PARIS WASTE TO ENERGY PLANT IMPROVES ODOUR MITIGATION WITH SMART SENSORS AND ENVIRONMENTAL INTELLIGENCE

A waste to energy (WtE) plant in northern Paris, known as the 'L'étoile Verte' or 'Green Star' waste recovery facility, which was originally built in an industrial area, is now surrounded by residential development. This has presented a number of challenges; not least of which is odour. The company ELLONA has therefore been contracted to establish a smart continuous odour and gas monitoring network, so that the sources of odour can be identified, and improvement measures can be underpinned by scientific data.

Commissioned in 1990 and built in an area that has hosted industrial activity since 1919, the WtE plant is situated at Saint-Ouen-sur-Seine and has an incineration capacity of 600,000 tonnes of domestic waste per year. Steam from the combustion process is used to generate electricity; the majority of which is used by the plant. In addition, heat is supplied to the Parisian district heating network.

The WtE plant is owned by Syctom; the largest European Public Authority in charge of the treatment of waste produced by 6 million inhabitants of the Capital Region of France. With a focus on innovation, Syctom makes waste a resource and optimizes waste recovery channels. As such, Syctom performs a major role in the development of the circular economy and sustainable cities.

Green Star plant modernisation

Situated within Les Docks, a 100-hectare eco-district, the owner of the WtE facility, Syctom, is implementing an urban integration project at a cost of €210 million, with completion due in 2024. The project involves construction work, tree planting and the improvement of the flue gas and wastewater treatment processes. In addition, with residents now located just a few metres from the plant, Syctom has installed a network of ELLONA continuous air quality monitoring devices to identify the sources of odour, so that effective mitigation measures can be implemented.

Odour management at the Green Star WtE plant

In addition to the odour monitoring network, reports of odour occurrences by local residents help the plant to identify potential sources of odours. However, this process has a number of limitations. For example: some odour instances may go unreported, especially when they occur at night time; some odours may have been created by external sources; and odour is a subjective observation because different odours affect different people in different ways. Nevertheless, the main objective of odour management is to reduce or eliminate the effects of odour on local residents, so their feedback is essential.

Syctom has created a website for local residents association, Mon Voisin des Docks, which provides updates on developments at Green Star, and residents are able to report odour instances via the website http://etoile-verte.syctom-paris.fr/signalement-odeur/. A short training course was provided for some residents; helping them to better characterise and report odours.

Prior to the installation of the odour monitoring network, it was difficult to correlate odour complaints with potential sources, so it was clear that odour monitoring would be necessary. However, the traditional method involves the collection of spot samples, so it was determined that a continuous odour monitoring system was necessary.

"The ELLONA monitoring network was established for a number of reasons," says Claire Bara, Syctom Director of Urban Ecology and Environmental Regulation. "Firstly, it was clear that we would need continuous monitoring to be able to identify odour events. Secondly, air quality monitoring alone would be insufficient

because of the complexity involved with odour detection and perception. Thirdly, the identification of peaks would enable us to correlate odours with specific processes and locations within the plant. So, by identifying the main sources of odour, we would be able to implement improvements that would also be monitored by the ELLONA network.

"Classical modelling tools would not be able to accommodate the complexities of the urban environment, so one of the main aims of the tool was to be able to identify every odour source – both on-site and in the surrounding neighbourhood," Claire explains.

Odour monitoring

The presence of an odour does not necessarily mean that it is offensive. Odour is considered to cause pollution if it causes offence to human senses or the environment. The characteristics of an odour that are taken into account when assessing its offensiveness are frequency, intensity, duration, odour unpleasantness, and location.

The standard method for the determination of odour concentration (EN 13725:2022) involves the collection of a gaseous sample for dynamic olfactometry evaluation by a panel of trained human assessors. The advantage of this method is that the human nose is extremely sensitive, and of course humans are the receptors for this form of pollution, so

the method is appropriate. However, the major disadvantage, apart from the time delay and the cost, is that the gas sample represents one moment in time, so it cannot be truly representative. This is because odour levels may have been much higher or lower before or after the sample was taken, but there would be no data to show this. Continuous monitoring is therefore preferable, but only if the data are representative of the local odours.

A further complication with odour is that it is rarely the result of one individual chemical. Frequently, odours are caused by a mixture of chemicals, and there may be synergistic effects between different odorous compounds. For this reason, the standard method (grab samples) is based on human perception. In order to be able to monitor odour continuously, it is necessary to utilise an 'electronic nose' or IOMS (Instrumental Odour Monitoring System), with the capability to measure all of the most common odorous compounds. For this reason, the ELLONA monitors employ a suite of monovariant and multivariant sensors that are capable of measuring volatile organic compounds (VOCs), sulphurous compounds such as hydrogen sulphide, mercaptans and other odorous compounds such as amines or aldehydes. The detection of specific gases, however, is not sufficient on its own, to effectively monitor odour; it is also necessary to be able to identify site-specific odours and to conduct multidimensional mapping so that sources can be identified.

Prior to the configuration of Green Star monitors, ELLONA collected representative Tedlar bag samples from the site, and conducted comprehensive laboratory and dynamic olfactometry analysis of the potentially odorous compounds present. Odour threshold limits were established using the dilution method outlined in ASTM E679. This enabled ELLONA to create a quantitative fingerprint for the site's odours and to thereby install monitors that are capable of detecting the specific odorous compounds that exist at the site. Using the same training, a quantitative fingerprint allows the identification of the nature of the odours as well as their sources.

At Green Star, the incinerator is burning domestic waste, from which odour production varies according to the weather (temperature), which is why continuous monitoring is so important.

Each of the ELLONA monitors (WT1) at Green Star features a comprehensive array of sensors measuring temperature, humidity, pressure, hydrogen sulphide, ammonia and VOCs. Other important variables are wind speed and direction, which have obvious effects on odours. Wind is therefore monitored at the site continuously; not just to be able to model the movement of odour plumes but also to be able to differentiate any odours that arrive from an external source. ELLONA therefore worked in partnership with the high-performance computing and modelling company NUMTECH to model the complex air flows that take place in the plant and in the surrounding urban environment. Meteorological conditions determine whether the site's emissions are dispersed in the local streets. The combination of numerical simulations (forward and backward) and the network measurements make it possible to identify the contribution of the site and the potential sources.

The WT1 units store measurements internally, but the data are also transferred to the Cloud every 10 seconds for processing. Data from the physical sensors and from the virtual sensors (created from the physical sensors' data and mathematical models) provide information on air quality, odour identity, intensity and duration. The measurements and the derived odour information are provided in real-time to Syctom via a dedicated website, which also provides the facility to view historical data.

The advantages of network monitoring

It would have been possible to install a single ELLONA monitor at the Green Star site, and to model odour around that point, but by installing a network of 19 WT1 monitors Syctom derives a number of important advantages. For example, networks of IoT monitors improve the capability to track the speed and direction of odour as it moves across the network, which in turn helps to identify odour sources. Similarly, if all of the monitors report an unrecognised odour moving across the network, it is likely that it is derived from a diffuse external source or a distant point source. However, if one monitor in the network reports an odour incident; it is more likely to be derived from a point source within the network.

Odour levels at any point are generally comprised of odours from different sources, so the ability of the ELLONA system to identify sources means that it is able to measure the relative contribution of the different individual sources to each odour incident.

Most of the WT1 monitors are located within the local neighbourhood. This enables the evaluation of the amplitude of odour change in comparison with the reference situation. Alarm thresholds have been set for the physical and the virtual sensors, and an alert is issued each time a threshold is exceeded. Consequently, Syctom is able to respond quickly to any odorous incident.

Summary

Continuous, smart odour monitoring has been shown to offer major advantages over spot sampling. However, the unique features of the ELLONA solution are that the monitoring network is developed to match the specific odours that exist at the Syctom site, and ELLONA's mathematical models enable the continuous delivery of source identification with both qualitative and quantitative data.

The continuous odour monitoring system has improved Syctom's understanding of the processes that affect odour, including specific events and the volume of waste being handled for example. In addition, the availability of trustworthy transparent data has provided reassurance to local residents.

Explaining the value of the insights that the ELLONA solution delivers, Claire Bara says: "The monitoring system has confirmed the main odour sources that we have on-site; in particular, it has demonstrated that odours arising from waste truck movements are more important than we initially expected. To-date, the measurement network has helped us to identify and implement the most effective mitigation measures. That work is currently ongoing, but we expect the system to show us that these measures have enabled odour improvement, for the benefit of our staff and local residents."

Looking forward, now that the concept has been proven, the plan at the Green Star site is to further lower odour nuisance by implementing odour mitigation measures and identifying those which are the most successful. As time passes, the constituents of household waste are likely to change, but with the monitoring system in place, Syctom will be able to respond accordingly to any changes in odour generation.

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