GSE would like to stress that any work on gas quality standards, including for biomethane and any other type of renewable gas, should be carried out with a view to defining acceptable levels of all components which may influence operation of storage. It is important when setting those limits that transmission networks are not considered in isolation but rather in the context of the broader gas chain whose one part is also underground gas storage. In other words, quality limits set for the injection of gas into the transmission system should be compatible with the specificities of underground gas storage and its operating conditions. Failure to do so can compromise the sound operation of storage facilities and could, in turn, go contrary to the EU objectives of market integration and integration of successful renewable energy sources.