SPECTRA

Scientific Validation of the Measurement Method

www.byautoma.com
sales@byautoma.com

Odorant in natural gas networks: in-line measurement and continuous monitoring with AUTOMA's SPECTRA solution

During transportation/distribution in the network, natural gas must be "odorized", i.e. mixed with a substance with an acrid odor, so that users can immediately notice even the slightest leak. In order to ensure an adequate level of odorizer in the gas, it is necessary to carry out periodic checks on the concentration of odorizer, which must be readily detectable by smell.

SPECTRA technology, developed by **AUTOMA**, which has always been active in the research of solutions for the remote monitoring of methane gas distribution networks, was born from the desire to propose an odorizer **measuring instrument as an alternative to gas chromatographs, able to allow in situ measurement and continuous monitoring**.

Gas chromatographs are measuring instruments that generally do not allow continuous monitoring and are rather expensive both in the purchase and in the maintenance phase (maintenance requires the involvement of specialized personnel and consumables are required for routine operation).

Discontinuous monitoring over time is not very effective in the analysis of historical trends and in the timely detection of malfunctions and abnormal situations for which it is often necessary to provide an immediate remedy. In addition, field gas chromatograph technology is not well suited when classes of compounds other than odorant (such as aromatic hydrocarbons, which are hazardous to health) are to be measured.

The **SPECTRA** continuous natural gas monitoring system is **AUTOMA**'s answer to these issues.

SPECTRA system

SPECTRA is an instrument designed for in situ installation, in-line measurement and fully automatic operation that does not require direct supervision, as well as to **provide continuous and accurate monitoring** of odorant concentration in the gas. The measurement method used by **SPECTRA** is not based on the physical separation of the components of a gaseous mixture, as it happens in gas chromatography, rather on the principle of the different interaction of the gaseous components with UV-Visible light, called **UV-Visible absorption spectroscopy**.

Since 2014, **AUTOMA** has been experimenting **SPECTRA** on gas distribution lines obtaining very positive feedbacks both in terms of analysis/trends and in terms of measurement accuracy. In parallel to the experimentation in the field, **AUTOMA**, in collaboration with the University of Camerino and the CNR-ICCOM of Florence, aimed to obtain, and actually gained in 2020, the publication of the spectroscopic analysis of the data obtained with this measurement method in a very specific scientific journal of the sector, **Applied Spectroscopy**.

Applied Spectroscopy is a scientific journal extremely specialized in spectroscopy and its countless applications. It is a peer-reviewed journal of quality and this means that each article, to be published, must

Automa s.r.l.
Via Casine di Paterno, 122/A
60131 Ancona

Phone +39.071.8028042
Fax +39.071.802374
P.IVA IT01090140425

Numero REA AN: 108287
Capitale Soc.: 92962,00 € i.v.

illustrate the data and methods with undeniable scientific rigor and must have elements of innovation compared to the rest of the scientific literature.

The article: Odorant Monitoring in Natural Gas Pipelines Using Ultraviolet–Visible Spectroscopy

The scientific article "*Odorant Monitoring in Natural Gas Pipelines Using Ultraviolet–Visible Spectroscopy*" was written thanks to the collaboration of **AUTOMA** with various experts in the sector: Dr. **Rossana Galassi** (University of Camerino), **Dr. Christian Contini** (Automa), **Engineer Matteo Pucci** (Automa), **Dr. Ennio Gambi** (Polytechnic University of the Marche) and **Dr. Gabriele Manca** (Institute of Chemistry of Organometallic Compounds, Florence) and is composed of four main sections:

- Introduction
- Spectroscopic analysis
- Computational analysis
- Experimental section

The introduction describes the **state of the art of odourant concentration measurement in natural gas**. An overview is given of the most common odorants and their importance in preventing explosions caused by gas leaks. A **comparison of the main measurement techniques** is also presented, with a focus on their desirable and undesirable characteristics. Finally, the theory behind spectroscopy is explained, with particular focus on UV and visible gas phase spectroscopy.

In the section on spectroscopic analysis, the UV-Visible **spectra of the two most common odorants, THT and TBM, are shown for the first time in the scientific literature**. It is also shown that light hydrocarbons (mainly methane and ethane) do not interfere with the measurement of odorants, irrespective of their concentration.

In the third part of the paper, concerning the computational analysis of the energy levels of the two odorants, **the correspondence between the experimentally detected signals and the signals obtained mathematically from the theory of molecular orbitals is demonstrated**. The simulation of the orbitals and energy levels of the two odorants has thus made it possible to assign each UV signal detected by **SPECTRA** to a specific energy transition within the molecule, and this has made it possible to understand the nature of each absorption characteristic of the two substances.

Finally, in the experimental section it is shown **that the two odorants - THT and TBM - respect the Lambert-Beer law**, a fundamental law of spectroscopy, even within a complex matrix such as natural gas. **The variations observable in the spectra of odorised natural gas over a long period are also presented** and the characteristic signals are assigned to the specific substances responsible for them, laying the foundations for measuring the concentration of other sulphur compounds (dimethyl sulphide) and aromatic hydrocarbons (benzene, toluene, xylene).

Conclusions

www.byautoma.com
sales@byautoma.com

Since the publication of this article it is now evident and definitive that **SPECTRA solution is based on a scientifically rigorous measurement method**, and odourant concentration measurements are totally independent of the variability of the concentration of the hydrocarbons that make up almost all natural gas. In addition, the method can also be effectively applied to the measurement of other sulphur compounds and aromatic hydrocarbons.

The article is available at the following permanent link: https://doi.org/10.1177/0003702820960737.

This result represents the **first scientific acknowledgement of the validity of the SPECTRA measuring system** in the field of natural gas odorisation measurement and joins many other successes that over the years have rewarded the continuous research of **AUTOMA**.

Automa s.r.l.
Via Casine di Paterno, 122/A
60131 Ancona

Phone **+39.071.8028042**
Fax **+39.071.802374**
P.IVA IT01090140425

Numero REA AN: 108287
Capitale Soc.: 92962,00 € i.v.