

Odorous gases monitoring on industrial sites and algae decomposition using Cairsens smart sensors

Ben Daoud A.^{1,*}, Caron A.¹, Akiki R.¹, Aflalo S.S.¹, Laplagne J.¹,

¹ ENVEA, 111 boulevard Robespierre 78300 Poissy, FRANCE,

*corresponding author: E-mail: a.bendaoud@envea.global

Abstract

The appearance of natural odors sources (*Sargassum* beaching events) or odors generated by the human activity (industrial sites) represent a major challenge for municipalities. Combined with intolerance of nuisances by residents, and/or tourists, it forces municipalities and industrial players to manage and control diffused emissions of odors in a more stringent and efficient way.

Hydrogen sulphide (H₂S) and ammonia (NH₃) have been identified as the main odorous nuisance sources, they also have high adverse effects on health, and therefore they must be monitored and controlled.

Real-time and continuous monitoring of both H₂S and NH₃ emissions near industrial sites using advanced micro-sensors, based on amperometric detection, has been carried out in this study. Compared to reference and standardized analyzers, providing precise measurements at a single place, micro-sensors are an effective and cheaper solution that can be easily deployed on large areas.

This paper presents the monitoring of odorous gases emitted by algae putrefaction, fertilizers and waste treatment plants across Atlantic coast by Cairnet stations network combined with the Caircloud software monitoring platform. The results show the contribution of micro-sensors network in order to improve the management of odorous gas emissions from industrial or natural sources.

Keywords: Sargassum odors, emissions monitoring, micro-sensors, Cairnet Mini-Station, Caircloud software

1. Introduction

Sargassum beaching events are new to many residents in the southern Caribbean, Brazil and West Africa, but are well known in the northern Caribbean islands, the Sargasso Sea and the Gulf of Mexico. This phenomenon is the origin of a smelling gas emanating from the putrefaction of algae. Among these gases, H₂S and NH₃ have been identified as the main parameters to be controlled. This is due to their high olfactory impact as a result of their low human olfactory threshold (Table 1).

The World Health Organization recommends monitoring of H₂S as a surrogate for odor in

determining the effect odor nuisance has among exposed populations and they warn that concentrations of H₂S should not exceed 4.7 ppbv for a 30-minute averaging period ^{Air quality guidelines}. Consequently, instruments that measures these compounds need low-level detection capabilities.

Table 1. Human olfactory thresholds for H₂S, CH₃SH and NH₃

Compound	Human olfactory threshold	Smell
H ₂ S	18 ppbv	Rotten egg
CH ₃ SH	1 ppbv	Cabbage, garlic
NH ₃	5-6 ppmv	Pungent, irritant

Reference and standardized analyzers' available in the market, including fluorescence-based detection ^{Toda K., Dasgupta} or flame photometric detector ^{Lestremat F.}, provide very precise measurements at a given time and place, but such analytical devices are expensive, they need skilled agent for operation and maintenance and are not easily field transportable. Thus, those instruments cannot be mass-deployed and they are not appropriate to give a full picture of current pollution. The spatial and temporal dimensions, which define the diffused pollution, are then lost.

For these reasons, a solution composed by multiple "sampling" points combined to an efficient software application is required; thus micro-sensors are the best devices because they are effective, cheap and can be easily deployed on large areas. This study aims to monitor H₂S and NH₃, emitted across Atlantic coast, with multiple Cairnet stations combining different micro-sensors with the Caircloud software.

2. Material and Methods

Air quality monitoring network Cairnet mini-station based on very accurate micro-Sensors Cairsens[®] (manufactured by ENVEA Group) has been deployed across Atlantic coast and located as close as possible to stranding areas but also to the population (Figure 1), particularly so-called sensitive people, in schools, nurseries, hospitals, etc. Cairnet stations network are innovative tools that enables the real-time monitoring of the critical factors influencing a site's odor emissions,

as well as the corresponding impact on the surrounding community.



Figure 1. Picture of (a) Sargassum beaching in Martinique and (b) Cairnet station installed

3. Results and Discussion

Up to 4 parameters are measured by station, completely autonomous thanks to a miniature cost-effective sensors based on amperometric detection, developed to monitor H₂S and NH₃ at ppbv levels with response time around 90 s (Figure 2). Combined with wireless communication, a solar panel and a backup battery, one can set up an autonomous network of sensors and completely highly mobile. The sensors are calibrated in metrological laboratory using standard reference AQMS monitors (Figure 2), certificated for a year (lifetime of the sensor). Figure 3 shows the good agreement between Cairsens measurements and the reference TRS analyzer for H₂S monitoring on field.

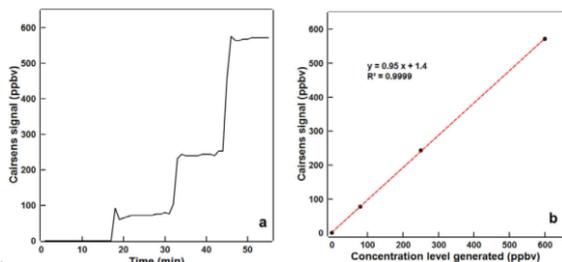


Figure 2. Sensor signal exposed (a) to 0, 80, 250 and 600 ppbv of H₂S and (b) the linear regression.

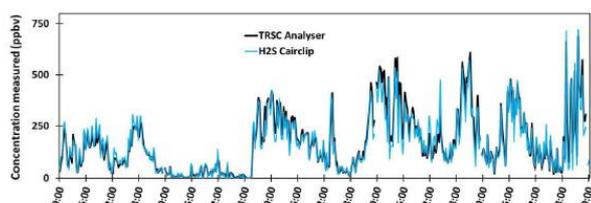


Figure 3. 5 days field monitoring of H₂S by Cairsens and validated by TRS analyzer

The complete GPRS/3G communication system of the Cairnet automatically transmit data to the CairCloud® (Figure 4), the ENVEA's Cloud data processing application and continuously exported (API link) to the data base of local Air Quality Monitoring Department institutions (AQMD).

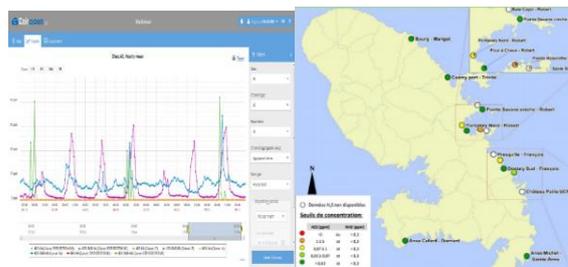


Figure 4. Caircloud® secured Cloud interface for automatic data analysis and visualization

Adaptable and responsive, the monitoring network provides decision support for local institutions^{C.Boullanger} by transmitting updated data daily. Thus, the Cairpol network is a reliable and efficient network that perfectly meets the needs of local issues. This solution encompasses primary functions in order to anticipate, monitor and minimize a sargassum beaching's odor.

4. Conclusion

The implementation of real-time emissions monitoring solutions allows for a more constructive and positive dialogue amongst industrial site or municipalities stakeholders including site management and operations staff, community residents and local government and regulatory officials, ultimately resulting in a considerable reduction in the number of odor complaints. Local site Operations staff are greatly assisted in their efforts to determine the source having the greatest impact at the time in question, facilitating process optimization and resolution of the issue.

References

- Toda K., Dasgupta P. K., Li J., and Tarver G.A. (2010), Fluorometric Field Instrument for Continuous Measurement of Atmospheric Hydrogen Sulfide, *Anal. Chem.*, **73**, 5716- 5724.
- Lestremau F., Desauziers V., Roux J.-C. and Fanlo J.-L. (2003) Development of a quantification method for the analysis of malodorous sulphur compounds in gaseous industrial effluents by solid-phase microextraction and gas chromatography-pulsed flame photometric detection, *J. Chrom. A*, **999**, 71-80.
- Air quality guidelines for Europe, World Health Organization Regional Office for Europe (2005), *Regional Publications*: Copenhagen, Denmark, 146-148.
- C.Boullanger, D. Wirth, S. Gandar, S. Falguière. (2019), Monitoring & alert network. in response to the health problems of Sargasso algae, international symposium "Individual Air Pollution Sensors: Innovation or Revolution?", Villeneuve d'Ascq, France, 2018.