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Software Visualization Management Tool for Studying Carbon Monoxide Effect on Climate Changes Using Mathematical Modelling

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ABSTRACT

Carbon monoxide (CO) is one of the major gases that causes climate changes and pollution in the world. The study is aimed to develop mathematical model with Runge Kutta of fourth order to estimate the rate of production of carbon monoxide (CO) with respect to oxygen and also to estimate the rate of reactions that lead to production of carbon monoxide (CO) with methane (CH4) and oxygen (O2). Pollution of environment that always lead to climate changes which is drastically affecting the human existence in term of agricultural production, supply of water for drinking, excessive flooding, drought and other climatic problems that normally resulted from increase in temperature due to human activities especially in developed and developing countries of the world due to Green gases emission through carbon. The study uses MAThematical LABoratory (MATLAB) Version 7.5 to develop visual representations of carbon monoxide production, rate of reaction of oxygen and methane to produce carbon monoxide. The model will assist to predict the carbon monoxide (CO) production and modeling of carbon monoxide (CO) reduction through the rate at which the carbon monoxide (CO) is being produced in a visual form by considering the mole of reactant, i.e. methane (CH4) and oxygen (O2)

Keywords: Carbon monoxide, climate change, mathematical modeling, management, tools, etc.**Keywords**: Software, Operating system, distributed system, DOS, architecture.

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1. INTRODUCTION

Carbon monoxide (CO) is a pollutant that is caused by incomplete combustion of carbon. Methane is one of the organic carbon that produces carbon monoxide as a result of incomplete combustion. Thus, carbon monoxide plays a major role in both air pollution and climate changes, and is therefore regulated in many parts of the world. Among various pollutants, carbon monoxide is very common in the lower atmosphere. His is because it can last for a month or moret to be transported long distances but not so long that it becomes distributed nearly uniformly [1] [13].

Shindell [12] also ascertained that although carbon monoxide is only a weak greenhouse gas, but its influence on climate goes beyond its own direct effects. Its presence affects concentrations of other greenhouse gases including tropospheric ozone and carbon dioxide. Carbon monoxide readily reacts with the hydroxyl radical (OH) forming a much stronger, greenhouse gas--carbon dioxide. A NASA report indicates that carbon monoxide is responsible for a 13% reduction in hydroxyl concentrations and through other reactions, a 9% drop in sulfate concentrations. Sulfates are credited for offsetting some of the global warming due to greenhouse gases by reflecting incident solar radiation back to space.

Like many pollutants, carbon monoxide has both anthropogenic and natural sources [10]. Natural sources include volcanoes and forest fires while human sources (which make up over half of all carbon monoxide produced) are mainly vehicle emissions and slash and burn agriculture, but also include some industrial activities [3]. Also, carbon monoxide exposure is still one of the leading causes of unintentional and suicidal poisoning gas and it causes a large number of deaths annually in Africa [2][3]. Furthermore, high concentrations of carbon monoxide kill in less than five minutes. At low concentrations, it will require a longer period of time to affect the body [4][6].

As automobile emission controls have improved in recent years, carbon monoxide emissions in western countries have decreased. However, a rapid increase in industrialization and in the number of automobiles in rapidly developing countries like China and India have resulted in increased carbon monoxide emissions in those countries. Biomass burning is the burning of vegetation, which includes burning fires started by lightning and fires started by humans. The latter includes fires for the purpose of land clearing to increase agricultural areas or to get rid of the stubble from the previous year's crops. For instance, NASA satellites were able to track the huge plumes of carbon monoxide resulting from these fires. Furthermore, in 2007, large portions of Southeast Asia were engulfed by the smoke from fires caused by humans.

As part of an effort to study the future air quality and climate change, a team of researchers from different countries recently used 26 state-of-the-art atmospheric chemistry models to simulate present-day and projected near-future carbon monoxide. Existing simulations were compared with near-global observations from the Measurements of Pollution in the Troposphere (MOPITT) instrument flown on NASA's Terra satellite and with local surface measurements [5][7][8]. The models show large underestimates of carbon monoxide at middle and high latitudes in the Northern Hemisphere, while typically performing reasonably well elsewhere. Carbon monoxide detectors, which are designed to protect against high concentration of carbon monoxide are required to sound an alarm when concentration of carbon monoxide are required to sound an alarm when concentration are greater than 100ppm. Respiratory capacity decreases while the risk of heart attack increases at levels well below 50ppm. [15].

With the review of the literature given above, the mathematical illustrations and graphical representation are highly needed in order to predict the rate at which carbon monoxide can be formulated when the reactants involved in its production are been reacted. Software visualization techniques have been used to analyze and display large volume of multidimensional data in manners as to allow the users to extract useful information quickly and easily. Therefore it is often viewed that visualization is much more effective and useful when dealing with large arrays of data. Since it is hard for human to properly perceive data of these sizes in raw form, it is usually clearer to see what the data shows when displayed in a graphical form.

The word Software Visualization simply referred to as (SV), is the use of visual representations to enhance the understanding and comprehension of the different aspects of a software system. Price, Baecker and Small [11] gave an elaborate definition of software visualization as the combination of utilizing graphic design and animation combined with technologies in human-computer interaction to reach the ultimate goal of enhancing both the understanding of software systems as well as the effective use of these systems. The need to visualize software systems evolved from the fact that such systems are not as tangible and visible as physical objects in the real world. In order for software visualization to be meaningful, it must be related to certain phenomena; in our own case production control system of carbon monoxide is the chosen aspect [9][14]

According to Burbidge [4] production control (PC) is the function of management which plans, directs and controls the material supply and processing activities in an enterprise. Production control is concerned with the activities involved in handling materials, parts, assemblies, from their raw or initial stage to the finished product stage in an organized and efficient manner. It may also include activities such as planning, scheduling, routing, dispatching, storage, e.t.c. The problem with regard to production control is to determine when and how much to produce in a given manufacturing system in order to satisfy a set of objectives [9]. This activity is performed by production control systems (PCS), which González and Framinam (2009) defined as being a set of rules defining order release and material flow control in a manufacturing system.

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2. MATERIALS AND METHOD

The material used in this study is based on equation given as

$2CH_4 + 3O_2 \longrightarrow 2CO + 4H_2O$…………eq. 1

Where
CH_4 is methane
O_2 is Oxygen
CO is Carbon monoxide
H_2O is Water

In order to develop the model for the study, the assumptions to be taken are as follows:

1. Two reactants are involved in the reaction and two materials are produced.
2. Volume of one reactant determines the amount of other reactant taken place in the production.
3. Methane and oxygen are only two reactants taking in the production of carbon monoxide and water.
4. Boundary conditions must be given for the reaction as K(u) = m, where K and u are the two reactants while m is the initial for the first reactant and h is the step increase for u, which is the second reactant.

In eq. 1 above, 2moles of methane (CH_4) is reacted with 3moles of oxygen to produce 2moles of carbon monoxide and 4moles of water.

Let CH_4 be represented by w, O_2 by x, CO by y and H_2O by z:

Eq. 1 above can be related to Runge Kutta 4th order as:

$\frac{dw}{dx} = w + \frac{H}{6}(K_1 + 2K_2 + 2K_3 + K_4)$ ……………eq. 2

From eq. 2, where $K_1 = f(x, w)$
$K_2 = f(x + 0.5h, w + 0.5h K_1)$
$K_2 = f(x + 0.5h, w + 0.5h K_2)$
$K_4 = f(x + h, w + h K_3)$

The above model can be used to predict the rate of reactions that lead to production of carbon monoxide with respect to the rate at which methane and oxygen are reacted. Also, we can measure the rate of production of carbon monoxide with respect to oxygen by this formula given below:

$\frac{dy}{dx} = y + \frac{H}{6}(K_1 + 2K_2 + 2K_3 + K_4)$ …………eq. 3

From eq. 3, where $K_1 = f(x, y)$

$K_2 = f(x + 0.5h, y + 0.5h K_1)$
$K_2 = f(x + 0.5h, y + 0.5h K_2)$
$K_4 = f(x + h, y + h K_3)$

3. DISCUSSION OF RESULT

The results were generated with MatLab in order to accommodate the graphical representation which is the sole aim of this study. Various results were generated and discussed as follows:

Table 1: The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.5 mole

Oxygen	Carbomonoxide
60.0000	20.0000
60.5000	26.5000
61.0000	28.8333
61.5000	29.7778
62.0000	30.2593
62.5000	30.5864

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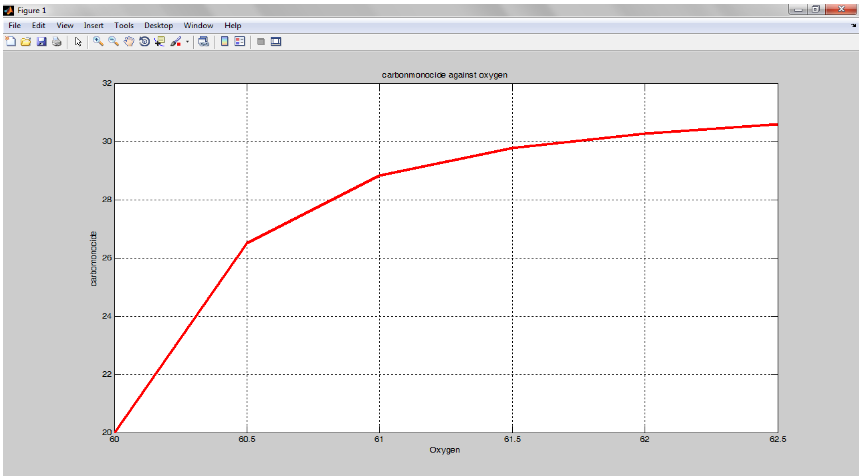

Figure 1: The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.5 mole

From the Table 1 above, the initial values of oxygen and carbonmonoxide are 60 moles and 20 moles respectively at step length of 0.5 mole. When the value of the oxygen is 60 moles, 20 moles of carbonmonoxide will be produced. When the mole of oxygen is increased to 60.5000, 26.5000 moles of carbonmonoxide will be produced . As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 1.

Table 2:The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.25 mole

Oxygen	Carbomonoxide
60.0000	20.0000
60.2500	26.2031
60.5000	28.6074
60.7500	29.5872
61.0000	30.0327
61.2500	30.2779

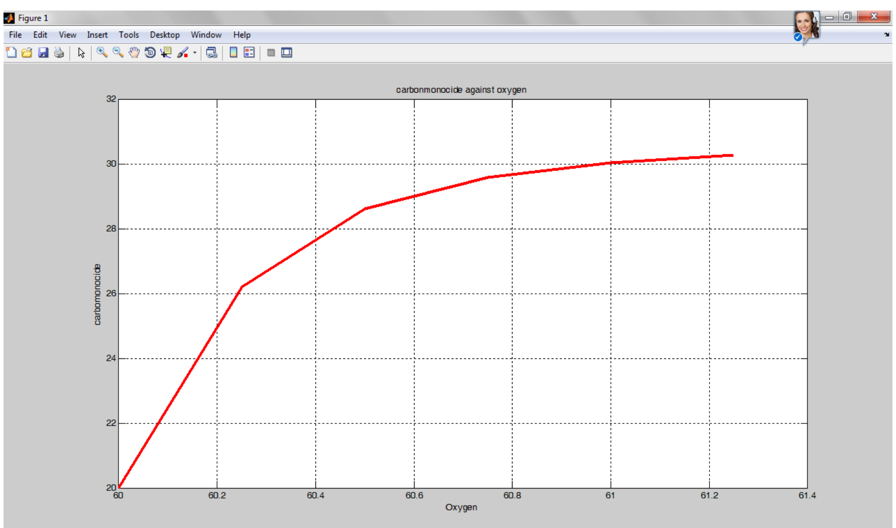

Figure 2: The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.25 mole

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From the Table 2 above, the initial values of oxygen and carbonmonoxide are 60 moles and 20 moles respectively at step length of 0.25 mole. When the value of the oxygen is 60 moles, 20 moles of carbonmonoxide will be produced. When the mole of oxygen is increased by 0.25 mole to 60.2500, 26.2031 moles of carbonmonoxide is produced . As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 2.

Table 3: The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.125 mole

Oxygen	Carbomonoxide
60.0000	20.0000
60.1250	23.9189
60.2500	26.3214
60.3750	27.8038
60.5000	28.7278
60.6250	29.3130

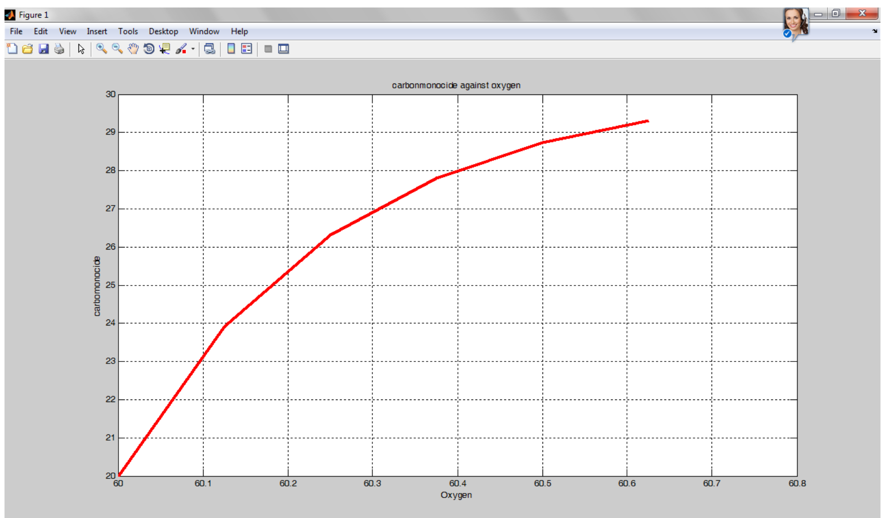

Figure 3: The rate of production of carbonmonoxide with respect to rate of change in oxygen at interval of 0.125 mole

From the Table 3 above, the initial values of oxygen and carbonmonoxide are 60 moles and 20 moles respectively at step length of 0.125 mole. When the value of the oxygen is 60 moles, 20 moles of carbonmonoxide will be produced. When the mole of oxygen is increased to 60.12500, 26.2031 moles of carbonmonoxide is produced . As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 3.

Table 4:The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.5 mole

Oxygen	Methane
30.0000	10.0000
30.5000	13.1667
31.0000	14.3889
31.5000	14.9630
32.0000	15.3210
32.5000	15.6070

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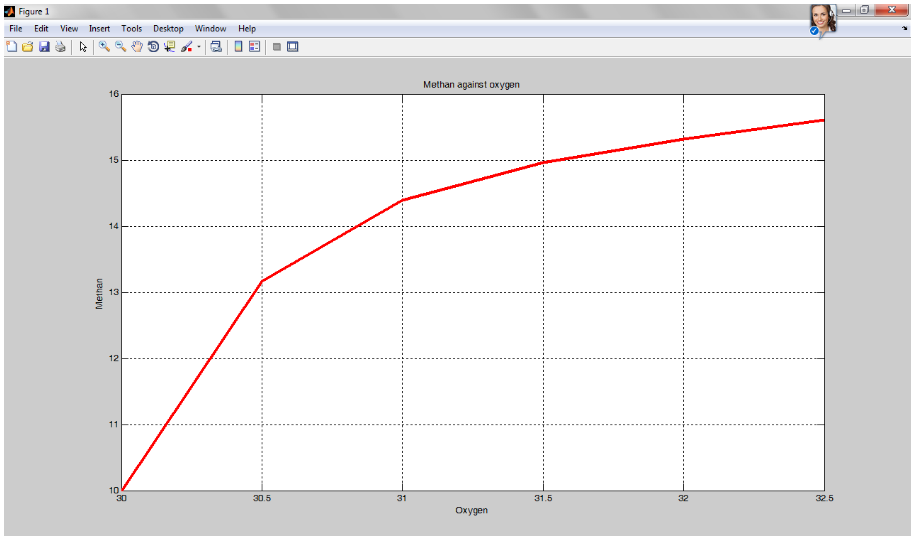

Figure 4: The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.5 mole

From the Table 4 above, the initial values of oxygen and methane are 10 moles and 30 moles respectively at step length of 0.5 mole. When the value of the oxygen is 10 moles, 30 moles of methane will be required for the reaction. When the mole of oxygen is increased to 30.5000, 13.1667 moles of methane will be reacted. As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 4.

Table 5: The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.25 mole

Oxygen	Methane
30.0000	10.0000
30.2500	13.0781
30.5000	14.3105
30.7500	14.8508
31.0000	15.1316
31.2500	15.3150

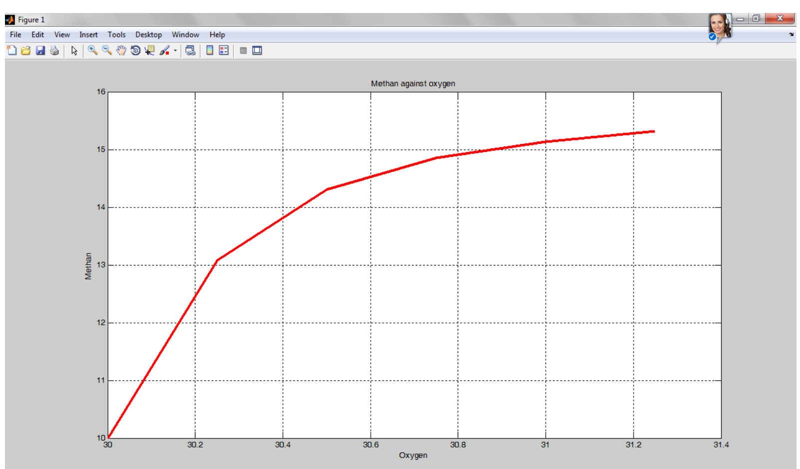

Figure 5: The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.25 mole

From the Table 5 above, the initial values of oxygen and methane are 10 moles and 30 moles respectively at step length of 0.25 mole. When the value of the oxygen is 10 moles, 30 moles of methane will be required for the reaction. When the mole of oxygen is increased to 30.2500, 13.0781 moles of methane will be reacted. As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 5.

Table 6: The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.125 mole

Oxygen	Methane
30.0000	10.0000
30.1250	11.9528
30.2500	13.1623
30.3750	13.9207
30.5000	14.4055
30.6250	14.7242

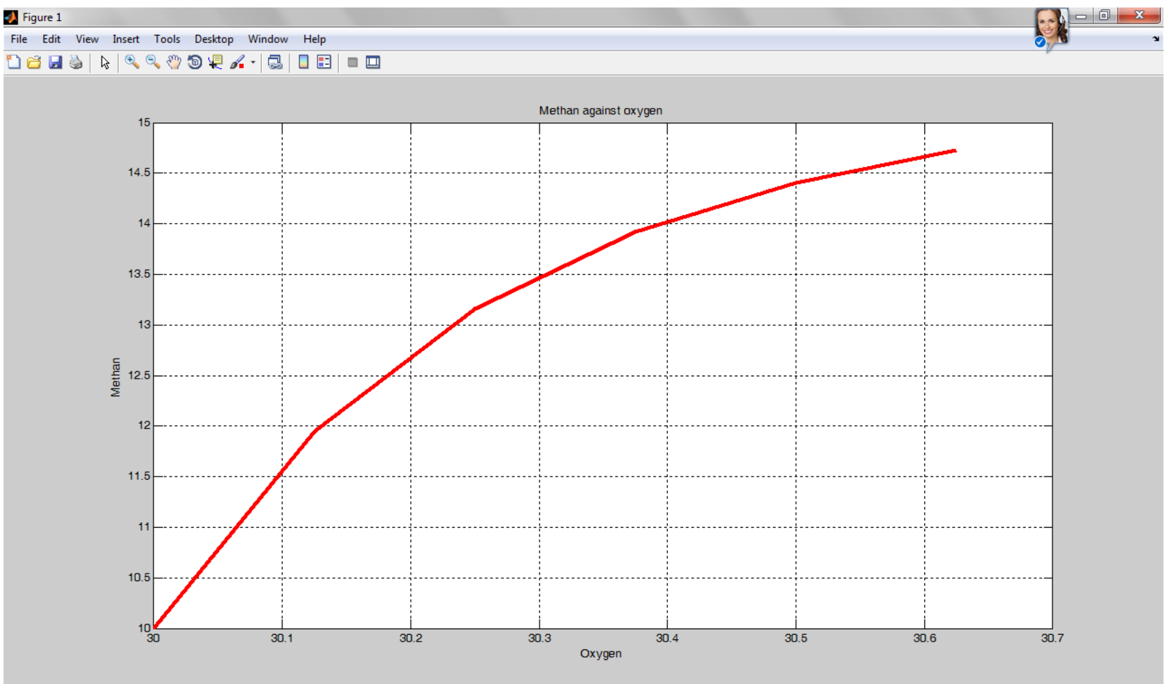

Figure 6: The rate of reaction of methane with respect to rate of change in oxygen at interval of 0.125 mole

From the Table 6 above, the initial values of oxygen and methane are 10 moles and 30 moles respectively at step length of 0.5 mole. When the value of the oxygen is 10 moles, 30 moles of methane will be required for the reaction. When the mole of oxygen is increased to 30.1250, 11.9528 moles of methane will be reacted. As the step increases, it will get to a stage at which a constant output will be expected and that constant output is as a result of more oxygen that took part in the reaction which leads to the production of complete combustion which remains constant as shown in the figure 6.

4. CONCLUSION AND RECOMMENDATIONS

Based on the findings of our study, we here conclude that:

(i) oxygen has effect on the carbonmonoxide production

(ii) Oxygen also determines the amount of methane that will be reacted together to produce carbonmonoxide and water.

(iii) The rate of reaction which is interval at which the reaction takes place between methane and oxygen and interval of production of carbonmonoxide based on oxygen has a great effect on the production rate.

We recommended that:

(i) Small amount of oxygen can produce carbonmonoxide and when it increases it will produce either carbondioxide or shoot

(ii) The software that was developed can be used to predict carbonmonoxide production pattern at different rates.

(iii) The software can also be used as alternative to balance the reaction rate of that involves two reactants especially methane and oxygen to produce carbonmonoxide and water.

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