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Impact on Greenhouse Effect of the Heat Flow of the Earth Surface

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ABSTRACT

Climate change due to enhanced greenhouse effect arising as a result of human activities is considered a major global environmental threat to mankind. This study experimentally investigates and determines the heat flow in and out of the earth surface, and the impact of greenhouse effect on the heat transfer. A high voltage electric bulb was placed between two bottles; an empty bottle containing only air and the other bottle containing a mixture of baking soda and vinegar, evolving CO_2. We observed that the vinegar and baking soda in the filled bottle reacted and produced carbon dioxide (CO_2). This CO_2 absorbs and retains more heat from the high voltage bulb than the empty bottle of normal air. We also observed that visible light passes through the glass and is absorbed by darker surfaces inside. The demonstration of this study proves that greenhouse gases like CO_2 is one of major greenhouse gases that are responsible for global warming by trapping heat thereby giving a rapid rise in temperature over time because of the concomitant lower heat loss to its environment.

***Keywords*:** Greenhouse effect, carbon dioxide, greenhouse gas, heat, atmospheric temperature, Vinegar, high voltage

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1. INTRODUCTION

The greenhouse effect is the way in which heat is trapped close to earth's surface by greenhouse gasses [1]. These heat-trapping gases can be thought of as a blanket wrapped around the earth, keeping the planet toastier than it would be without them. Greenhouse gases include carbon dioxide, methane, nitrous oxides, and water vapor (water vapor, which responds physically or chemically to changes in temperature is called feedback). Greenhouse gases occur naturally and are part of our atmosphere's makeup. For that reason, Earth is sometimes called the Goldilocks planet. Its conditions are not too hot and not too cold, but just to allow life to flourish. The level of carbon dioxide in earth's atmosphere has been rising consistently for decades and traps extra heat near earth's surface, causing temperature to rise. Many harmful gases cause different health problems to human beings [2]. Gases such as carbon dioxide, sulphur dioxide and hydrogen sulphide can be removed from exhaust gases by different methods [3]. Greenhouse gases allow shortwave radiations to pass through the earth's atmosphere and heat the land and oceans.

The long wave radiations emitted from earth surface cannot pass through atmosphere due to these greenhouse gases. This phenomenon leads to greenhouse effect [1, 3]. Life as we know it would be impossible if not for the greenhouse effect, the process through which heat is absorbed and re-radiated in that atmosphere [3]. The intensity of a planet's greenhouse effect is determined by the relative abundance of greenhouse gases in its atmosphere. Without greenhouse gases, most of Earth's heat would be lost to outer space and our planet would quickly turn into a giant ball of ice. Fortunately, the strength of Earth's greenhouse effect keeps our planet within a temperature range that supports life [4, 5].

Greenhouse gases allow the sun's light to shine onto Earth's surface, and then the gases, such as ozone, trap the heat that reflects back from the surface inside Earth's atmosphere. Greenhouse gases such as methane, carbon dioxide, nitrous oxide, and water vapor significantly affect the amount of energy in the Earth system, even though they make up a tiny percentage of Earth's atmosphere. Solar radiation that passes through the atmosphere and reaches Earth's surface is either reflected or absorbed. Reflected sunlight doesn't add any heat to the Earth system because this energy bounces back into space. However, absorbed sunlight increases the temperature of Earth's surface, and the warmed surface re-radiates as long-wave radiation also known as infrared radiation [6, 7]. Infrared radiation is invisible to the eye, but we feel it as heat. The four major greenhouse gases and their percentage contribution to the overall greenhouse effect on Earth are;

- Water vapor (H_2O), 36~72% (~75% including clouds);
- Carbon dioxide (CO_2), 9~26%;
- Methane (CH_4), 4~9%;
- Tropospheric ozone (O_3), 3~7% [8]:

Water vapor is the most abundant greenhouse gas and plays an important role in regulating the climate [9]. Changes in water vapor from human activities such as irrigation and deforestation can directly affect temperatures at the Earth's surface. However, because human emissions of water vapor do not significantly change water vapor levels in the atmosphere, water vapor is not counted in the United States or international greenhouse gas inventories [10].

Scientists have determined that carbon dioxide's warming effect helps stabilize Earth's atmosphere. Remove carbon dioxide, and the terrestrial greenhouse effect would collapse.

Without carbon dioxide, Earth's surface would be some 33 °C (59F) cooler. According to scientists, the average temperature of Earth would drop from 14 °C (57F) to as low as –18 °C (–0.4F), without the greenhouse effect [1]. Clouds also influence the greenhouse effect. A thick, low cloud cover can enhance the reflectivity of the atmosphere, reducing the amount of solar radiation reaching Earth's surface, but clouds high in the atmosphere can intensify the greenhouse effect by re-radiating heat from the Earth's surface [11].

Altogether, this cycle of absorption and re-radiation by greenhouse gases impedes the loss of heat from our atmosphere to space, creating the greenhouse effect. Increases in the amount of greenhouses gases will mean that more heat is trapped, increasing the amount of energy in the Earth system (Earth's energy budget), and raising Earth's temperature. This increase in Earth's average temperature is also known as global warming [12]. The greenhouse effect, which influences Earth's average temperature, affects many of the processes that shape global climate and ecosystems. The model below in Figure 1, shows some of the other parts of the Earth system that the greenhouse effect influences, including the water cycle and water temperature.

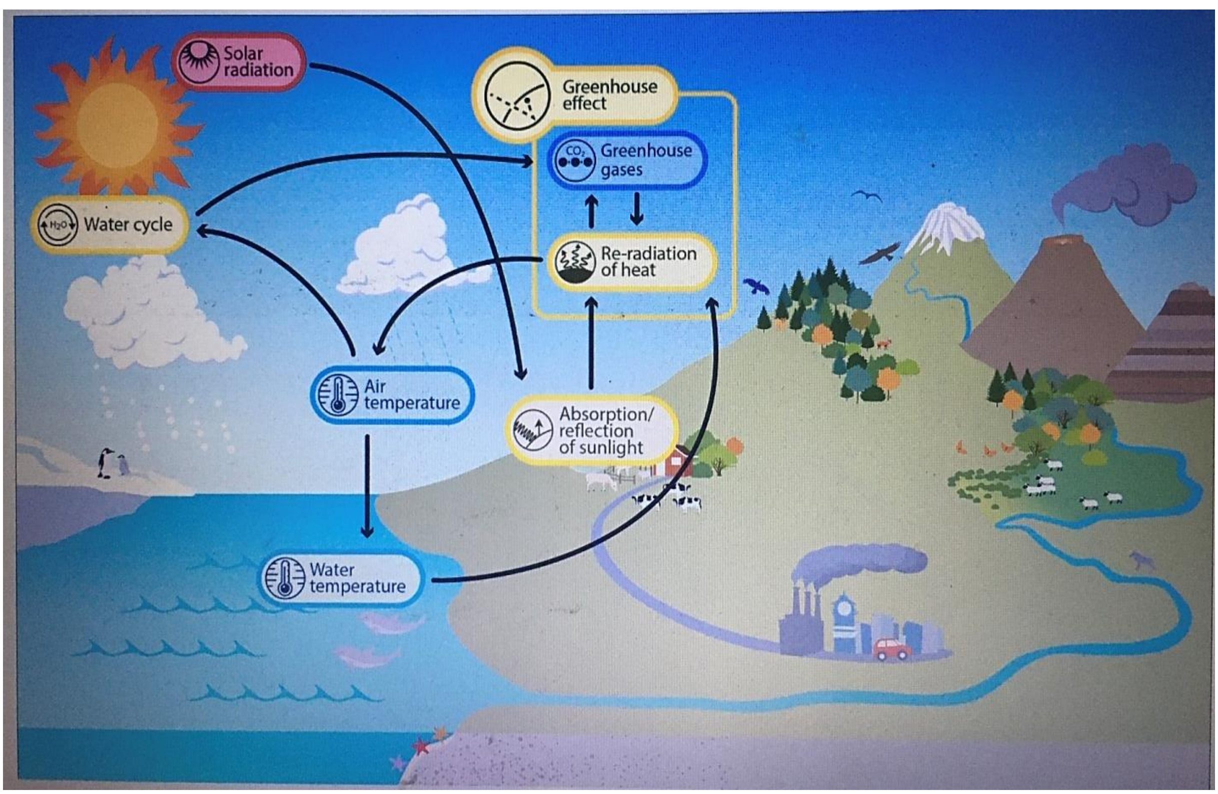

Fig. 1. The model of global climate and ecosystems.

Some greenhouse gases come from natural sources, for example, evaporation adds water vapor to the atmosphere. Animals and plants release carbon dioxide when they respire, or breathe. Methane is released naturally from decomposition. There is evidence that suggests methane is released in low-oxygen environments, such as swamps or landfills. Volcanoes (both on land and under the ocean), release greenhouse gases, so periods of high volcanic activity tend to be warmer [13]. Many researchers have carried out studies on greenhouse gases, their effect and control. Current review summarizes research and studies on greenhouse gases [14].

Carried out studies on greenhouse gases and means of their prevention. According to them, water vapor is one of the greatest contributors to the greenhouse effect on earth. According to their studies water vapor plays dominant role in the greenhouse effect. Other gases such as carbon dioxide, chlorofluorocarbons, methane, and nitrogen dioxide also affects greenhouse phenomenon. An investigation carried out by [15] shows that vehicular and industrial pollution is main contributor to the global warming. Their studies indicated that the main cause of greenhouse effect is effect of pollution and atmospheric stability conditions.

According to them, the causes for global warming can be divided into two parts, natural and manmade. Purchase and use of environmental friendly products can help the cause.

Studies carried out by [16] indicated that the climate changes as a result of global warming have reached irregular levels. Few indications are rainfall and hurricanes of unusual intensity. Also they proposed an ecological model for understanding the impact of greenhouse warming on the natural environment. According to [17] combination of solar radioactive heating and the strength of the greenhouse effect determine the surface temperature of a planet. He noted that water vapor plays a very important role in energy transport by convection. They concluded that direct human efforts are required to reduce the atmospheric carbon dioxide level [18].

Carried out studies on the effects of environmental warming and drying on instantaneous CO_2, CH_4 and N_2O fluxes in three sedge fens. They used open top chambers (OTCs) for inducing warming. They observed that the drainage effect overrode warming effect. [9] Carried out investigation on effects of soil temperature and moisture on methane uptake and nitrous oxide emissions. They studied three distinct semi-natural or natural ecosystems. [10] Studied analysis of current greenhouse gas emission trends. They studied greenhouse phenomenon in the light of prevailing policies and regulations. According to their estimates, the current policies may lead to 3.7 degree rise in temperature. [11], carried out studies on radioactive forcing of greenhouse gases. Their studies indicated that CO_2 radioactive forcing is consistent. They found a logarithmic relation between greenhouse intensity and water vapor content. According to [22], rising concentration of CO_2 should result in the cooling of climate. According to them, methane accumulation has no essential effect on the earth's climate.

According to studies carried out by [14], use of fossil fuel is major source of emission of greenhouse gases. Use of natural gas can reduce the emission to considerable extent. He noted that unprecedented investment in natural gas infrastructure and regulatory oversight can be a limiting factor. [11, 24] carried out studies on literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide. They stated that there is no reason to worry about warmer climate. According to them, warmer climate extends the growing seasons and generally improves the habitability of colder regions. [3, 25] carried out studies on various soil physical factors and the biological processes which cause the production and consumption in soils of greenhouse gases. The release of carbon dioxide, according to them, is function of temperature for considerably wide range of temperature. For dry soil, it becomes function of water contents. Gas diffusivity, according to them is main factor controlling oxidation. According to studies carried out by [6], the rapid heating of earth is taking place due to greenhouse effect, more so in last two decades. According to their studies the carbon dioxide and water vapor emission by human being also contributes to the greenhouse effect. In their studies, they presented the combined effect of greenhouse gases due to human activities and greenhouse gases emitted by human population.

Greenhouse gas emissions affect more than just temperature. Another effect involves changes in precipitation, such as rain and snow. Over the course of the 20th century, precipitation increased in eastern parts of North and South America, northern Europe, and northern and central Asia. However, it has decreased in parts of Africa, the Mediterranean, and southern Asia [27]. As climates change, so do the habitats for living things. Animals that are adapted to a certain climate may become more threatened. Many human societies depend on predictable rain patterns in order to grow specific crops for food, clothing, and trade [28].

If the climate of an area changes, the people who live there may no longer be able to grow the crops they depend on for survival. Some scientists also worry that tropical diseases will expand their ranges into what are now more temperate regions if the temperatures of those areas increase. Most climate scientists agree that we must reduce the amount of greenhouse gases released into the atmosphere [14].

Greenhouse gas emissions increased 70 percent between 1970 and 2004. Emissions of CO_2, rose by about 80 percent during that time. The amount of CO_2 in the atmosphere far exceeds the naturally occurring range seen during the last 650,000 years. Most of the CO_2 that people put into the atmosphere comes from burning fossil fuels. Cars, trucks, trains, and planes all burn fossil fuels [30]. Many electric power plants do as well. Another way humans release CO_2 into the atmosphere is by cutting down forests, because trees contain large amounts of carbon. People add methane to the atmosphere through livestock farming, landfills and fossil fuel production such as coal mining and natural gas processing. Nitrous oxide comes from agriculture and fossil fuel burning. Florinated gases include chloroflourocarbons (CFCs), hydrochloroflourocarbons (HCFCs), and hydroflourocarbons (HFCs). They are produced during the manufacture of refrigeration and cooling products and through aerosols.

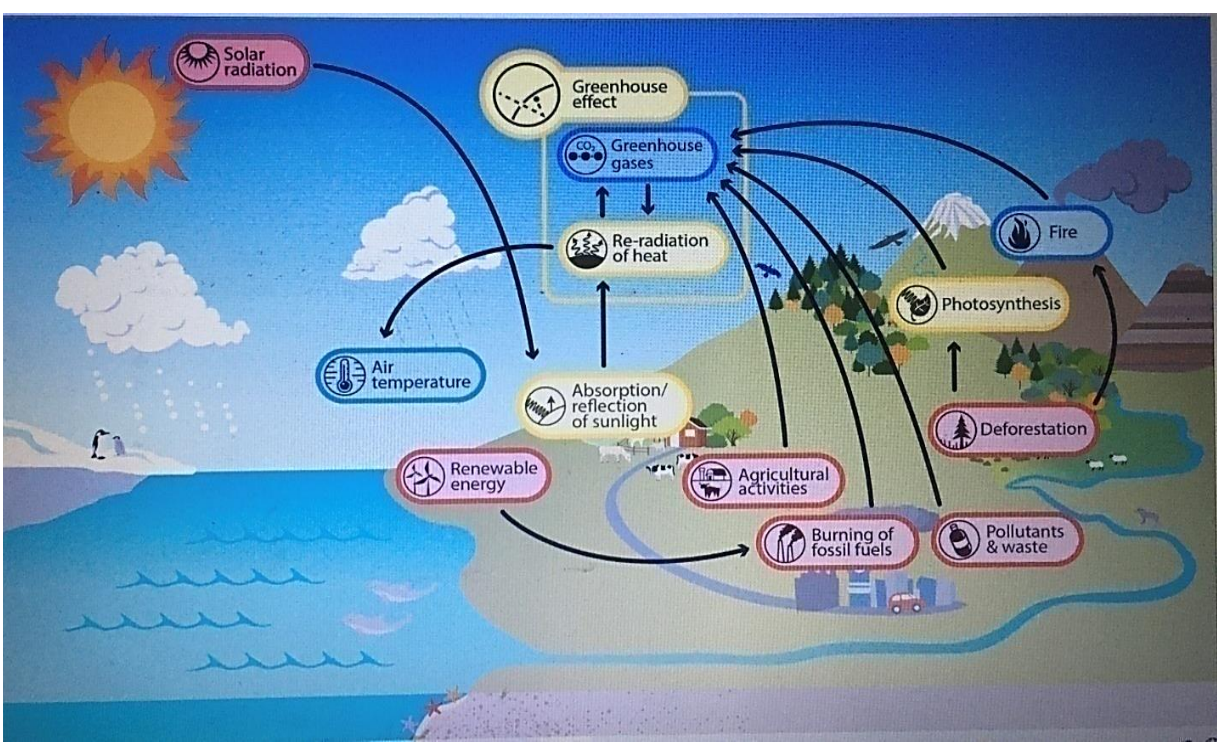

Fig. 2. Cycle of human activities

All of these human activities add greenhouse gases to the atmosphere. As the level of these gases rises, so does the temperature of Earth. The rise in Earth's average temperature contributed to by human activity is known as global warming [13]. Hotter matter emits shorter wavelengths of radiation. As a result, the Sun emits shortwave radiation as sunlight while the Earth and its atmosphere emit long wave radiation. Sunlight includes ultraviolet, visible light, and near-infrared radiation [31]. Sunlight is reflected and absorbed the Earth and its atmosphere.

The atmosphere and clouds reflect about 23% and absorb 23%. The surface reflects 7% and absorbs 48% [32]. Overall, Earth reflects about 30% of the incoming sunlight, [20] and absorbs the rest (240 W/m^2). The Earth and its atmosphere emits long wave radiation, also known as thermal infrared or terrestrial radiation. Informally, long wave radiation is sometimes called thermal radiation. Outgoing long wave radiation (OLR) is the radiation from Earth and its atmosphere that passes through the atmosphere and into space.

Different substances are responsible for reducing the radiation energy reaching space at different frequencies; for some frequencies, multiple substances play a role. Carbon dioxide is understood to be responsible for the dip in outgoing radiation (and associated rise in the greenhouse effect) at around 667 cm^{-1} equivalent to a wavelength of 15 microns [34]. Part of what makes Earth so amenable is its natural greenhouse effect, which keeps the planet at a friendly 15 °C (59F) on average. But in the last century or so, humans have been interfering with the planet's energy balance, mainly through the burning of fossil fuels that add carbon dioxide to the air. The level of carbon dioxide in Earth's atmosphere has been rising consistently for decades and traps extra heat near Earth's surface, causing temperatures to rise [15].

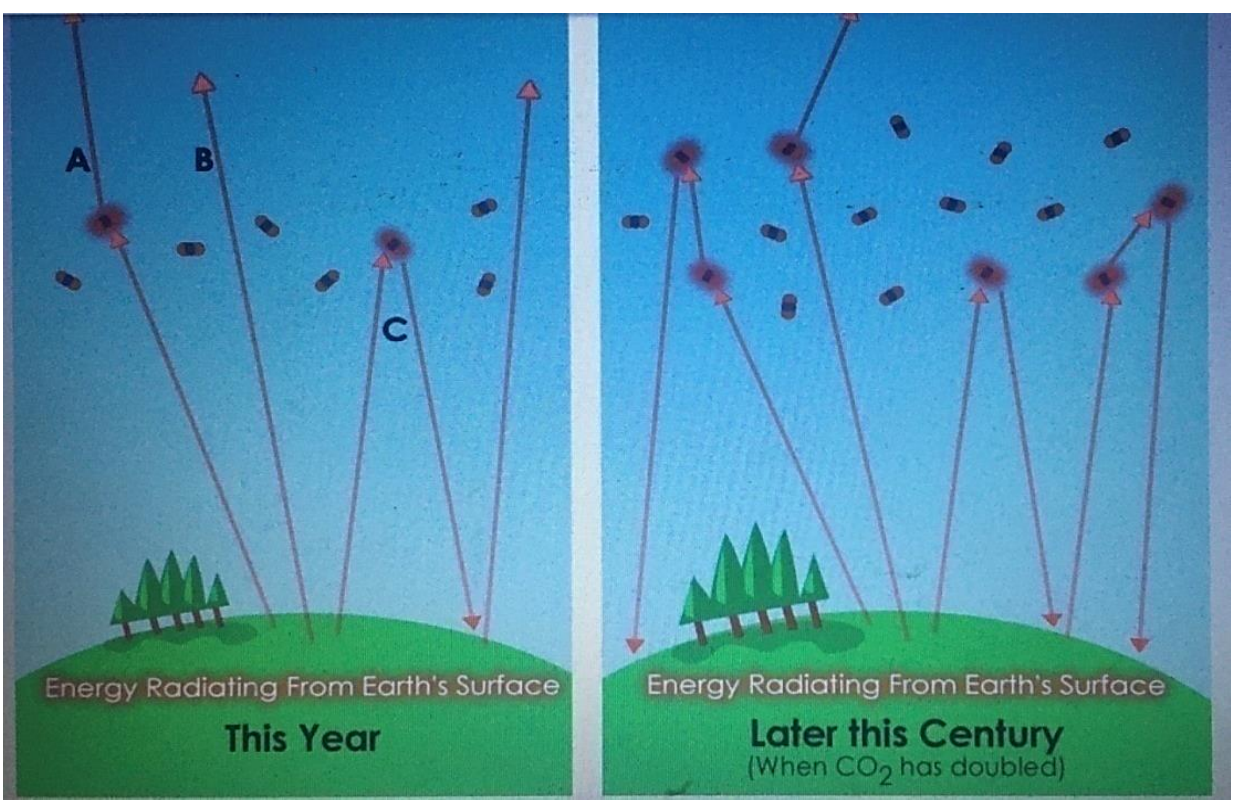

Fig. 3. Earth's surface.

In Fig. 3 above: (Left) The Earth's surface, warmed by the Sun, radiates heat into the atmosphere. Some heat is absorbed by greenhouse gases like carbon dioxide and then radiated to space (A). Some heat makes its way to space directly (B). Some heat is absorbed by greenhouse gases and then radiated back towards the Earth's surface (C). (Right) With more carbon dioxide in the atmosphere later this Century, more heat will be stopped by greenhouse gases, warming the plane [16-18].

Climate change is a major risk facing mankind. At the United Nations Climate Change Conference held in Paris at the end of last year, 195 countries agreed on a plan to reduce emissions of CO_2 and other greenhouse gases, aiming to limit global temperature increase to well below 2 °C (relative to pre-industrial climate, [36] meaning a future warming of less than 1.4 °C because temperature had already increased by 0.6 °C by the end of the twentieth century). The link between CO_2 and climate warming has caught the attention of scientists and politicians, as well as the general public, via the well-known ''greenhouse effect''. Solar radiation passes largely unhindered through the atmosphere, heating the Earth's surface. In turn, energy is re-emitted as infrared, much of which is absorbed by CO_2 and water vapour in the atmosphere, which thus acts as a blanket surrounding the Earth [23]. Without this natural greenhouse effect, the average surface temperature would plummet to about -21 °C, rather less pleasant than the 14 °C experienced today.

The basic concepts of planetary energy budget and the greenhouse effect were first put forward in the early nineteenth century by the French scientist Joseph Fourier, [24] although he never mentioned greenhouses in his writing. Fourier recognized that the atmosphere is opaque to ''dark heat'' (infrared radiation), but he was unable to identify which components were responsible. A few decades later, John Tyndall, an Irish physicist working in London, discovered that infrared absorption is largely due to carbon dioxide and water vapor, based on a series of carefully designed laboratory experiments. What was needed was quantitative proof, converting the results of the experimental work into mathematical equations.

The Swede Svante Arrhenius is remembered for his work on the conductivities of electrolytes, a topic of research that would earn him the Nobel Prize for chemistry in 1903. It was a combination of his talents that led him to perhaps his greatest achievement: the construction of a quantitative mathematical analysis of the influence of CO_2 on planetary energy budget, culminating in the publication of his famous paper, „on the influence of carbonic acid (CO_2) in the air upon the temperature of the ground". Arrhenius forged ahead with developing equations to quantify how widely atmospheric CO_2 would have to vary in order to bring about changes to both colder and warmer climates sufficient to explain the ice ages [25].

The calculations involved balancing the radiative heat budget (thereby assuming a state of equilibrium), namely solar radiation arriving at the Earth's surface (including the effect of albedo from clouds and the Earth's surface) and the subsequent absorption of re-emitted infrared radiation by the atmosphere [26]. Calculating this absorption required integration across the different wavelengths that encompass the absorption spectrum of CO_2 and water vapor, as well as integrating across different zenith angles (the distance from vertical at which sunlight strikes the atmosphere) and the corresponding path lengths associated with incoming and outgoing radiation. Atmospheric absorption by water vapour occurs at many wavelengths whereas absorption by CO_2 takes place in three main bands at 2.7, 4.3, and 15 μm [27].

The rise of industrialization was in reality much faster than Arrhenius and Ekholm expected. Society became urbanized and manufacturing continued apace in the early twentieth century as railroads ferried raw materials such as iron and steel to factories where machines now did much of the work [28]. International trade was expanding, fueled by a growing demand for consumer goods, including new inventions such as the telephone and gasoline powered automobiles. The CO_2 story was, however, largely forgotten until Guy Stewart Calendar emerged on the scene in the 1930s. Calendar was by profession a steam engineer and inventor, second son of Hugh Long Bourne Calendar, distinguished professor of physics at Imperial College London. The younger Callendar also took a keen interest in meteorology and, despite ranking as an amateur, was more than a match for his professional counterparts. Callendar, with his expertise in physics, was fully acquainted with Arrhenius's calculations linking global temperature change to atmospheric CO_2. Calculations based on theory were all very well, but Callendar wanted proof. With his interest in meteorology, Callendar set about compiling the necessary data [29]. He extracted monthly average temperature records from the World Weather Records, a hefty series of volumes published by the Smithsonian Institution. After adjusting for the non-uniform geographical distribution of data, he could estimate global temperature based on 147 stations around the world.

Using this information, Callendar calculated a global increase in land temperatures of about 0.3 °C between 1880 and the late 1930s. Measurements of CO_2 during this period were not of the uniformly high standard they are today and additional biases occurred in samples taken from inner city areas. The data were scattered throughout the literature of many countries and Callendar selected only those which he thought were representative of clean air, calculating a 6% rise in atmospheric CO_2 between 1880 and 1935.

This increase was, he remarked, consistent with combustion of fossil fuels that had generated about 150 thousand million tonnes of CO_2, with three quarters of it having remained in the atmosphere [30]. Like Arrhenius, Callendar did not foresee the potential detrimental impacts of climate warming. Rather, he emphasized the societal benefits that might accrue from increasing temperature: crop production would be enhanced, especially at northerly latitudes, and the return of another deadly ice age would be delayed indefinitely [26]. Indeed, as late as the mid-1950s, the famous cartoonist Virgil Partch was gaily illustrating the coming „revolution in weather" and „boom in the north". A source of uncertainty with Callendar's calculations had been the role of the ocean, which, as a reservoir, contains fifty times more carbon than that of the atmosphere.

It could be argued that CO_2 of industrial origin would not remain in the atmosphere for long but would instead be absorbed and sequestered in this vast storage pool [31]. The idea was refuted by Roger Revelle, an American oceanographer and climate scientist, who demonstrated that, due to the chemical nature of carbon in seawater, the ocean is buffered and can only absorb gases from the atmosphere rather slowly. The debate surrounding the dangers of climate warming due to the „invisible pollutant" was hitting up. „Human beings", remarked Revelle, „are now carrying out a large scale geophysical experiment [combustion of fossil fuels] that could not have happened in the past nor be reproduced in future". The International Geophysical Year (IGY) arrived in 1956 and Revelle was joined at the Scripps Institution of Oceanography (San Diego, California) by Charles David Keeling, who was to lead an IGY programme on atmospheric CO_2 [32]. Keeling thus started the now iconic series of measurements at the Mauna Loa volcano in Hawaii, which have shown the progressive year-on-year increase of CO_2 in the atmosphere

Analysis of ice cores has subsequently vindicated Callendar's early CO_2 estimates, and it has been shown that his calculations of Earth temperature agree remarkably well with modern estimates for the same period. In order to formally establish the physical link between warming and CO_2, [33] Callendar sought to apply his expertise in physics to calculate the Earth's heat balance from first principles. He set about constructing a set of equations that was similar to that of Arrhenius, again based on an equilibrium state, but with improvements. He used the infrared absorption spectrum for CO_2 of Rubens and Aschkinass, rather than Langley's measurements. Unlike Arrhenius, Callendar's model divided the atmosphere into layers, thus representing its vertical structure with respect to temperature, water vapor, and CO_2 content.

The water vapor feedback was again the only one represented. Like Arrhenius, Callendar undertook calculations for different levels of CO_2 in the atmosphere, from which he distilled the results in to a single graph. Based on the results, Callendar suggested that about half of the warming from 1880–1935 was due to changes in CO_2. Moreover, he calculated temperature increase to the end of the twentieth century, [34] although the resulting figure of 0.16 °C was considerably too low given that the actual warming was about 0.6 °C. The cause of the discrepancy was not, however, because of fundamental deficiencies in Callendar's equations. Rather, he had used estimates of atmospheric CO_2 increase that were much too conservative. Furthermore, he considered only CO_2 and water vapor when calculating radiative transfer, whereas the role of several other greenhouse gases, including methane, nitrous oxide, and chlorofluorocarbons, is now well known. Aerosols (particulates) released during the burning of fossil fuels are also important because they cause cooling by direct reflection of sunlight and by modification of the optical properties of clouds [35].

The aim of this paper demonstrated the greenhouse effect on rise in Earth's average temperature contributed to by human activity and determined the variations of heat flows into and out of earth's atmosphere as a result of different in temperatures. This study was limited to the climate of Cross River state, Nigeria which is tropical regions which characterized with relative humidity. The average temperature of the state is between 15 °C and 30 °C. However, this climatic condition is different in locations within the Cross River state such as the high plateau of Obudu, which has a record of a fall in temperature between 4^0C and 10^0C, as a result of the high altitude of this area [36].

2. MATERIALS AND METHOD

2. 1. Materials

The materials used to demonstrate the greenhouse effect on temperature include the following; Two white bottles, 2 corks (bottle cover), 2 thermometers, Vinegar (white Distilled Vinegar), Baking soda, A high voltage bulb (Heat source)

In this demonstration, the reaction between baking soda (sodium bicarbonate) and vinegar (dilute acetic acid) generates carbon dioxide gas.The chemical equation for the vinegar and baking soda reaction is as follows:

$$\mathbf{CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2}$$

where: CH_3COOH represents acetic acid (vinegar), $NaHCO_3$ represents sodium bicarbonate (baking soda), CH_3COONa represents sodium acetate, H_2O represents water, and CO_2 represents carbon dioxide. Baking soda is an alkaline compound that, when combined with an acid (distilled white vinegar), produced carbon dioxide gas. The small bubbles of carbon dioxide gas become trapped in sealed container, causing it to inflate, or rise. Vinegar is an acidic liquid produced through the fermentation of ethanol by acetic acid and bacteria. It may be produced from a variety of materials: apples, grapes (wine or cider vinegar) and industrial alcohol (distilled white vinegar which is the one we used in this project work).

Fig. 4. Picture of the Materials used

2. 2. Method

The procedures used to demonstrate the greenhouse effect on temperature with the above listed materials in section 3.1 are;

i) Fill the bottle with 100 ml of distilled white vinegar and a tablespoon of baking soda and close the mouth with a cork.
ii) Insert the thermometer through the cork so that the bulb of the thermometer does not come in contact with the content in the bottle
iii) Another thermometer was inserted through the cork into the empty bottle
iv) These two bottles were placed opposite a high voltage bulb of 200W so that they both will receive the same amount of heat
v) The initial temperature was recorded and kept in track of them for an hour with internal heat of 5 minutes.
vi) The initial temperature and other subsequent temperature by the two thermometers were read and recorded as shown in Table1 below.

Fig. 5. Set up of the materials before the practical

Fig. 6. Set up of the materials during the practical

3. RESULTS AND DISCUSSION

3. 1. Demonstration of Greenhouse Effect on Temperature

The demonstration includes two parts. In the first, greenhouse using transparent bottle containing air and the initial temperature was taken and recorded in Table 1 below as temperature of empty bottle (°C). In the second, greenhouse using transparent bottle with mixture of baking soda and white distilled vinegar, initial temperature was also taken and recorded in table1 as temperature of filled bottle (°C). This procedure was repeated in interval of 5 minutes for 1 hour and the subsequent temperatures of the empty and filled bottles were taken and recorded as shown in Table1 below.

Table 1. Values of Temperature of two bottles.

S/N	Time interval (minutes)	Temperature of empty bottle (°C)	Temperature of empty bottle (K)	Temperature of filled bottle (°C)	Temperature of filled bottle (K)
1	0	37.00	310.00	37.00	310.00
2	5	42.85	315.85	39.27	312.27
3	10	42.89	315.89	40.10	313.10
4	15	39.99	312.99	40.98	313.98
5	20	39.01	312.01	39.78	312.78
6	25	39.11	312.11	45.22	318.22
7	30	40.02	313.02	46.99	319.99
8	35	40.05	313.05	48.08	321.08
9	40	40.06	313.06	49.09	322.09
10	45	40.05	313.05	50.56	323.56
11	50	39.09	312.09	50.57	323.57
12	55	40.00	313.00	60.02	333.02
13	60	38.99	311.99	65.67	338.67

In the above practical, We observe that the vinegar and baking soda in the filled bottle reacted and produced carbon dioxide (CO_2). This CO_2 absorbs and retains more heat from the high voltage bulb than the empty bottle of normal air. It demonstrated that the greenhouse effect (greenhouse gases CO_2) rises the earth's temperature as indicated by values of the reading in Table 1 above. It also observed that visible light passes through the glass and is absorbed by darker surfaces inside. This absorbed energy heats up the materials, also warming the surrounding air. But convection is restricted by the enclosing glass and the inside temperature of greenhouse rises. The greenhouse effect in Earth's atmosphere is caused by a number of gases that behave in a similar way to glass. They are transparent to visible light, but absorb in part of the infrared spectrum.

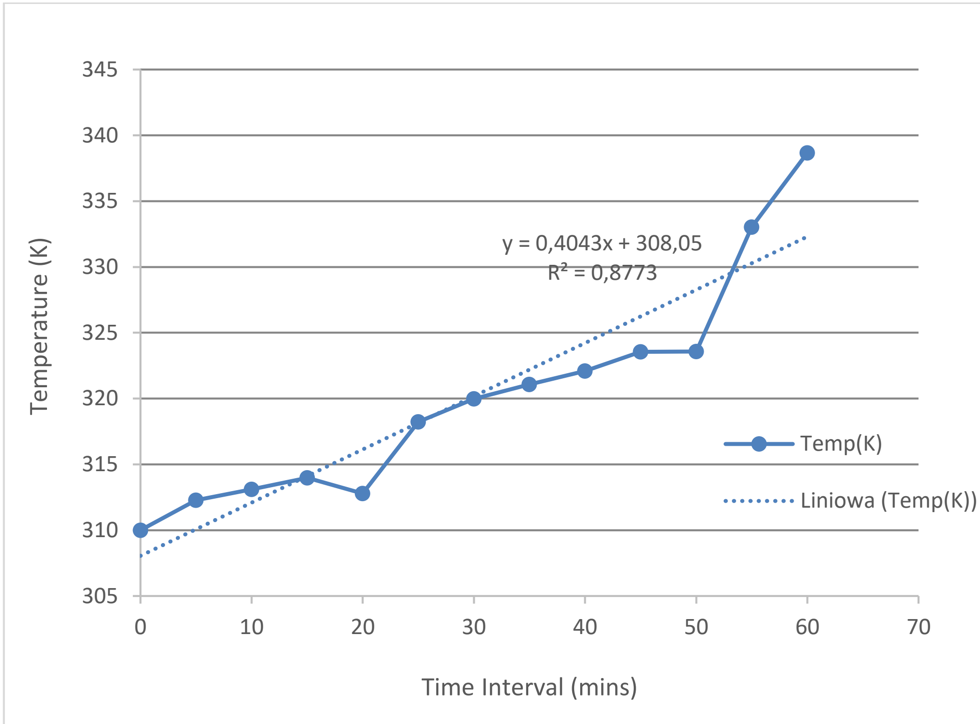

Fig. 7. Temperature (K) of the bottle contains mixture of baking soda and Vinegar against Time interval (mins)

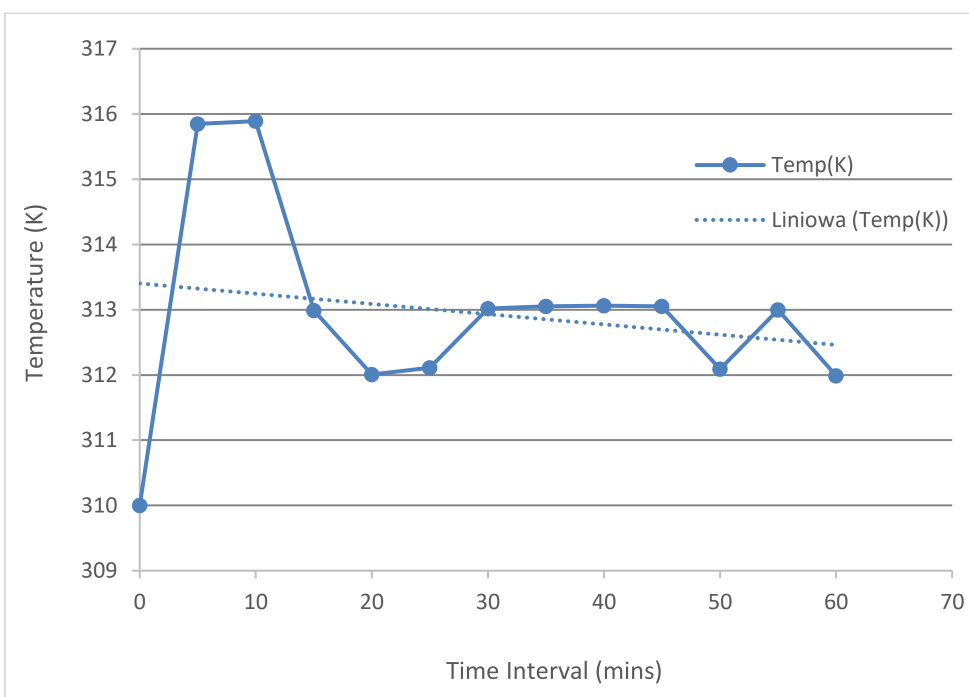

Fig. 8. Temperature (K) of the empty bottle against Time interval (mins)

It can be seen that carbon dioxide is the most important greenhouse gas because of its relatively high concentration in the atmosphere rather than its intrinsic greenhouse efficiency.

In Fig 7; the temperature of bottle containing mixture of baking soda and vinegar against time interval. Baking soda was added to vinegar. Baking soda reacts with the vinegar to produce carbon dioxide gas, sodium acetate, and water. It took energy to break the baking soda and vinegar apart and energy was released when the carbon dioxide, sodium acetate and water were formed. Since more energy was needed to break the baking soda and vinegar apart, the temperature went down (endothermic reaction), which is the reason for slight decrease as shown in the graph at the first 15 minutes. The energy released during the reaction of the baking soda and vinegar is in form of heat, which interacts with molecules of CO_2in a way that prevents some of the heat from escaping. The trapped heat energy together with the external heat source increases the temperature, of the bottle.

In Fig 8; the temperature of empty bottle against time interval. Temperature and air pressure are closely related. As the temperature of the air in the empty bottle rises and becomes heated due to the external heat source, the heated air in the bottle becomes lighter and rises to the top of the bottle and is released to the external surrounding of the bottle, as the air pressure in the bottle decreases. The system absorbs heat from the external heat source and allows the escape of heat and as shown in the graph. The temperature slightly increases and slightly decreases at the time intervals, and maintains equilibrium.

4. CONCLUSION

The accumulation of greenhouse gases will only enhance greenhouse effect thereby causing climate change and global warming. This study highlights the manmade and even natural activities that contributes to producing greenhouse gases which prevents heat reaching the earth surface from leaving the atmosphere making the earth hotter and affecting climate negatively. This study also highlights the need to be aware and curb the emission of these greenhouse gases, and to maintain a sustainable climate for mankind.

4. 1. Recommendations

Based on findings from this study the need to switch to cleaner sources of energy for instance, the use of solar panels and electric engines is emphasized. Deforestation and some farming practices like fertilizer application to the soil should be prohibited. Also environmental sustainability schemes and regulations should be undertaken by governmental bodies and local communities in other to heal our planet

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