A Potential Development of Breathing Gas Sensor Using An Open Path Fibre Technique

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***Abstract*— This paper describes a potential development of Methyl Mercaptan or bad breathing gas measurement in the 200 *nm* - 250 *nm* region. Methyl Mercaptan shows a potential peak selection at 204 nm and the absorption cross section spectrum display a similar pattern with the theory. A cross sensitivity analysis is also reported and it shows that there is no discernible interference effects between the Methyl Mercaptan gas with other breathing gases such as carbon dioxide, oxygen and water vapor at 204 *nm*.**

***Keywords*—optical sensor, breathing gas, spectroscopy.**

I. Introduction

Breathing gas is a mixture of gaseous chemical elements and compounds involved in a respiration process (inhaled and exhaled gases). A research and development of breathing gas sensor can give significant contribution especially in medical industry. One of the main medical applications for breathing gas sensor development is to detect halitosis. Halitosis or bad breath is normally measured to diagnose dental hygiene in clinical dentistry. The main chemical constituents of oral odorous chemicals are volatile organic compounds such as Methyl Mercaptan CH_3SH [1, 2]. Human beings are sensitive to halitosis in others but unable to assess the halitosis in their own breath. There are many breathing sensors that have been investigated and developed but they are for different kinds of breathing analysis usage. Morisawa and Muto [3] has developed a simple breathing condition sensor to measure humidity in breathing gases. Lewicki et al [4] has developed a breath sensor to detect ammonia due to the presence of bacteria in the stomach.

In this initial investigation of the breathing gases sensor, it is focused on Methyl Mercaptan detection. Breathing sensors for halitosis are also reported and developed previously but they are using different technology such as MEMs and MOS sensor which have their own drawbacks as discussed in previous paper [5]. One of the main disadvantages is that they are not selective to single gas detection alone especially when measuring the gas in the presence of water vapor [6]. Therefore a development of a new breathing sensor that is selective to single gas detection is necessary and can be a great alternative to the current existing commercial sensors. In order to develop a selective breathing sensor, a preliminary study on the Methyl Mercaptan gas must be carried out. In this paper, the absorption cross section spectrum of the Methyl Mercaptan gas in the ultraviolet region is reported.

Interference with unrelated measurand in a rich environment when performing a gas concentration measurement can reduce the reliability of the developed sensor. Since the interference problems can affect the accuracy of the measurement, different approaches have been employed to overcome this problem, such as using gas separation techniques [7-8] or a ratio calculation [9]. In this paper, the interference possibility with the main components of breathing gas which are oxygen, carbon dioxide and water vapor is investigated and discussed.

II. Theory

Different gas species absorb light at different characteristic wavelengths and for Methyl Mercaptan gas, it has its own specific gas absorption spectrum. A comprehensive collection of absorption cross sections for most common atmospheric gases molecules can be accessed from the Max Planck Institute, MPI Mainz UV-VIS database [10]. The data from this database vary from source to source and they depend on temperature and wavelength range. Two examples of Methyl Mercaptan gas absorption spectra reported by McMillan (1996) [11] and Vaghjiani (1993) [12] are shown in Figure 3.

For absorption spectrum comparison with the theoretical data shown in Figure 3, the Beer-Lambert Law has been utilised. The Beer-Lambert law described the linear relationship between absorbance and concentration of an absorbing species and its general form is shown in equation (1).

$$\frac{I}{I_o} = e^{(-\sigma.N.l)} \qquad (1)$$

Where I is the transmitted intensity, I_o is the incident intensity, l(*cm*) is the distance that light travels through the gas, σ (cm^2/*Molecule*) is the absorption cross section and N (*Molecules*/cm^3) is the gas concentration.