Air Pretreatment Platform for Indoor Air Quality Monitoring

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A humidity stabilization and gas delivery system which delivers equal quantities of gas to three sensors simultaneously was developed at CSEM. To date, it has been successfully used to test and calibrate gas sensor prototypes. It has also been incorporated into the prototype Air Quality Monitor of the European project INTASENSE.

Many diseases including sick building syndrome, respiratory problems and cancers can be caused by exposure to high concentrations of toxins commonly used in modern building materials, paints, glues and furniture. To minimize exposure to these toxins, it is important to have air exchange with the outside environment. However, this is usually not energy efficient because the air must be heated or cooled. The purpose of the Intasense Project was to resolve this problem by creating a device which determines the current quality of air within the building (Figure 1). This information could then be used to control the ventilation system within an energy efficient building. CSEM designed and constructed the fluidic platform which includes a humidity buffering system, and is able to deliver equal quantities of gas to three sensors simultaneously. To date it has been used in two versions of the Intasense Prototype [1] and used to calibrate novel gas sensors.

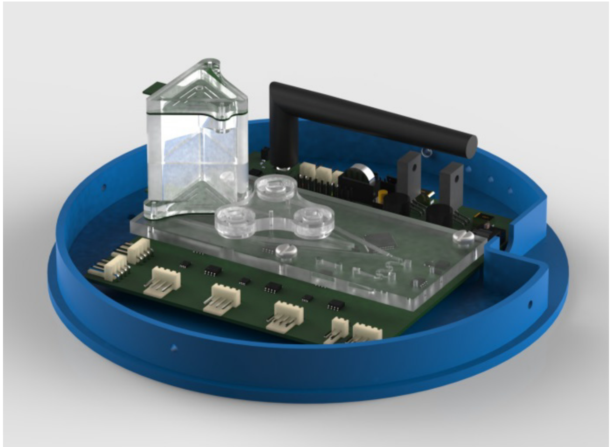

Figure 1: CAD drawing of the fluidic platform integrated into the Intasense prototype.

In both of these applications simultaneous delivery of equal quantities of the sample gas are required for optimal gas sensor signal processing: equal quantities are required so that the amount of analyte in contact with each sensor is the same and simultaneous delivery allows all three sensors to respond concurrently. This was achieved by creating a computational model of gas flow through the system, conducting a parameter sweep and then selecting the optimal set. To confirm that the model and machine error was not significant, a Greco-Latin square design was used to test the platform. This test showed that gas delivery to each channel was equal within statistical boundaries [2].

Another major challenge was buffering humidity fluctuations without loss of analyte gas. This was necessary, because the Intasense platform's gas sensors are also sensitive to humidity fluctuations [3]. To prevent a false positive caused by a rapid humidity increase, a reversible adsorbent was placed upstream of the gas sensors. However, there was concern that the adsorbent may remove analyte gasses. To optimize the tradeoff between humidity buffering and loss or delay analyte signal, a computational model of adsorption and desorption of gasses within the filtration system is under development. It is being experimentally tested using benzene, carbon monoxide, formaldehyde and nitrogen dioxide. Preliminary results of the model as compared to the experiments can be seen in Figure 2.

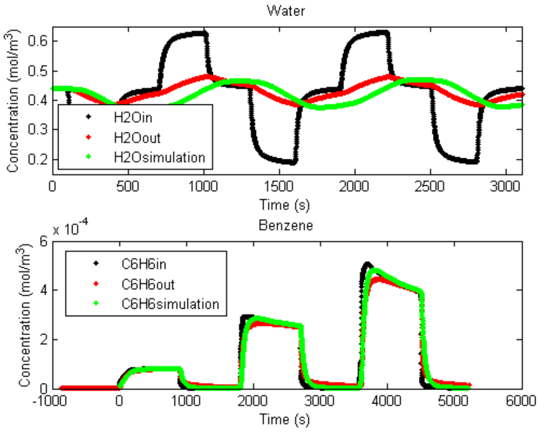

Figure 2: Results of the Computational model of analyte adsorption and desorption from the gas stream as it passes through the humidity buffer.

In this figure, the inlet gas concentration and humidity, shown in black, were measured by metal oxide semiconductor sensors and Sensirion THS 75 sensors respectively. The measured outlet concentration is shown in red. Experimental inlet concentrations are used as the inlet concentrations in the computational model. The simulated outlet concentration is depicted in green. Work is ongoing to further perfect this model.

To date ten platforms have been delivered to laboratories throughout Europe. Three are being used to test and calibrate gas sensors [4], the remaining elements have been used to create prototypes of the Intasense air quality monitor.

• Laboratoire de Production Microtechnique, EPFL, CH

[1] www.intasense.eu

[2] E. Hammes, *et al*., "The Transport Phenomena behind the INTASENSE Indoor Air Quality Monitor Product Design". American Society of Chemical Engineers, 2015

[3] E. Hammes, *et al*., "A Smart Air Quality Monitor for Energy Efficient Buildings". Smart Systems Integration, 2015

[4] G. G. Mandayo, *et al*., "The INTASENSE Project Approach for Toxic Gas Detection Indoors." International Congress on Architectural Envelopes, 2015