Compensating for Relative Humidity Changes While Monitoring Air Quality Using an Electronic Nose

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A miniature electronic nose (ENose) has been designed and built at the Jet Propulsion Laboratory; this ENose was designed to detect, identify and quantify ten common contaminants and relative humidity changes while monitoring air quality in an enclosed environment.[1] In this array of sensors, polymer-carbon black composite films are used as the sensing films and most of the sensors in the array are responsive to changes in humidity. We will present data showing the effects of relative humidity (RH) on different sensing films, as well as several approaches to analyzing events which include a humidity change. The analysis of these data has led us to include a separate humidity sensor in the design of our next generation ENose system.

This ENose was used in a demonstration experiment aboard STS-95 (October-November, 1998), in which the ENose was operated continuously for six days and recorded the sensors' response to the air in the mid-deck of the space shuttle. Cabin air in the shuttle varied from 30-55% RH, with localized humidity changes of 10% or more, over 10-20 minutes. This represents a substantial change in sensor response, which may swamp smaller responses to other analytes. In the first generation JPL ENose, humidity was treated as a separate analyte, and any events detected by the ENose would be analyzed by deconvoluting humidity changes from any other analytes present. Event identification and quantification were done using the Levenberg-Marquart Non-linear Least Squares Method.[2,3] This approach was successful in identifying and quantifying mixtures in the laboratory, and marker events on the space shuttle experiment.

Electronic noses have been built using many different classes of chemical sensors, including polymer films, conducting polymer films, and metal oxide films.[4] These sensors are chosen because they show relatively broad sensitivities to many analytes, including water. In some electronic nose applications the sample environment is carefully controlled; the sensor array is trained at a constant humidity, and then the samples are tested at the same humidity. This approach is not feasible for an air quality monitor. Other approaches for handling relative humidity changes include data analysis approaches,[3,4,5] or some combination of additional humidity sensing to compensate in the data pre-processing.[2]

The large fluctuations in relative humidity on the space shuttle makes it necessary to have a good understanding of the relative humidity effects on the sensors. Although our data analysis approach was successful in separating humidity events from other analyte events, we were interested in testing whether subtraction of humidity effects before event identification and classification would improve our results.

We will present work which has been done to study the calibration of the sensing films at different humidities. Analysis of this work suggests that if the humidity is monitored using a separate sensor, then it is possible to subtract humidity changes from the data, and subsequently analyze events. This humidity background subtraction improves the ability of the software to identify events such as spills in which contaminants may be present in small concentrations and accompanied by large changes in humidity. We will present data showing the effects, as well as the improvement in event analysis. This improvement in the data analysis has helped shape part of the design for our next generation ENose, which will include a separate humidity sensor.

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