Chemical Engineering Doctoral Defense

A Portable Colorimetric Sensing Platform for the Evaluation of Carbon Dioxide in Breath

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abstract

This work describes the development of a device for measuring CO2 in breath, which has applications in monitoring a variety of health issues, such as COPD, asthma, and cardiovascular disease. The device takes advantage of colorimetric sensing technology in order to maintain a low cost and high user-friendliness. The sensor consists of a pH dye, reactive element, and base coated on a highly porous Teflon membrane. The transmittance of the sensor is measured in the device via a simple LED/photodiode system, along with the flow rate, ambient relative humidity, and barometric pressure. The flow is measured by a newly developed flow meter described in this work, the Confined Pitot Tube (CPT) flow meter, which provides a high accuracy with reduced flow-resistance with a standard differential pressure transducer. I demonstrate in this work that the system has a high sensitivity, high specificity, fast time-response, high reproducibility, and good stability. The sensor has a simple calibration method which requires no action by the user, and utilizes a sophisticated yet lightweight model in order to predict temperature changes on the sensor during breathing and track changes in water content. It is shown to be effective for measuring CO2 waveform parameters on a breath-by-breath basis, such as End-Tidal CO2, Alveolar Plateau Slope, and Beginning Exhalation Slope.

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