Publishable Summary for 18SIP03 Si-S/Biogas
Improvement of the European quality infrastructure for the measurement of total silicon and sulphur content of biogas

Overview

This project evaluated the industrial biomethane measurement capability for total silicon and total sulphur impurities with traceable primary gas standards (objective 1) and provided training and knowledge transfer on best practice sampling and analysis of biomethane within industry (objective 2). It also promoted the wider uptake of standardisation of biomethane purity requirements (objective 3). Furthermore, the project addressed industry's need for standardised, reliable impurity measurements, thus it improved the overall quality of the framework within the biomethane distribution network. The end-users now understand their measurement capabilities better and can perform better measurements with smaller uncertainties knowing how to avoid potential hidden bias.

Need

Impurities in biogas can cause extensive damage to the gas infrastructure if the impurity thresholds are not set lower than certain critical thresholds. Therefore, accurate measurement of impurity content is vital and will also help to better support the growing European biogas industry. In response to EC mandate M/475, two EN standards have been published which specify the maximum recommended impurity threshold levels within biomethane (EN 16723-1 and EN 16723-2).

There was a need to increase industry's awareness of these EN standards, in order to prepare for future legislation and facilitate the uptake of standardisation within currently employed ad-hoc gas network-entry agreements (within which local gas distributors and independent gas transporters sign unique contracts with biomethane producers to specify the level of purity testing required). These purity measurements have been performed throughout Europe. However, there was a lack of traceability, so robust validation through a coordinated comparison of measurement capability was required.

Additionally, there was a need to educate the industrial biomethane purity laboratories in best practice sampling and measurement in order to avoid hidden measurement bias, which can lead to incorrect pass / fail criteria being reported for biomethane purity tests due to impurities being adsorbed during sampling and analysis. Specifically, the two most challenging measurements that are prone to these errors within the EN standards are **total silicon and total sulphur contents**, due to their highly adsorptive nature. The project addressed these needs by providing traceable gas standards and organising inter-laboratory comparisons for the evaluation of industrial laboratory measurement capability. The comparisons were performed in conjunction with a workshop and webinar-based training on best practice in sampling and measurement of total silicon and total sulphur in biomethane. The results of the inter-laboratory comparisons, along with the requirements of EN 16723-1 and EN16723-2, were promoted at international events and communicated with related stakeholders to highlight the importance of traceability within the gas quality infrastructure.

Objectives

The overall aim of the project is to use traceable primary gas standards to evaluate total silicon and total sulphur impurities in biomethane.

The specific objectives are:

1. To evaluate the measurement capability of industrial laboratories performing measurement of total silicon and total sulphur concentration in biomethane with traceable primary gas standards, and to publish the results in an industry publication or an open-access peer-reviewed journal.
2. To disseminate knowledge outputs of EMRP project ENG54 Metrology for biogas in best practice sampling and analysis of total silicon and total sulphur concentration of biomethane to industrial analysis laboratories.

3. To increase the awareness of standards EN 16723-1 and EN 16723-2 within the wider biogas and biomethane industry to support their wider uptake, and to provide input to ISO working group ISO/TC193/SC1/WG25 Biomethane.

Results

Evaluation of the measurement capability of industrial laboratories performing measurement of total silicon and total sulphur concentration in biomethane (Objective 1)

The project successfully organised two inter-laboratory comparisons for the sampling and analysis of total silicon and sulphur-containing components in biomethane. The participants were from gas producers, calibration and testing laboratories, instrument manufacturers, NMIs/DIs, research institutes, and other end-users. The large number of participants from these stakeholders shows that organising inter-laboratory comparisons with traceable gas standards is a useful way to address their needs. The evaluation results not only provided metrologically traceable validation of the measurement methods used in industry, by using traceable gas mixtures prepared by the partners, but it also showed interesting scientific insights.

Two reports on the inter-laboratory comparisons for the sampling and analysis of total silicon and total sulphur content in biomethane have been produced. The findings of the industrial laboratory comparisons were presented to the participants and disseminated at webinars, workshop and conference. The results are also being included in a paper which will be submitted to a suitable biogas trade publication, or to a peer-reviewed journal.

Knowledge transfer and training (Objective 2)

Five webinars were organised by the consortium, focused on best practice sampling and on the analysis of the total silicon and total sulphur content in biogas and/or biomethane. A final project workshop was held towards the end of the project, during which presentations from the consortium and stakeholders were organised. Knowledge transfer and exchange were clearly recognised. Feedback was collected from the participants of the 5 webinars and the final project workshop. The participants were from gas producers, calibration and testing laboratories, instrument manufacturers, NMIs/DIs, research institutes, and other end-users. Training materials on the sampling and analysis of siloxanes and sulphur-containing components were prepared and used for the webinars.

A paper containing the results from the inter-laboratory comparisons was written and uploaded to the open-access project website. Two comparison reports were shared with the participants of the comparisons as well as with the audiences of the webinars and the final project workshop. A lecture presentation was given at the European Conference on Fuel and Energy Research and its Applications. Two abstracts were accepted at the GAS2021 conference which was postponed to 2022 due to the COVID-19 pandemic. These two lectures will be given at the GAS2022 conference (after the project officially ended).

When the project just started, an informal workshop combined with the project kick-off meeting was organised. An introduction, discussion and feedback on the project activities were provided from both the consortium and the participants. A flyer was prepared and distributed at the GAS2019 conference; the project was introduced to the conference participants. A flyer was prepared, and the project was introduced during the European Energy Gases workshop. Project outputs were provided to the EMN on Energy Gases. Other social networking activities were performed as well to enlarge the impact of the project and the contacting community. A stakeholder committee was established which had around 40 members.

Increasing the awareness of standards EN 16723-1 and EN 16723-2 and contributing to ISO working groups (Objective 3)

The partners attended several ISO/TC193/SC1/WG25 “Biomethane” and Dutch national NEN NC310408 “Biomethane” meetings where the project’s outputs were presented. The test methods used in the inter-laboratory comparisons have been delivered to these Working Groups and feedback was received. This feedback along with the results of the inter-laboratory comparisons will lead to a realistic overview of industrial capabilities.

The standards EN 16723-1 and EN 16723-2 were introduced and referred to in the conference presentation(s), at the webinars, workshops, and in a written paper. This will support wider uptake by the biogas and biomethane industry.

Impact

The project organised two inter-laboratory comparisons, a series of training webinars and workshops for the sampling and analysis of total silicon and sulphur-containing components in biomethane. Flyers and presentations promoting the project's activities were disseminated at conferences and other events. A paper containing results from the inter-laboratory comparisons was drafted, uploaded to the open-access project website and will be submitted to an open access peer-reviewed journal. Project outputs were provided to standardisation bodies (such as the ISO/TC193/SC1/WG25 "Biomethane" and the Dutch national NEN NC310408 "Biomethane") and to the EMN on Energy Gases. A stakeholder committee was established which consists of around 40 members.

Through the results outlined in the Results section above, the following impact has been (or will be) generated:

The high-level impact of the project was achieved by improving the framework that underpins the growing biomethane industry, thus furthering the diversification of the European energy supply, reducing reliance on fossil fuels and increasing the proportion of renewable energy used in Europe. Moreover, this was made possible through the enhanced industry awareness of the EN standards that specify maximum recommended limit levels of impurities of biomethane for injection into the gas grid and use in vehicle fuel (EN 16723-1 and EN16723-2, respectively). The enhanced visibility of these EN standards will provide both large- and small-scale businesses with the know-how they need to prepare for future legislation and grid entry agreements with gas distributors.

The inter-laboratory comparisons using accurate and SI-traceable gas mixtures, paired with the dissemination of knowledge in best practice in the sampling and analysis of impurities in biomethane will provide industry with confidence in their capability for measuring these compounds in biogas and biomethane. It will also provide industry with an improved understanding of how to perform accurate measurements and on how to avoid hidden quantification bias which can lead to false negatives in pass / fail tests (*e.g.* impurities are adsorbed during sampling). This will directly impact the quality of the biomethane that is injected into the gas grid and used as a vehicle fuel. Reducing the damage caused by impurities will improve the long-term integrity of the associated gas infrastructure in both industrial and home settings.

PSI as primary supporter is directly benefitting from this project via participating in the comparisons, the uptake, exploitation and use of research outputs as well as the dedicated support of VSL and NPL. Not only that, PSI is gaining a better understanding of, and confidence in, their capability for measuring these compounds in biogas and biomethane, this has also endorsed their progress in multiple projects where clean biogas and knowledge of siloxanes and sulphur compounds are required. It also reduced the risk of using unqualified gas in the biogas cleaning systems that PSI is involved in. Accurate and traceable gas standards and knowledge on siloxanes and sulphur has also indirectly stimulated development and validation of cheap and reliable gas sensors for usage in sensitive downstream processes and advanced gas cleaning systems.

The training and inter-laboratory comparisons created direct impact on the European biogas industry by allowing biogas producers, operators of landfill and wastewater sites, gas distribution networks and testing laboratories to perform accurate and traceable measurements of total silicon and total sulphur in biogas and biomethane using metrologically validated methods that comply with purity quality standards. The wider promotion of standards EN 16723-1 and EN 16723-2 within the gas industry allows grid operators to improve the level of the impurity thresholds they set within network entry agreements and it drives legislation for improving the quality framework within the industry. The gas end-users will benefit from the increased accuracy in analytical results for harmful impurity levels which, if reported incorrectly, could cause damage to the gas infrastructure.

The project's output has been shared with the ISO/TC193/SC1/WG25 Biomethane working group to help the WG to have a more realistic overview of industrial capabilities which is helpful for revising relevant ISO standards or developing new ones. Furthermore, the metrology community is benefitting from calibration and measurement services, training and other joint services provided by the partners. In order to stimulate innovation in the production and upgrading of biogas to biomethane which meet industry's specifications, traceable gas standards and calibration services are needed. The project has engaged directly with industry by organising various activities (such as the inter-laboratory comparisons, knowledge transfer, training etc.) so the metrological community can obtain an insight into the actual measurement needs of industry, which will allow tailored calibration services to be developed.

Further expansion of the biogas/ biomethane industry in Europe is foreseen. The use of biogas (in the form of biomethane) for injection into the natural gas grid and for use as a vehicle fuel will reduce dependency on the

import of natural gas, liquefied natural gas (LNG), liquefied petroleum gas (LPG) and other oil and petroleum products into Europe, and improve the energy self-sufficiency of the continent. It will also provide a carbon-offset due to biogas being a carbon neutral fuel. Its use in road vehicles will provide decreased pollution levels compared to fossil fuel alternatives such as petroleum oil. Biogas use will also offset environmental damage caused by the extraction of fossil fuels. Decarbonisation of the world energy supply is at the forefront of global research efforts, with Europe leading its promotion and the utilisation of renewable energy. The project contributed to facilitating a reduction in carbon emissions and to promoting energy sustainability.

The use of biogas (as biomethane) in the existing natural gas infrastructure is promoted by EC Directives (2003/55/EC & 2009/73/EC) and will help meet target of the EC Renewable Energy Directive (REDII/2018/2001), which specify that at least 32 % renewables in the final energy consumption in the EU by 2030.

<table>
<tr><td colspan="2">Project start date and duration:</td><td>1 June 2019, 30 months</td></tr>
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<tr><td colspan="3">Primary Supporter: Serge Biollaz, Paul Scherrer Institut (PSI)</td></tr>
<tr><td>Internal Funded Partners:
1. VSL, Netherlands
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