Chapter 5

Correlating Electronic Nose and Field Olfactometer for Industrial Odor Concentration Measurement Using PLS and MLR

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ABSTRACT

Industrial odor concentration measurement in continuous mode is a challenging task using olfactometers, as it's expensive and requires human involvement for a prolonged time. This chapter presents the development of an indigenous metal oxide sensor-based electronic nose system for measurement of industrial odor in ou/m³. The results of electronic nose and field olfactometer were correlated using multilinear regression and partial least square regression techniques. The results showed satisfactory prediction by both the models, with RMSE (6.70, and 4.02), RAE (0.29 and 0.16), and NAE (0.89 and 0.96), respectively, for MLR and PLS. The results indicated better performance of PLS compared to MLR. The objective of the present work is to train and employ artificial olfaction system for continuous measurement of obnoxious emissions emitted from industries bypassing involvement of olfactometer.

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BACKGROUND

Industrial growth is associated with countries’ rapid economic growth; however, many such industries have obnoxious emissions associated with it. These odors are due to very low levels of odorant concentration and need to be measured and treated before its emissions into the environment. Therefore, both continuous odor emissions measurement at source point and ambient sources are necessary to maintain the clean surrounding environment and to retain overall sound quality for human dwelling (Chuandong et.al, 2016). Odor concentration (ou/m³) is a cumulative effect of the numerous VOCs present at the industrial site as well as environmental parameters like humidity and temperature. Traditionally odor has been measured using olfactometry. However, prolonged use of olfactometry is not suitable for measurement of industrial odors since it involves human panel. Further, olfactometric measurements are expensive due to the involvement of human panel. Analytical instruments like gas chromatography are expensive, time consuming and depict very little about the odor perceived. These tools basically give the representation of the major odorants and not the overall odor at the industrial site. In the present work pulp and paper industry is chosen as a case study to evaluate the use of electronic nose system for industrial odor concentration measurement. Indian pulp and paper industry is huge with high production of paper quantity and numerous employment generations. However, these industries during pulp manufacturing process emit highly obnoxious gases constituting of dimethyl sulphide [(CH₃)S], dimethyl disulphide [(CH₃)₂S₂], methyl mercaptan [(CH₃)₂SH] and hydrogen sulphide [(H₂S)] in different concentration levels (Deshmukh et.al, 2014). In this research work a metal oxide sensor based electronic nose system has been developed and trained using field olfactometer for measuring the odor concentration in ou/m³ pulp and paper industries. The electronic nose results were correlated with field olfactometer using multilinear regression (MLR) and Partial Least Square regression (PLS). The results on these aspects are presented in this paper.

The motivation and contribution of this chapter is to propose an alternative way to measure industrial odor concentration using an electronic nose system. The chapter presents some onsite industrial odor concentration data collected and measured using an indigenously developed electronic nose system with minimum training sets.

MATERIALS AND METHODS

Developed Electronic Nose Setup and Experimental Procedure

A portable electronic nose system was developed for the measurement of odor concentration (ou/m³) using commercially available metal oxide sensors. The sensors were procured from FIGARO, USA (Figaro, USA) of TGS series TGS 823, TGS 825, TGS 2610, TGS 2602, TGS 826, TGS 832, TGS 2620, TGS 2611. The TGS sensors are of thick film type, and the sensing element of the TGS sensor is tin dioxide (SnO₂) doped with different impurities. The developed system consisted of (a) stainless steel sample holder (the steel material had no reaction to the sulphurous odorants) (b) programmable suction pump (c) compressed pure air canister for purging of the leftover gases (d) data acquisition system and (c) olfaction software.
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