THE ROLE OF SENSOR-BASED AIR QUALITY SOLUTIONS IN MITIGATING INDUSTRIAL POLLUTION

Industries are increasingly prioritizing the reduction of their environmental impact, and sensor-based air quality systems have emerged as an essential tool to manage improved environmental actions, economic efficiency, and overall sustainability.

Industry pollution is a major concern which causes significant damage to the population and to wildlife and ecosystems. However, it is not only a climatic impact issue but the high societal costs caused by air pollution from the industry. According to the European Environmental Agency (EEA), the cost of industrial pollution in 2024 ranged between €268-428 billion. The last few decades have seen clear progress in activities related to industrial air emission control. The incorporation of innovative technologies and more efficient production processes, not only enhances environmental awareness, but also mitigates the overall environmental impact.

Thus, the first step is understanding and controlling industrial emissions. New cost-effective, and robust methodologies designed for the identification of fugitive emissions and industrial pollutants, such as sensor-based air quality devices, are valuable tools for the implementation of fenceline monitoring. Sensor-based air quality systems afford real-time monitoring with suitable spatial coverage for the determination of representative pollutants at the industrial fenceline, providing useful information on overall concentration levels and potential problem areas. These systems enhance the protection of public health and worker safety, by controlling emissions within diverse industrial processes. They enable the detection of inefficiencies in the production process, facilitating the mitigation of product losses and leading to cost reductions, thus, enhancing overall operational efficiency and economic sustainability.

Air quality sensor-based systems are compact and cost-effective air quality solutions, which can integrate different sensors, more related to air quality, i.e. NOx, O_3, SO_2, CO_2 and particulate matter, but also other pollutants for different industrial sectors, such as HCl, H_2S, VOCs, CH_4 and NH_3.

Even though sensor-based systems provide an excellent option to monitor different pollutants, they are not regulated yet. Over the past decade, there has been a worldwide effort to evaluate sensor-based systems, focusing on data quality, such as the AQSPEC program in the US, and the Airlab Microsensor Challenge in France. These independent evaluations were the first attempt to show independent performance assessments of sensor-based systems. However, there is a lack of an internationally accepted standard protocol that allows comparing the performance of instruments in different evaluation studies. In Europe, the CEN/TS 17660-1:2021 was developed but has not been validated yet, while the USEPA created different evaluation protocols. Besides, other certification bodies created specific certifications, such as MCERTS Certification for Indicative Ambient Particulate Monitors in the UK.

Kunak AIR Pro station in a WWTP

As one of the leaders in the sensor-based instrument market, Kunak develops compact and cost-effective air quality solutions, designed for harsh environments with an easy integration of real-time data into industrial systems and maintaining wireless data transmission to the cloud software, Kunak Cloud. Kunak AIR solutions were awarded as the Most Accurate Multipollutant Sensors in the Airlab Microsensor Challenge in 2021 and 2023 editions, as well as demonstrated its performance and high accuracy in several independent evaluations (AQSPEC Program, QUANT evaluation organised by UKRI and DEFRA, RICARDO evaluation, etc.), together with the MCERTS Certification for Indicative Ambient Particulate Monitors.

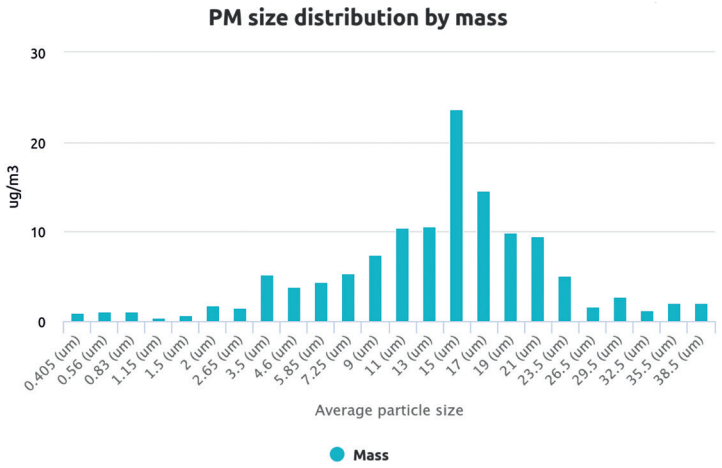
Several applications showcase the successful advantages of employing sensor-based systems for continuous pollutant monitoring:

Odour monitoring

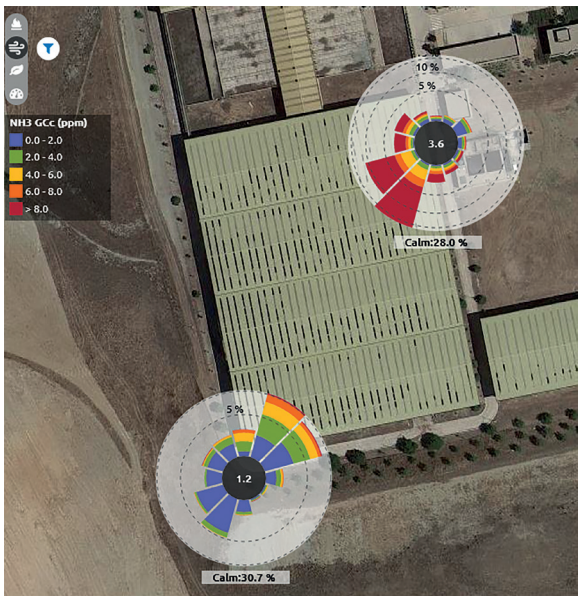
Monitor pollutants related to odour nuisance to prevent possible effects on nearby populations in Waste Water Treatment Plants (WWTP), landfill sites & manure, pulp & paper, compost management and fertilizers plants. Control del critical points in which odour episodes could occur and forecast affected areas.

Typical projects for odour monitoring in which Kunak participates are the monitoring of H_2S, VOCs and NH_3 in a WWTP. Kunak systems equipped with anemometers are deployed in the field, allowing pollution sources characterization. In one of the projects, the accuracy of the H_2S sensor was tested by comparing its readings against an H_2S analyzer. The results indicated a high level of precision, with a correlation coefficient (R^2) of 0.77 and a mean absolute error (MAE) of 6.9 ppb. Besides, the H_2S and VOC sensors were able to identify concentrations of methyl-mercaptans, not detectable by the H_2S analyzer. This discrepancy resulted in a slightly lower R^2 for the H_2S sensor when compared to the analyzer. Essentially, the combined use of H_2S and VOC sensors provided a more comprehensive understanding of the pollutants present. Additionally, another successful case was the identification of ammonia emission sources stemming from the sludge treatment plant.

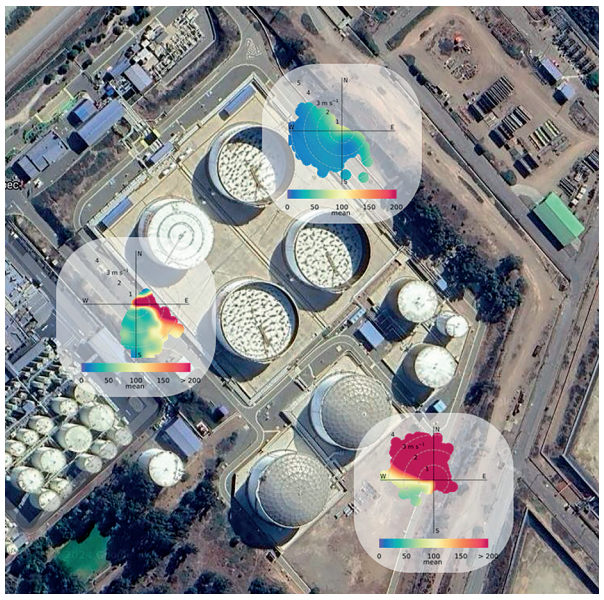
Left image: Kunak Air Pro deployed at Las Palmeras coal mine.



Right image: PM size distribution in Kunak AIR Cloud.



NH_3 pollutant detection (pollution rose) in a sludge treatment plant.



VOCs detection (polar plot) from a petrochemical industry.

Heavy industry

Industrial monitoring for the detection of leakage and fugitive emissions and hotspot identification. Sensor-based systems are suitable for evaluating actions to minimize the impact of the operations, comply with environmental regulations, and economic savings by reducing maintenance costs and implementing more efficient systems and technologies. The main industries to deploy a pollutant monitoring network are cement and steel industries, power plants and transportation.

One of the real use cases is the air quality monitoring at the CEMEX plant in Monterey (Mexico). CEMEX deployed a Kunak AIR Pro monitoring network, both in the quarry and in the factory, providing excellent data quality on the main pollutants derived from cement production. The monitoring network records the main parameters to alert when any of them exceed pre-established levels through a notification system and thus helps in taking preventive measures.

Oil & Gas industry

Pollutants monitoring at in-mission helps to create a more sustainable future by measuring the impact of petrochemical industry emissions on air quality. The use of sensor-based instruments facilitates the identification of operational issues within the industry, such as inefficiencies, leakages, and breakages. Furthermore, these instruments aid in promptly detecting maintenance deficiencies by monitoring an increment in diffuse emissions, thereby enabling cost savings and quick intervention to address inefficiencies.

There are several study cases in which Kunak AIR solutions were deployed in petrochemical industries, such as Latin America and the Middle East (customer names are confidential). Kunak AIR devices are deployed in the oil and gas industries, equipped with VOCs, HCl and SO_2 sensors among other pollutants, to identify the emissions, ensure the health of the workers, and protect and preserve the environment. Additionally, the Kunak AIR Cloud provides diverse tools for analyzing pollutant behaviour, facilitating a comprehensive understanding of emission sources.

Mining and Construction Industry

A sensor-based network allows the assessment of the environmental impact of mining operations in real-time to protect the environment and people's health. This will facilitate increased efficiency through the identification of emission sources, compliance with legislation, and support of dust control mechanisms (irrigation, chemical suppressants, etc.), leading to reduced costs through mitigation actions.

One study case is the deployment of a hybrid network of Kunak AIR Pro devices, together with equivalence particulate matter instruments, GRIMM analyzers (Dugar Group) in Las Palmeras coal mine in Colombia to control both dust and suspended particles derived from the extraction and processing of minerals that could affect nearby populations. The air quality monitoring network deployed enables the recording of the target parameters, facilitating the establishment of alert thresholds and supervision systems to aid decision-making. Besides, it provided accurate and reliable data in mining activities, contributing to the identification of critical periods during the extraction processes.

Conclusions

Sensor-based air quality systems provide a useful solution for continuous monitoring, offering real-time data on various pollutants, which helps reduce the environmental impact of the operations and contributes protection of the health of workers and nearby populations. Additionally, the use of sensor-based instruments results in cost savings by quickly identifying inefficiencies or malfunctions in the industrial processes, allowing for immediate interventions to solve them, and avoiding any economic losses.

In this context, Kunak stands out as a leader in the sensor-based instrument market, offering compact and cost-effective air quality solutions. Proven to be highly accurate through numerous evaluations and certifications, Kunak's solutions establish themselves as trusted tools for pollution source characterisation, leakage detection and comprehensive environmental monitoring. Elevate your industry standards with Kunak's reliable and efficient solutions.

As industries continue to focus on reducing their environmental footprint, the integration of innovative technologies like sensor-based air quality systems emerges as a key strategy for achieving better environmental outcomes, economic efficiency, and overall sustainability.

Kunak AIR Pro station installed at CEMEX Plant in Monterey (Mexico).

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