NOSE 2026: Deployment of a PID sensor to differentiate composition of VOCs in gas samples.

The presence of volatile organic compounds (VOCs) in the air poses significant challenges to human health. Exposure to these compounds is linked to various adverse effects. VOCs, originating from sources such as industrial processes, vehicle emissions, and household products, can contribute to the creation chemicals such as BTEX (benzene, toluene, ethylbenzene and xylene), which have been associated with respiratory diseases, cardiovascular problems, and other health issues. Understanding and mitigating the impact of VOCs on human health first requires an understanding of the scale of the issue, which can only be achieved through direct measurement [1]. It is clear there is a need for new measurement tools for VOC measurement in ambient air. Current approaches are either based on lab based analytical techniques, which have a price point too high for widespread usage, whilst low-cost gas sensors that have the form factor/low power capabilities, may not have the sensitivity and inability to differentiate between different VOCs. The most accurate small form factor VOC sensor on the market today is a Photoionization detector (PID), even though this sensor lacks the ability to differentiate VOCs. However, IMS is a very similar and related technology to PIDs, as they both use ionization methods and both detect charged ions. The advantage of IMS is that use of high voltages inside the device differentiate between different VOCs, something that PID are yet to achieve.

PIDs are lightweight and respond in real time to the concentrations of volatile organic compounds (VOCs), making them suitable for environmental measurements on many platforms. However, the nonselective sensing mechanism of PIDs challenges data interpretation, particularly when exposed to the complex VOC mixtures prevalent in the Earth's atmosphere [2]. Therefore, the aim of this research is to develop a small-form factor PID that provides differentiation of VOCs with the advantages of both an IMS and a traditional PID and then deploy this device into environmental monitoring. Such a sensor is beyond current state of the art. Its development requires extensive modelling of ion flow in electric fields, the development of new detection approaches and the creation of a new small form factor/portable sensor. Once completed, it provides the opportunity to test the unit in different environmental settings to understand its capability and learn more regarding the pollution levels around the local area.

The progress so far includes miniaturised bulb drive circuits using microprocessor-generated signals utilising a planar transformer. Detection methods, involving logarithmic amplifiers to increase dynamic detection range and high voltage sweep circuit to differentiate the constituent gases. These show the ability to create a system that can ionise VOCs and control the flow of ions to a highly sensitive detector. The results that will be presented at this conference will include the progress with the current circuitry, the methods to achieve best practice and the current data obtained from gas flow experiments.

[1] Montero-Montoya R, López-Vargas R, Arellano-Aguilar O. Volatile Organic Compounds in Air: Sources, Distribution, Exposure and Associated Illnesses in Children. Ann Glob Health. 2018 Jul 27;84(2):225-238. doi: 10.29024/aogh.910. PMID: 30873816; PMCID: PMC6748254.

[2] Matthew P. Stewart, Paul E. Ohno, Karena McKinney. Prediction of the Response of a Photoionization Detector to a Complex Gaseous Mixture of Volatile Organic Compounds Produced by α-Pinene Oxidation.