ISSN: 0976-3104
SUPPLEMENT ISSUE
Nasiri et al.

THE IIOAB JOURNAL

ARTICLE OPEN ACCESS

A PROPOSED SOLUTION TECHNIQUE FOR TELEMETRY OF METHANE USING OF CARBON DIOXIDE LASER WITH COMSOL SIMULATOR

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ABSTRACT

Detecting the presence, concentration and the ratio of gases, as well as the standardization of gas transfer especially methane is important for various reasons such as life threatening risks for people who are exposed to this gas and many ways to measure this gas are proposed and implemented. Among the variety of proposed contact and non-contact sensors (remote), contact sensors for reasons such as delay or short lifelong which is mainly due to the establishment of chemical bonds are restricted in application. However, these problems are solved in non-contact sensors, yet the use of this type of sensor need complex electronic circuits. This article uses carbon monoxide gas laser, provided a new model for measuring methane. Results indicated the success of the model with the accuracy of 5ppm and time less than 1.4 seconds.

Published on: 25th -Sept-2016

KEY WORDS

methane, carbon dioxide, COMSOL

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INTRODUCTION

Because on the one hand contact sensors due to chemical bonds such as covalent and dative require time to display changes or return to their initial state and on the other hand, sensors such as optical sensors that are remote sensors (non-contact) have solved the problem because there are no bonds, they are always the same and are very fast in performance, therefore working on this type of sensor that are frequently used in the industry seems very important.
Materials:

1. Laser:

The laser is common source of light with particular characteristics and applications. Since its invention in the late 60's, it led high technology developments and removal of laser from many technologies today is no longer possible. [1] In general, lasers are divided into four main categories according to their type of active ingredient: laser doped with insulator, semiconductor lasers, gas lasers, color lasers. Gas Lasers are divided into three categories: atomic lasers, ion lasers and molecular lasers. [2]

2. Carbon dioxide laser:

Lasers that their active ingredient is gas are called gas lasers. Gas lasers are bulky and usually the more powerful they are their size will be larger. Since the atoms in gases have very narrow absorption lines, it is almost impossible to release energy in them with the help of light pump. Considering different kind of lasers and laser material, different methods of pumping are used. For example, in gas lasers such as carbon dioxide lasers, discharge method is used. This laser is of the most important lasers of its kind in terms of its technical application

ELECTRONICS

are classified among the most important lasers. This laser is built with high efficiency (30%) and continues high output power (several kV). The structure of a gas laser is shown in **[Figure- 1]**.

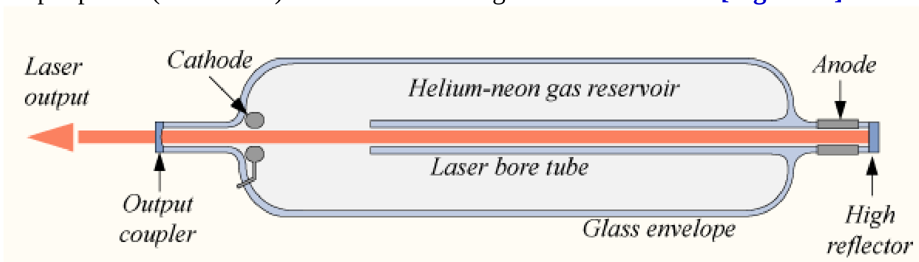

Fig: 1. Structure of a gas laser

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3. Methane

With the molecular formula of CH_4 is a greenhouse gas and is used as fuel. The simplest alkane is methane. It is the main ingredient of natural gas that is formed from the breakdown of plant material in lagoon areas. Because of its ability to absorb large amounts of heat, the gas has greater greenhouse effect than carbon dioxide. In standard conditions of temperature and pressure, the gas is odorless, colorless, subtle and lighter than air and is the first combination of saturated hydrocarbons. The gas is produced from the decomposition and decaying of organic matter in nature, especially corruption of plants in the swamps, so it is called "swamp gas" as well. [3-5]

METHODS

In this study, COMSOL software was used to measure methane and following steps were performed during the simulation.
The first step: First, as **[Figure 2]** a chamber was simulated that on one side of it there was a hole to transmit light and on opposite side there was an optical receiver. Two lenses are located on this structure to parallel the light rays.

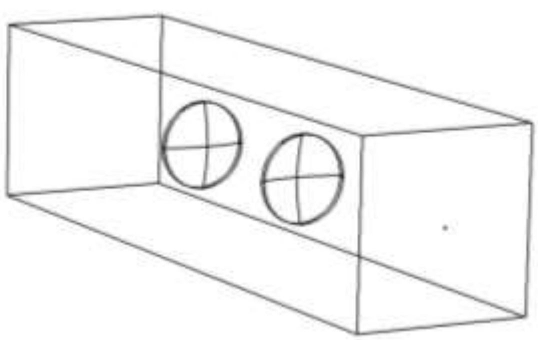

Fig: 2. Simulated structure

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The second step: once the chamber was tested in vacuum and results were registered as a comparison reference. The third step: the chamber were tested once by air, once with methane and once by combination of these two gases. In this test, sending light beams was in the carbon dioxide laser wavelength range, which is between 9.6 and 10.4, micrometers [13], the optical receiver receives it, and measuring the received power was at 3 seconds interval.

RESULTS

[Figure- 3] indicates the intersection differences in gas conditions with the reference one where the blue one is related to vacuum and green is related to the existing gas conditions.

ISSN: 0976-3104

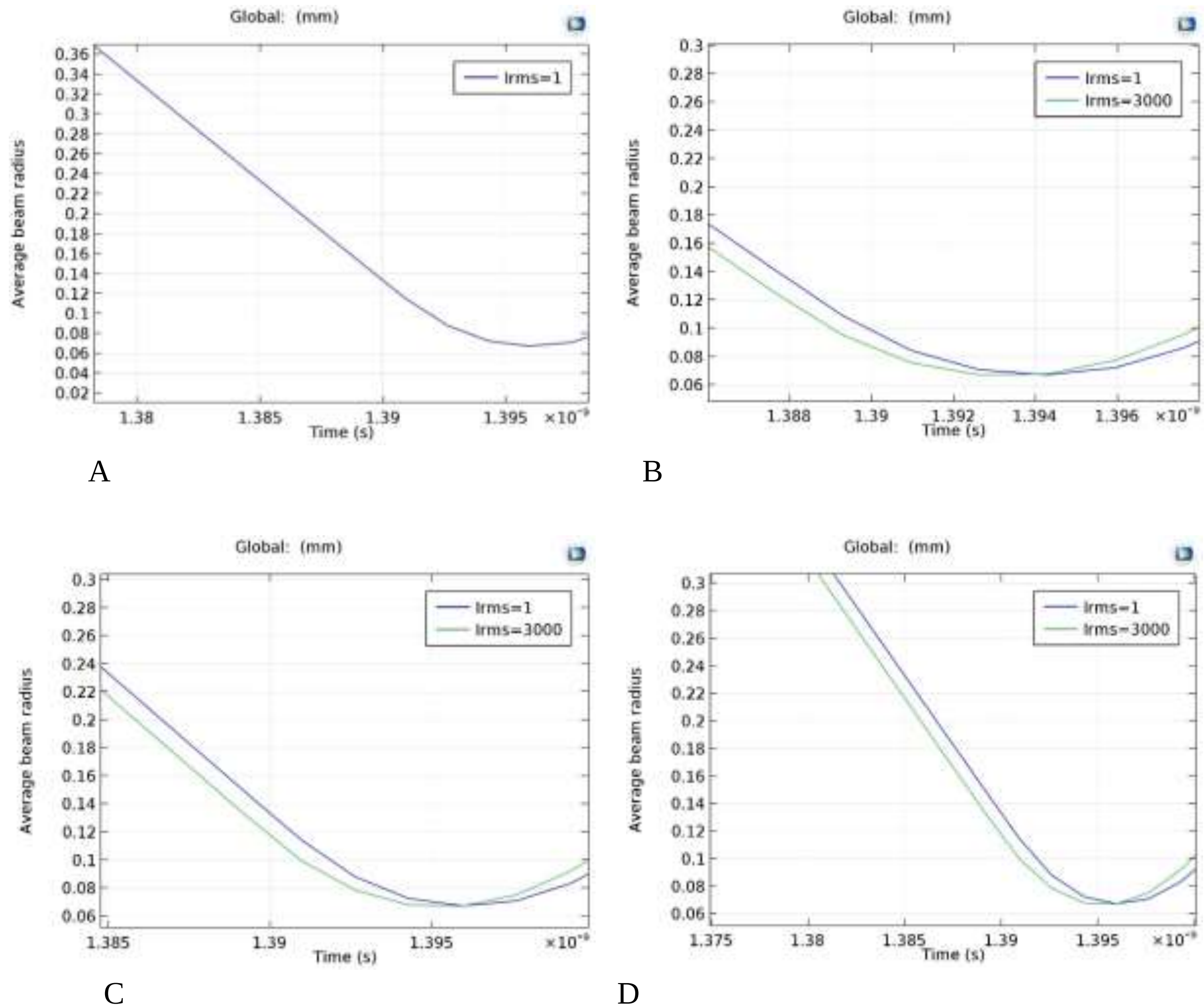

Fig: 3. Results of simulating A) vacuum B) the presence of air C) the presence of methane D) equal mix of air and methane.

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The numerical values of these points are given in **Table- 2**.

Table: 2. Achieved outputs

Condition	Air	equal mix of air and methane	Methane
Time (s)	1.39405	1.396.3	1.39604
Value (micrometer)	67.54	67.46	67.41

These differences show that the carbon oxide laser is capable of detecting methane gas and can measure methane concentrations in the environment very well with high accuracy of 5 ppm. In addition, in terms of detection time in all the cases, it was less than 1.4 seconds, which is a good rate compared to previous research.

CONFLICT OF INTEREST

Authors declare no conflict of interest

ACKNOWLEDGEMENTS

None

FINANCIAL DISCLOSURE

None

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