EuroTeQ Collider February - May 2022

Theme: Detection management of gas leakages

Introduction

Methane emissions are a significant contributor to the rising concentration of greenhouse gases in Earth's atmosphere and are therefore partially responsible for near-term global heating. Reducing methane emissions by capturing or utilizing the gas can produce simultaneous safety, environmental and economic benefits.

From network gas infrastructure perspective, the amount of methane emitted from a facility depends on equipment type and condition, maintenance procedures and the frequency of maintenance, and operations at the facility under consideration, moreover on the quality and swiftness by which gas leakages are being detected. Gas network operators work systematically on both, avoiding new leakages, and to detect existing leakages as soon as possible.

Who is behind this initiative?

GasNet is the operator of the largest gas distribution network in the Czech Republic. It provides reliable and secure natural gas supplies for more than 2.3 million customers. GasNet has a roughly 80% share in the distribution of natural gas in the Czech Republic and manages 65,000 kilometers of gas pipelines in almost all regions of the Czech Republic.

The company's primary focus, in addition to reliably and safely delivering energy to 2.3 million customers, is to support the Czech Republic's decarbonization goals. These goals include the replacement of lignite for heat and power production by natural gas and biomethane in a first phase till 2030 to 2038. In phase 2, the goal of reaching net zero carbon emissions by 2050 by replacing natural gas by hydrogen and by eliminating emissions in GasNet's own operations shall be achieved. To successfully manage this unprecedent transformation process, GasNet will intensely invest not only into the renewal and retrofit of its network, but also into new advanced technologies and new work approaches.

What is the challenge of gas and methane leakage detection?

The detection of natural gas leakages is equally important for safety, environmental and financial reasons. As the gas network includes various asset classes (gas mains, pressure reduction stations, meters), each of them with technical specifics, and as the network is for its majority installed beneath the ground and spread over a wide regional area, detection in time is a challenge.

This challenge has several dimensions:

i. To apply the right detection technologies, or to invent further improved technologies
ii. To select efficient inspection methods, depending on network specifics, city versus rural area or asset class (gas mains, pressure stations, meter devices)
iii. To work and analyze collected data properly, to make the right conclusions and to feedback those into GasNet's operation

Interested university teams are asked to engage in either of the above areas or in a combination of those.

Detection technologies

- Existing technologies include detection sensors with manual application or by car
    - **CL - catalytic sensor (Pelistor)**: works on the principle of catalytic combustion – the gas concentration is measured in accordance with the amount of heat released during a controlled combustion reaction. The reaction is prompted by a suitable temperature and the presence of a catalyst.
    - **Infrared cameras:** A Infrared detector (IR) uses an ability of gases with two ore more atoms to absorb infrared (IR) light, e.g. carbon dioxide, methane. Infrared detectors use wavelengths specific corresponding to vibration or rotation of a bond between two atoms in the gas molecule. The higher gas concentration the lower IR signal (approx. logarithmic function).
    - **PID detection applications:** A Photoionization detector (PID) uses an ultraviolet (UV) light source to ionize chemicals to positive and negative ions that can be easily counted with a detector. Ionization occurs when a molecule absorbs the light energy. The gas becomes electrically charged. These charged particles produce a current that is then amplified and displayed on the meter as "ppm" or even "ppb".
    - **Electrochemical sensors:** Electrochemical sensor consists of 2, 3 or 4 electrodes, which are located in a gel electrolyte. A system of electrodes and the electrolyte is separated from the atmosphere by a diffusion barrier. Gas molecules diffuse through this barrier and react with the electrolyte. There are oxidation and reduction reactions at the electrodes and they cause a change of cell potential. The higher the gas concentration is, the higher the potential will be.

Inspection methods

- **Installations of detection equipment on handhelds, at cars, drones, or stationary installations.** Gas Net uses a variety of those and is planning to introduce further developed and innovative solutions.
- **Satellites** can track methane over very wide areas. The dynamic innovation process allows to see not only very large emissions and lack the resolution to identify sources but also to detect a vast number of smaller emissions, with year on year increasing precision. GasNet is willing to test satellite technologies.

Data Management

- Field data from the daily work shall be properly collected and (statistically) analyzed to make the right conclusions and to suggest optimized work approaches in the operations for various asset classes.

Relevant considerations for the challenge / theme:

A selection of the relevant focus area i) to iii) shall be made first, to identify whether the team wants to work on rather technological aspects or rather on statistical data management.

Students are asked to sign a NDA prior to the start of its work.