

**OPTICAL ABSORBANCE CHEMOSENSOR BASED ON DIGITAL LOCK-IN
AMPLIFIER FOR THE LOW LIMIT REAL-TIME DETECTION OF
ETHYLAMINE AS A VOLATILE ORGANIC COMPOUND**

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DECLARATION AND RECOMMENDATIONS


Declaration


This thesis is my original work and has not been presented for an award of diploma or conferment degree in any institution.

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Recommendation

This thesis has been examined, passed and submitted with our approval as University supervisors.

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DEDICATION

I gladly dedicate this work to my dear parents, my spouse and my children for believing in me and for their unwavering support.

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ABSTRACT

Volatile organic compounds (VOCs), frequently released from industrial processes and domestic products, pose serious threats to both environmental quality and human health. Continuous real-time monitoring of VOCs in air and water is therefore critical for environmental protection and occupational safety. Conventional methods such as electrochemical sensors and gas chromatography are limited by high cost, complexity, and slow response, while colorimetric chemosensors often suffer from poor reliability due to high signal-to-noise ratios. This presents a straightforward, affordable, and extremely sensitive technique for real-time monitoring of VOCs, concentrating on the ethylamine (Et-NH₂) as a pollutant. The primary goal of this research was to design, build, and test an optical absorbance chemosensor using a digital lock-in amplifier for signal processing and isoindoline dye (ID1) as the sensitizer. In particular, the study aimed to performed detailed characterizations of the LEDs and the dye to understand its optical properties including absorption spectra and response to Et-NH_{2(aq)}, to design and build a sensor circuits suitable for real time monitoring of VOCs, to test the functionality of the sensor based on a digital lock-in amplifier for low limit real time detection of Et-NH_{2(aq)} under laboratory conditions and to compare the obtained results using the fabricated sensor with commercially available sensors. The sensor was constructed by building an AC+DC adder circuit integrated with a photodiode and an infrared LED tuned to the dye's responsive absorption band. The LED light, modulated by the digital lock-in amplifier, excited the dye film and the transmitted intensity was recorded and analyzed. Calibration was achieved by titrating solution of Et-NH₂ into a sampling cuvette, while an oscilloscope was employed to monitor signal characteristics. The results in the developed system demonstrated strong sensitivity to aqueous Et-NH₂, with a limit of detection (LoD) of 2.35 μ M which is far below the aquatic toxicity threshold of 2.22 mM. This presents high sensitivity to Et-NH₂, rapid response, excellent selectivity against interfering species and stable performance. In conclusion, the developed optical absorbance chemosensor offers a reliable, low-cost, and real-time method for detecting VOCs in aqueous environments without the need for phase membranes. It is recommended that further optimization be conducted to extend the applicability of the sensor to a broader range of VOCs and to integrate the sensor into portable devices for on-site environmental monitoring.