Advances in Thermal Processes and Energy Transformation
Volume 3, 2020, PETK01, p. 86-89
ISSN 2585-9102

Natural Gas Leak Detection and Quantification in the Gas Industry

František Šucha[1] ● Viera Peťková[2]

[1]Eustream, a.s., Votrubova 11/a, 821 09 Bratislava, Slovakia, frantisek.sucha@eustream.sk
[2]Eustream, a.s., Votrubova 11/a, 821 09 Bratislava, Slovakia, viera.petkova@eustream.sk

Category : Original Scientific Paper
Received : 14 December 2020 / Revised: 22 December 2020 / Accepted: 27 December 2020

Keywords : natural gas, detection and quantification leaks,

Abstract : One of the basic goals of Eustream is environmental protection Methane emissions are classified according to their origin in three different types: Fugitive emissions, Vented emissions, Incomplete combustion emissions.
Searching for leaks during transmission and gas distribution is an important diagnostic activity. Based on the results diagnostic (detection and quantification) the company Eustream prioritizes maintenance activities to eliminate the identified defects. This approach both increases the safety of the operational facilities and decreases losses due to by leaks.

Citation: Šuha František, Peťková Viera: Natural Gas Leak Detection and Quantification in the Gas Industry, Advance in Thermal Processes and Energy Transformation, Volume 3, No.4, (2020), p. 86-89, ISSN 2585-9102

1 Introduction

Natural gas is considered a comparatively and clean fossil fuel ecologically because on combustion it has the lowest specific emissions of carbon dioxide (CO_2 per unit of released energy) of any fossil fuel. The use of natural gas has also the advantage of moderating the growth of the greenhouse effect. Recently, attention has been focused on the emission of methane (CH_4), which is the most important component of natural gas. Methane emissions represent a serious problem, as methane is a greenhouse gas with a warming potential 25 times higher than that of carbon dioxide.

Methane is an active gas that prevents re-radiation of incident solar radiation into space, and therefore it contributes to the growth of atmospheric disorders and the continuous increase in the Earth's temperature. This effect is called the "total greenhouse effect". Frequent methane leakage into the air means that the advantage connected with a transition to using it as a fuel could in fact become a disadvantage. It is necessary for all important producers of methane emissions to realize that a reduction in methane emissions is a very important element in the strategy of preventing total climate change. As for the problems associated with safety and the environment, the European gas engineering companies traditionally apply a policy of "best practice", despite the fact that they are not always forced to do so by legislation and that there is no economic incentive to do so.

Eustream has become a member of the Oil & Gas Methane Partnership, a global partnership in which oil and gas companies have committed to new rules for monitoring, reporting and reducing methane emissions. It is a joint initiative of the Climate and Clean Air Coalition, the UN Environment Program, the Environmental Defense Fund and the European Commission

One of the basic goals of Eustream is environmental protection, and it therefore pays significant attention to methane emissions and their evaluation, and not only to achieve the lowest operating costs. Eustream attempts to identify all aspects relating to decisions connected with minimization of leakages and to find the optimum approach.

2 Background

Searching for leaks during transmission and gas distribution is an important diagnostic activity. The purpose is not only to reduce the losses but also to prevent dangerous situations and incidents that may occur when certain conditions are met. Diagnostic

methods and devices for gas detection are the key factors, and the purpose of this paper is to provide information on the use of an optical gas imaging (OGI) system to find leaks.

A number of diagnostic methods and tools have been applied to detect natural gas. The system used by Eustream and the process for detecting and quantifying of leaks at gas facilities in Slovakia are described here.

The transmission system consists of pipelines with a total length of more than 2273 km, with pipe diameters mainly of 1200 mm and 1400 mm, and four compressor stations with a total installed power 541 MW.

Identification of leak sources in Eustream is specific because of the extraordinary design of the Slovak transmission system. The system consists of four, in some parts five, parallel lines of gas pipes with diameters DN1200 and DN1400. A ball valve station is located at approximately every 25 km, and every third or fourth ball valve station contains a complete interconnection of all the pipelines.

3 Methods

3.1 Detection

The identification of methane emissions was divided into two parts:

- location of leak sources in the pipeline system and turbo-compressor installations
- identification of leaks and methane ventilation during maintenance works.

Leaks in the pipeline system are mainly connected with insufficiently tight valves, flange joints, and cracks.

The following sources proved to be the most significant:

- external leaks at ball valves and other valves
- passing boundary valves, e.g., valves on emergency depressurization systems.

A project team of specialists at Eustream sets the goals for the project to locate and quantify gas leaks. The main goals are the localization and quantification of leaks. The assessment of the severity and danger of a leak and the determination of the priority for repair are also very important objectives. [2]

The first part of the project was to choose reliable, fast, and accurate measurement instruments for the search, visualization, and subsequent quantification of gas leaks into the air. A large number of diagnostic methods are available for detecting gas leaks, including study the use of a thermal OGI camera and a laser detector.

The focus was on a passive thermographic system that allows the visualization of leaks. An OGI camera can be used to scan large areas rapidly and pinpoint leaks in real time. An additional conventional infrared camera can deliver additional information about the inspected area.

Undetected gas leaks represent an increased threat to the technological equipment in operation plants. The task of increasing safety is key in all industrial operations and this is met by implementing a program of gas leak detection and quantification, and this can be done quickly and effectively using optical visualization equipment.

3.2 Visualization

It is common practice around the world to control each component (potential leak) and to "sniff" it with a hand-held gas detector. However, this is time consuming, laborious, and costly, and is limited by the number of components the inspector can reach during the inspection.

Current diagnostic devices and techniques for detecting gas leaks (e.g., bubble test, acoustic detector, and gas analysis) require the inspector to visit and inspect every element that is a potential source of a gas leak.

Thousands of different elements and components are installed in the Eustream's operational facilities, and to control the approximately 45 000 components (valves, flanges, joints, ventilation chimneys, etc.) requires several workers working for several months. OGI cameras such as the FLIR GF320 allow quick and effective detection of hydrocarbon leaks from the pipelines.

These devices exploit the specific properties of methane and other hydrocarbons (infrared transmittance). They contain a spectral filter by means of which gases become visible. Pictures from the cameras are converted into digital form and by using a measurement device the leak can be quantified.

Using the OGI camera the leaking natural gas is directly visible against the background of the surrounding equipment. The leak is seen as a plume (Figure 1), and it is easy to identify the source, which needs to be repaired.

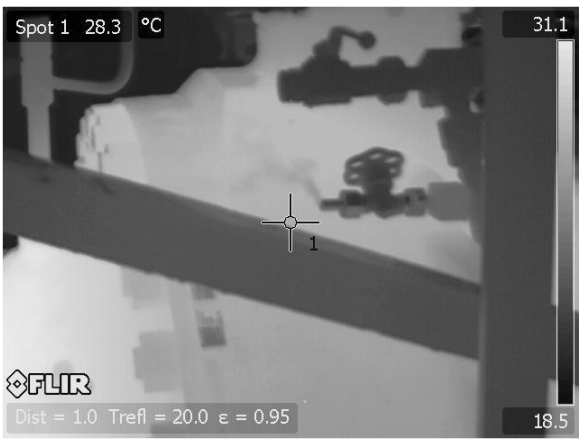

Figure 1 Identification of natural gas leaks.

Figure 2 Localization of gas leaks

The use of an imaging system makes it possible to check the selected components in a significantly shorter time. It is of great importance to use the imaging system in both the exterior and the interior spaces, in particular the latter where there a greater number of leaks occur (Figure 2). To use a laser detector in these areas is problematic.

3.3 Thermal camera (infrared)

In components such as a pipeyard (Figure 3) it is not possible to locate precisely where the gas leak into the atmosphere is. For example, there may be a gas leak into the air from the vent chimney, but it is not known which valve is leaking. In such cases the "classic" LW thermographic camera helps us greatly. [3]

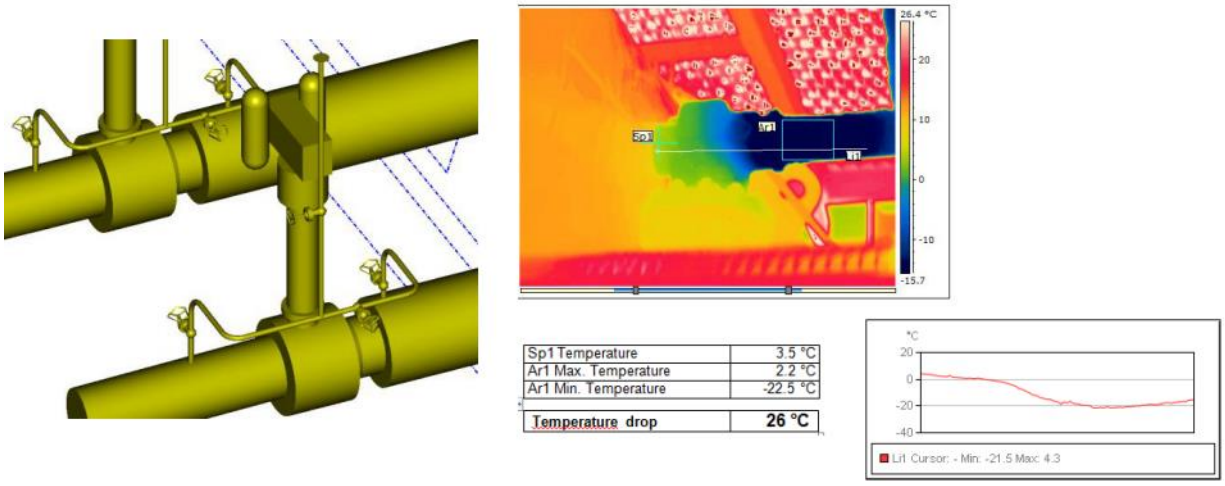

Figure 3 Pipeyard.

The conventional thermal camera exploits the fact that natural gas cools down on expansion and in doing so cools down its surrounding environment. A thermal camera enables these thermal differences to be visualized and thereby identify a natural gas leak. However, quantification of the leak is not possible by this technique.

3.4 Quantification [1]

The identified and visualized data are quantified using a particular method in a suitable form for further system processing. Various measuring devices can be used to determine (measure) the size of a gas leak (e.g., calibrated bag, rotary flowmeter, anemometer, and flow sampler).

The Bacharach Hi Flow Sampler (Figure 4) makes it possible to quantify each leak up to a flow rate of 250 l/min, and appears to be the most suitable method for quantifying natural gas leaks. Leaked natural gas is sucked into the instrument by means of a calibrated pump at a flow rate of 250 l/min.

The analyser simultaneously measures the percentage of methane in the mixture and evaluates the flow of methane, and displays the results directly on the device. The Hi Flow Sampler has a measurement accuracy of ±10%. By parallel connection of two instruments it is possible to increase the measuring range up to flow rates of 500 l/min, which sufficiently covers all current deficiencies in pipeline technologies. Using the Hi Flow Sampler a quantitative measurement is made to determine the leak rate and hence its priority for repair. The Hi Flow Sampler is the primary method used to measure the amount of gas leaked into the air.

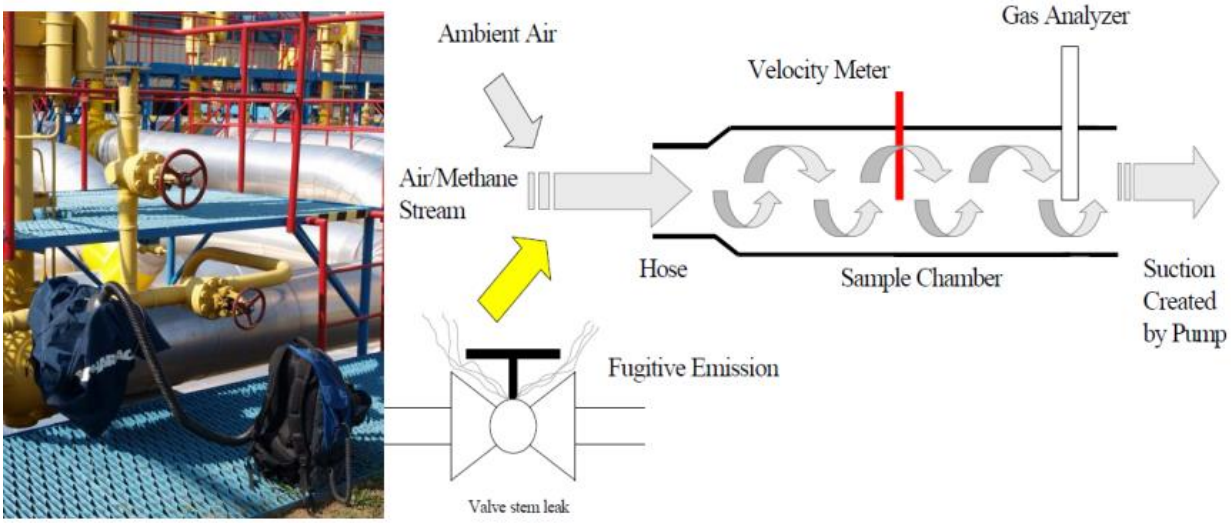

Figure 4 Quantification of methane using the Hi Flow Sampler.

4 Results

The location of possible sources of natural gas (methane) leaks is carried out on a large number of components across the entire Eustream transmission network. Based on the results of the survey (detection and quantification) the company prioritizes maintenance activities to eliminate the identified defects. This approach both increases the safety of the operational facilities and decreases losses due to by leaks.

For the purposes of system leak assessment Eustream's gas technology is divided into compressor stations, armature nodes, and gas pipelines. The evaluation methodology is defined in the Eustream internal regulations, which take into account the relevant legislation and standards. The leaks are divided into three groups according to their severity:

The system of measurement, identification, and continuous monitoring of the integrity of the pipe systems provides maximum security and reliability of gas transportation. By reducing gas leakage into the air to as little as possible the company not only makes considerable financial savings but also increases the level of life and health protection and the protection of the environment.

The reference list

[1] PEŤKOVÁ, V., SVOBODA, J.: *Termodiagnostika,* Košice, 2016

[2] ŇUKOVIČ, R., TÓTH, P., MIHÁLIK, V., ZELENAJ, A: Identification and Minimisation of Methane Emissions the Transmission Network. [Online]. Available: http://members.igu.org/html/wgc2009/papers/docs/wgcFinal00478.pdf (accessed September 6, 2017).

[3] ŠUCHA, F., SVOBODA, J.: *Vizualizace Plynů Pomocí Termografických Systémů*, Conference Proceedings, DIAGO® 2012, ciace technických diagnostiků ČR, o.s. , VŠB-TU Ostrava, 2012