SENSITIVITY ENHANCEMENT FOR A REFLECTIVE OZONE MONITOR

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INTRODUCTION

In the design of ozone sensor, sensitivity is one of the performance criteria that is considered [1-3]. Sensor sensitivity is the minimum input that will generate a readable output change[4]. For sensors based on absorption spectroscopy, sensitivity is directly proportional to optical path length [3, 5-8]. In the conventional design of a transmission type optical sensor, the beam of light is radiated parallel to the gas cell; hence a transmission type gas cell will have optical path length approximately equal to the length of the gas cell[3]. For our design, the basic laws of reflection are explored that is the angle of reflection equals the angle of incidence[9] in combination with factors that favours the reduction of head loss in fluid flow (the sudden enlargement transition is considered)[10] .

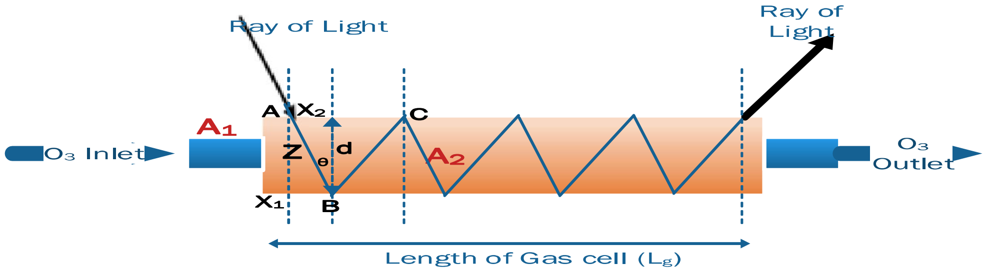

Fig 1: A Basic view of our proposed reflective type ozone sensor showing light transmission at incident and reflected angles

In fig. 1, all dimension are considered to be in centimeters (cm). AB and BC are incident and reflected rays respectively with dimension Z (cm); d (cm) is the diameter of the gas cell, while X_1 (cm) is the allowable distance between the edge of the gas cell and the placement of the light source, X_2 is the horizontal equivalent distance travelled by the incident or reflected ray and θ is the incident Angle. from triangle ABC,

$$\cos\theta = \frac{d}{Z}\ ;\ hence\ \ d = Z\cos\theta \tag{1}$$

$$\tan\theta = \frac{X_2}{d}\ ;\ hence\ X_2 = d\tan\theta \tag{2}$$

$$The\ total\ number\ of\ X_2 = (NX_2) = \frac{L_g - 2X_1}{X_2} \tag{3}$$

$$Optical\ path\ length\ L = Z \times (NX_2) \tag{4}$$

For the results obtained in fig. 2 and 3, X_1 is assumed to be 2cm since the diameter of a collimating lens is 9.525mm and to provide tolerance. Fig.2 shows the relationship between incident angle and optical path length for a 10cm gas with 0.4cm diameter.

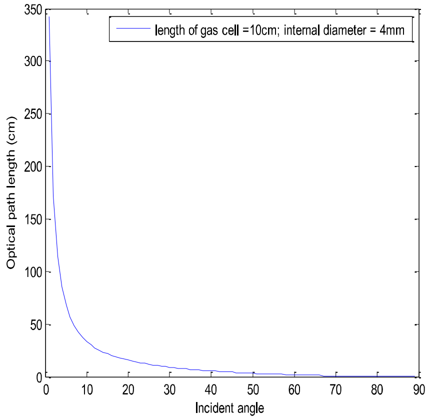

Fig 2: Optical path length at different angle of incidence

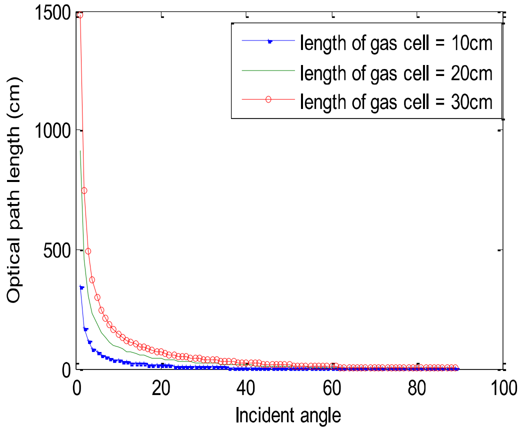

Fig 3: The effect of length variation on optical path length

At an incident angle of 1° the optical path length obtained is 342.7886 cm, which is about 34 times the gas cell length. At an incident angle of 27° the optical path length is 10.4926 cm which is about 1.0493 times the length of the gas cell; however at 28°, optical path length is 9.9631cm, which is 0.9963 times the length of gas cell. The effect of variation of length is clearly demonstrated in fig. 3. For the three different length considered (i.e. 10cm, 20cm, and 30cm), the ratio of the optical path lengths at each incident angle is 1:2.7:4.3.

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