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CATALYTIC REDUCTION OF CO_2 FROM BIO DIESEL USING COCONUT SHELL ACTIVATED CARBON

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ABSTRACT

Carbon dioxide (CO_2) is an abundant and stable form of carbon that is the product of respiration and burning of fossil fuels. As a result of these activities, the atmosphere concentration of CO2, a greenhouse gas, has been rising over the last century and contributing to global warming. Industries and Automobile manufacture contribute largely to the emission of CO_2 into the atmosphere, due to this there is a strong interest in developing methods for sequestering CO2 either by capturing it or chemically converting it to valuable chemicals. In this project CO_2 will be chemically converted into a non-polluting gas through catalytic reduction of the exhaust emission from the passenger vehicle. In this project, coconut shell activated carbon will be used as a catalytic reduction agent for the reduction of the exhaust emission. We will be designing and fabricating the chamber which will contain the coconut shell activated carbon and will be testing of the catalytic reduction chamber on an gasoline passenger vehicle using a gas analyzer.

Keywords: sequestering, coconut shell activated carbon, chamber, and catalytic reduction

INTRODUCTION

Carbon Dioxide (CO_2) is an abundant and stable form of carbon that is the product of respiration and burning of fossil fuels. As a result of these activities, the atmosphere concentration of CO_2, a greenhouse gas, has been rising over the last century and contributing to global warming. There is a strong interest in developing methods for sequestering CO_2 either by capturing it or by chemically converting it to valuable chemicals. Of particular interest are possible routes to reduction of CO_2 by multiple electrons to yield methanol and methane, which are renewable fuels. The reduction of CO_2 is difficult, with a limited number of reports of metal – based compounds able to catalyze these reactions. Even in biology only a few enzymes are known to reduce CO_2 The hunger for energy is unbroken and will not even stagnate in the face of a growing human population. The amount of CO_2 emitted in human activities was recently estimated to be about 5.5 Giga Tons of carbon per year. With a growing CO_2 concentration, the effects of greenhouse gases to nature enforce recurring discussions on how to handle this interference with effects on the climate that are already noticeable and will even rise. Beside direct heat emission (e.g., via combustion gases) these greenhouse gases are responsible for the greenhouse effect and, according to reports of the Intergovernmental Panel on Climate Change (IPCC), cause a slow but increasing global warming. Thus catalytic reduction of CO_2 is required to help reduce greenhouse effect and global warming to safe level to ensure the sustenance of human life.

In this project, we are mainly concentrating on reducing carbon dioxide emission from gasoline operated passenger vehicle, the main principle involved in this process is when the exhaust gas is allowed to pass through the catalyst, it absorbs the carbon dioxide from the exhaust gas which in turn reduces the amount of carbon dioxide emitted to the outer atmosphere.

About Carbon dioxide

Carbon dioxide (CO_2) is a naturally occurring chemical compound composed of two oxygen atoms covalently bonded to a single carbon atom. Carbon dioxide is colourless. At low concentrations, the gas is odourless. At higher concentrations it has a sharp, acidic odour. It is a gas at standard temperature and pressure and exists in Earth's atmosphere in this state, as a trace gas at a concentration of 0.039 per cent by volume. At standard temperature and pressure, the density of carbon dioxide is around 1.98 kg/m^3. Carbon dioxide has no liquid state at pressures below 5.1 standard atmospheres (520 kPa). At 1 atmosphere (near mean sea level pressure), the gas deposits directly to a solid. At temperatures below −78.5 °C (−109.3 °F; 194.7 K), the solid sublimes directly to a gas above −78.5 °C. In its solid state, carbon dioxide is commonly called dry ice.

Carbon Dioxide emission from gasoline vehicles: To meet Emission norms, every Automobile has been fitted with catalytic converters. A catalytic converter is a vehicle emission control device that converts toxic pollutants in exhaust gas to less toxic pollutants by catalyzing a Redox reaction (oxidation or reduction). These catalytic converters cause the oxidation of carbon monoxide to carbon dioxide.

$$2CO + O_2 \rightarrow 2CO_2$$

The amount of CO_2 created from burning 1 litre of fuel depends on the amount of carbon in the fuel. More than 99% of carbon in fuel is emitted as CO_2 with very small amounts of hydrocarbon and carbon monoxide. The average passenger vehicle emits about 411 grams of CO_2 per mile. This number can vary based on two factors: the fuel economy of the vehicle and the amount of carbon in the vehicle's fuel. Every gallon of gasoline creates about 8,887 grams of CO_2 when burned. Therefore, when driving one mile the CO_2 emission is about:

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`CO_2 emission per mile = CO_2 per Gallon / MPG

The average gasoline vehicle on the road today has a fuel economy of about 21.6 miles per gallon (9.183 kilometres per litre) and drives around 11,400 miles per year (1836.476 kilometres). Based on these numbers, a typical gasoline passenger vehicle emits about 4.7 metric tons of carbon Dioxide per year.

Annual CO_2 emissions = (CO2 per gallon / MPG) * Miles.

From this we can conclude that gasoline passenger vehicles contribute 4.7 metric tons of Carbon Dioxide per year which has resulted in an increase in Global Warming i.e.: the increase of Earth's average surface temperature due to effect of greenhouse gases, which trap heat that would otherwise escape from Earth. The European Union and many scientific bodies have concluded that avoiding the most severe outcomes of Global Warming will require keeping the total global average warming to no more than 2ºC/3.5ºF relative to pre-industrial levels (about 1.1Cº/2ºF above present levels). This can be achieved with the help of catalytic reactor chambers fitted on gasoline passenger vehicles which will reduce CO_2 up to 70%, thereby reducing the annual 4.7 metric tons of CO_2 produced by gasoline vehicles.

Carbon Dioxide levels in India: In 2012, a study was compiled by the University of East Anglia in the U.K. that stated that India's carbon emissions have shot up by an estimated 7.5% over the past year, while those recorded in developed markets like the U.S. and European Union had declined by 1.8% and 2.8%. In the report it was found India was the world's fourth largest carbon dioxide polluter, accounting for 7% of total carbon emissions in 2011. China topped the list, pumping about 23% of the world's total carbon dioxide last year, followed by the U.S. and European Union, which accounted for 16% and 11%, respectively. India's carbon emissions are still significantly lower than those of the U.S. or China, but with an annual growth rate as high as 7.5%, experts warn that may not be the case for long. Corinne Le Quéré, a professor who specializes in climate change and who headed UEA's research study stated in a interview that India's carbon levels will be at par with China, if not higher, by 2020. By 2020, India expects to reduce its carbon emissions by at least 20% of its gross domestic product against 2005 levels, largely based on sustained use of alternative energy, imposing fuel efficiency norms for vehicles, and by strengthening public infrastructure – roadways, footpaths and public transport – to reduce dependence on fossil fuels. Carbon emissions are measured as a ratio of GDP to give an overview of pollution produced per unit of output in a country.

Coconut Shell Activated Carbon: Coconut based activated carbon are black granules which has a particle size which is same of about 0.297mm with its mesh size 50mm. It has a bulk density of 720 kg/m^3. Its carbon tetra chloride adsorption 30%. The iodine adsorption is found to be 500 mg/gm with a total surface area about 500 m^2/gm .The ball pan hardness is 95% with a pH value of about 9.4.The impurities seen in this type has a ash content with a value of 5% and with maximum moisture content which is 5%.

Reactor Design

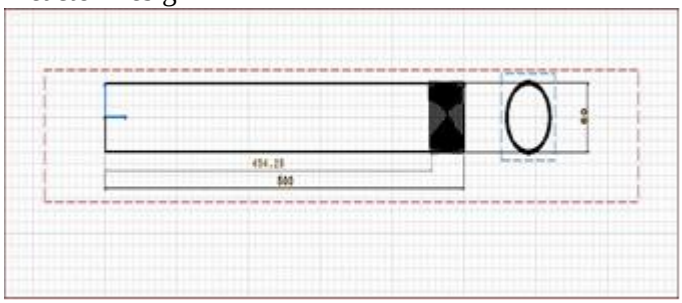

Figure 1 2-D Drafting of Reactor Chamber

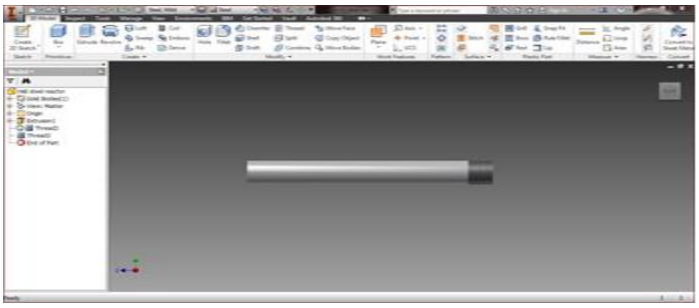

Figure 2 Inventor Model of Reactor Chamber

Table 1 Specifications of Reactor Chamber

PARAMETER	DIMENSION (mm)
Outer Diameter	60
Outer Diameter	58
Length	500
Material	Ms
Thread	
Pitch	4
Length	50
Depth	1.5

Engine specification: The engine use for this project was a single cylinder four stroke water cooled vertical engine.

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Table 2 Engine Specification

ENGINE	SPECIFICATIONS
Fuel	Punnai Oil
Bore	80mm
Stroke	110mm
Cr	17.5 To 12
Speed	1500 Rpm
No.Of Cyclinders	1
Load	Eddy Current Dynamometer

Punnai Oil Properties:

PROPERTIES	SPECIFICATION
Density	910 kg/m^3
Cv	39100 kgJ/kg
Kinematic Viscosity	32.45
Flash Point	22.8
Cetane No.	51
Carbon Residue	0.01
Cloud Point	-2.5 *C
Pour Point	-0.8 *C

Frabrication of Reactor: In this fabrication process we are going to insert the cylindrical mesh which consists of such a way that all the exhaust gases that passes inside the pipe should also pass through the Catalyst contained mesh. One end of the pipe is extended for certain distance after the mesh for the exhaust gas testing purpose and other end of the pipe is welded to the reducer which is connected to the exhaust tail end pipe of the engine.

Figure 3 Wire Mesh, Activated Carbon Wrapt in Wire Mesh, Reactor Assemble

Data Obtained from Testing: The testing was carried out with the help of a gas analyser (FGA4500) at 1200rpm which is capable of measuring Hydrocarbons (HC), Carbon Monoxide (CO), Carbon Dioxide (carbon dioxide), Oxygen (O_2), and Oxides of Nitrogen (NOX). The FGA4500 will instantaneously calculate readings and determine the Air to Fuel Ratio (AFR), Lambda, and Grams per Mile (GPM) or Grams per Kilometre (GPK) in real time.

EMISSION	FREE EXHAUST	CATALYTIC CHAMBER
CO (%vol)	0.38	0.16
HC hexane (ppm vol)	57	18
CO_2 (%vol)	3.50	1.60
O_2 (%vol)	15.92	18.46
NO (ppm vol)	8	14

RESULTS

Upon testing the coconut shell activated carbon reactor chamber at 1200rpm with punnai oil, it was found that there was a reduction of CO_2 from 3.50 to 1.60 (%vol) i.e. there was a 45.71% reduction in CO_2.