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Blind Prediction of Odor Concentration in Deodorization Process in Wastewater Treatment Plant Using E-nose and Dynamic Olfactometry

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Summary:
In response to the perennial challenge of mitigating odorous emissions from wastewater treatment processes, this project focuses on the innovative utilization of electronic noses (e-noses) for accurate odor concentration predictions. Undertaken at the SIAAP wastewater treatment plant, where the treatment of 2,600,000 m^3/day of wastewater generates persistent olfactory nuisances for nearby residents, this study addresses the pressing need for advanced monitoring solutions, compliant with regular audits using reference method as dynamic olfactometry)

Keywords: E-nose, odor unit, dynamic olfactometry, wastewater treatment, emission

Background

The SIAAP, since its establishment in 1970, has grappled with the olfactory consequences of treating wastewater laden with organic matter. The evolving nature of odorous compounds necessitated a progressive redesign of the existing measurement network. Traditional sulfur compounds are no longer sole indicators, prompting the quest for sensors that not only monitor odor emissions effectively but also present a cost-effective alternative to current systems.

Description of System

In pursuit of a viable solution, the study identified the Ellona Watch Tower (WT1) electronic noses coupled with the Ellona dryer as a promising technology for real time analysis to quantify odors and gas emissions in unstable environmental conditions. Two of these electronic noses were strategically deployed at the Seine Aval site, equipped with specialized hardware to meet SIAAP's stringent requirements for monitoring channeled sources. The deployment involved a meticulous training phase spanning three months, utilizing dynamic olfactometry data to optimize the e-noses for real-world scenarios.

Results

The results demonstrate a commendable success rate, with the optimized e-nose training achieving a remarkable 90% accuracy in predicting odor levels from blind samples. The linear regression model (PLS) built on multivariate statistics yielded calibration curves with an R^2 exceeding 0.93, showcasing a robust correlation between the electronic noses and olfactometry scores. The Ellona WT1 IOMS devices, equipped with Metal Oxide sensors and electrochemical sensors, not only quantified odors but also measured gases such as ammonia, VOCs, hydrogen sulfide, and mercaptans.

These devices, less expensive to purchase and maintain than traditional systems, offered a lower quantification threshold. Their successful deployment enabled the monitoring of atmospheric emissions from key odorous compounds, revealing concentrations below 500 EOU/m3, indicative of proper functioning deodorization facilities. Moreover, ongoing applications showcase the potential of the WT1 IOMS devices for real-time odor concentration monitoring and instantaneously displaying odor plumes in the SYPROS modeling tool from SIAAP.

Conclusions

This project not only addresses the inherent challenges of persistent odorous emissions in wastewater treatment but also presents a practical solution in the form of Ellona WT1 IOMS devices. Their versatility, robustness, and cost-effectiveness position them as valuable assets in the continuous improvement of environmental monitoring at the SIAAP wastewater treatment plant. This research contributes significantly to the ongoing pursuit of "zero nuisance" and enhances our understanding of odor emissions.