IR RADIOMETER FOR THE MEASUREMENT OF ATMOSPHERIC IR RAYS, TESTING AND ANALYSIS OF DATA, PART I

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IR spectrum measurement is required for many reasons. The most important of these is global warming caused by CO\(_2\) and CH\(_4\) gases. In addition, water vapor, NO molecule groups, H\(_2\)S and other molecules cause contamination of the atmosphere and change of structure.

This study consists of two parts. Construction of measurement system in Section I and II. the section consists of calibration and atmospheric data acquisition. In section I, IR sensors are used for the radiometer construction, based on semiconductor technology for UV, visible and IR measurement. The measurement range is 6 sensor with 300nm-8µm and PT1000 temperature sensor is used to control the ambient temperature. The sensors are protected by an IR-permeable half-spherical glass. In addition, in order to minimize the temperature effect of sensors, the electrical power of the peltier cooler, which is the environment thermoelectric module with sensors, is supported by the DC battery supplied by the photo voltaic battery. In the first part of the study, the initial data from the sensors confirmed that the system was running smoothly.

Keywords: CO2 Global Warming IR Radiometer.

Introduction

In this study, IR radiometer based on semiconductor technology was designed to understand the effect of greenhouse gases on climate and to determine the abundance of greenhouse gases. The study consists of two parts. The first one is the construction of the IR radiometer, the second one is the calibration process of the IR radiometer, the realization and analysis of the data acquisition. The first part was completed and the sensors were tested with 40W / m\(^2\) tungsten lamp and outdoors solar radiation. As a result of the test, it was determined that the IR radiometer produced data.

Literature Review

As it is known, since the industrial revolution, the atmosphere is constantly contaminated by the use of fossil fuels. There are many studies on this subject.

In 1990, the Curtis-Godson approach was used to determine the CO\(_2\) and O\(_3\) parameters by IR radiation measured in the middle and sub-atmospheres in the Infrared Radiation Parameters in Ming-Dah Chou Digital Climate Models. The same approach was studied in N\(_2\)O and CH\(_4\) [1].

In 2015, D. R. Feldman1 et al. Reported a study of the observations of surface radiation with CO\(_2\) from 2000 to 2010, which confirmed the theoretical predictions of the atmospheric greenhouse effect for anthropogenic reasons [3].
Hyo-Seok Park et al. In 2015, the study of the effect of the North Pole Winter Infrared Radiation on Early Summer Sea Ice was investigated [4].

Gaby Radel and colleagues in 2015 In visible and near-infrared wavelengths, in the studies of global irradiance and climate effect of water vapor continuity, the solar radiation component of water vapor feedback increases by about 4% and 9%; 18 are more negative and the global average precipitation response is reduced by 1% and 4%, and especially at atmospheric temperatures and wavelengths below 2 \( \mu m \), there is a need for improved continuous measurements [5].

In 2016, Thomas R. Anderson and his colleagues predicted that global warming would increase between 1-3 °C with increasing CO\(_2\) emissions [6].

In his work by Thomas Allmendinger in 2018, he argues in contrast to the fact that the atmospheric temperature in the mountains is lower than in low areas, despite the increasing density of sunlight, in contrast to its work in Thermal Radiation and its Role in Greenhouse Effect. On top of that, greenhouse gases such as carbon dioxide have no effect [7].

I. M. Nasrtdinov et al in their study in 2018 Siberian Summer Conditions IR Spectral Area and Smoke Aerosol Effects of the Direct Radiation Effects have examined. The DRE value at atmospheric boundaries in the thermal spectral region has been shown to be about 3% [8].

**Materials and Methods**

As known, IR radiometers measure the IR region of the spectrum from the sun, the excited gas molecules in the atmosphere, and the radiation reflected from the surface to the atmosphere and reflected by the greenhouse gases. Previous studies have identified solar radiation from IR (Duffie, John A., Beckman, William, 2013) [2]. The remaining greenhouse gases have an IR spectrum. IR radiation is divided into three regions, NR IR, M IR, F IR.

The world standard Eppley PIR radiometer measures the thermal radiation value. It measures only 0.3-3\( \mu m \) of atmospheric radiation. Within this wavelength range it includes near and medium IR radiation that passes through the atmosphere and is reflected. The IR radiometer is designed to measure the IR radiation in three parts: near middle and far. These objectives cover areas where greenhouse gases are heavily irradiated.

**Selection of Sensors**

In Figure 1-7, the intensity of the greenhouse gases in the atmosphere is given. As it can be seen from the figures, the sensors sensitive to these wavelengths were selected as the radiation intensity of sample molecules such as CO\(_2\), N\(_2\)O, CH\(_4\), H\(_2\)S. Two of these sensors measure CO\(_2\) and CH\(_4\) directly. Other molecules are measured in total. Thus, the ratio of greenhouse gases measured directly to CO\(_2\) and CH\(_4\) was determined and it was thought that other greenhouse gases could be detected [9].
Figure 2. Radiation intensity of CO$_2$,N$_2$O,CH$_4$,H$_2$S greenhouse gases between 1-2µm

Figure 3. Radiation intensity of CO$_2$,N$_2$O,CH$_4$,H$_2$S greenhouse gases between 1.6-2.5µm

Figure 4. Radiation intensity of CO$_2$,N$_2$O,CH$_4$,H$_2$S greenhouse gases between 2-3µm
Figure 5. Radiation intensity of $\text{CO}_2, \text{N}_2\text{O}, \text{CH}_4, \text{H}_2\text{S}$ greenhouse gases between 4-6µm

Figure 6. Radiation intensity of $\text{CO}_2, \text{N}_2\text{O}, \text{CH}_4, \text{H}_2\text{S}$ greenhouse gases between 7-8µm

Figure 7. Radiation intensity of $\text{CO}_2, \text{N}_2\text{O}, \text{CH}_4, \text{H}_2\text{S}$ greenhouse gases between 8-15µm
The sensors used for the above mentioned greenhouse gases (Si and InGaAs based semiconductor sensors) are used. These sensors are UV-Vis, NIR, MIR, FIR sensitive.

Sensors attached to the board are shown in figure 8. Sensors on board are respectively: 3-4.5μm CO₂, 300-1000 nm UV-Vis, 800-900 nm CH₄, 800-1.7 μm CH₄, H₂S, 8-15 N₂O, CH₄, CO₂ measures greenhouse gases.

![Figure 8: IR sensors measuring CO₂, CH₄, N₂O, H₂S greenhouse gases between 300nm-15μm.](image)

**Conclusion and Discussion**

After mounting of IR sensors, the values taken under dark and tungsten radiation are given in table 1. As can be seen from this table, the sensors were operated under a 40 W/m² radiation. This shows us that we are on the right track.

<table>
<thead>
<tr>
<th>Sensör</th>
<th>mV (40 W/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4.5μm CO₂</td>
<td>0.4</td>
</tr>
<tr>
<td>300-1000 nm UV-Vis</td>
<td>500000</td>
</tr>
<tr>
<td>800-900 nm CH₄</td>
<td>0.13</td>
</tr>
<tr>
<td>800-1.7μm CH₄,H₂S</td>
<td>71</td>
</tr>
<tr>
<td>400-1100μm</td>
<td>550</td>
</tr>
<tr>
<td>8-15μm N₂O,CH₄, CO₂</td>
<td>0.14</td>
</tr>
</tbody>
</table>

When the table values were examined, the test was completed and the IR Radiometer was achieved. Part I of this study was completed and II. test measurements will be started for section calibration, CO₂, CH₄,N₂O,H₂S molecular gas values will be tested in the laboratory condition with the radiation values and calibration will be completed. Afterwards, analysis will be made with the data to be taken under atmospheric conditions and will be concluded with an article.
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References


