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Conversion of plastic wastes to alternative fuel using G2F system

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ABSTRACT

The present decade saying ban plastic is much worried about the water scarcity. It's being revealed banning plastic bring more water scarcity as the alternative goods to plastic are more water consuming in its production. Water, air and land being the primary requirement for life should be preserved in every product invention and technological innovation. The present study proposes a suitable technology that saves all the required land resources. The so far used plastics are said to be dump threat to land resources and micro lives in it. The existence of plastic ban is a profound threat to water. Air is being polluted every day due to the exhaust of fuel and heaps of land fill. An alternative to plastics might be good invention but to recycle the already existing plastics are the real solutions to the plastics. Plastics are typically organic polymers of high molecular mass and often contain other substances. They are usually synthetic, most commonly derived from petrochemicals. However an array of variants are made from renewable materials such as polylactic acid from corn or cellulosic from cotton linters. Having a strong chemical bond that makes them degrade very slowly, which creates environmental issues and makes the soil unfit for vegetation. Conversion of plastic into alternative fuel may require high investment in terms of energy. The present project addresses the minimal energy (cost effective) to convert plastic wastes and sources to convert into crude and purified fuel resources. The results revealed that 600-800ml of crude oil can be obtained from one kilogram of one time disposable plastics through paralysis in 15 minutes. During the conversion 10% per Kg methane is also produced as by product.

Keywords: free energy; plastic conversion; fuel; petroleum; methane

1. INTRODUCTION

Energy is considered as a critical factor for economic growth, social development and human welfare. Since their exploration, the fossil fuels continued as the major conventional energy source with increasing trend of modernization and industrialization, the world energy demand is also growing at faster rate. To cope up the increasing energy demand, majority of the developing countries import crude oil apart from their indigenous production. This puts extra burden on home economy.

Hence, it is utmost important that the options for substitution of petroleum fuels has to be explored to control this burgeoning import bill. There is limited reserve of the fossil fuels and the world has already faced the energy crisis of seventies concerning uncertainties in their supply fossil fuels are currently the dominant global source of CO_2 emissions and their combustion is stronger threat to clean environment increasing industrialization, growing energy demand, limited reserve of fossil fuels and increasing environmental pollution have jointly necessitating exploring some alternative of conventional liquid fuels.In India, generation of plastics are increased from about 2.6 MT in 2003 to about 3.6 MT in 2007(MOEF, 2007). Also it is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacks TPD of MSW in the India (CPCB, 2003). 32 million of plastics were generated in 2011 in America, representing 12.7 percent of total MSW (EPA, 2011).

The present decade saying ban plastic is much worried about the water scarcity. It's being revealed banning plastic bring more water scarcity as the alternative goods to plastic are more water consuming in its production. Water, air and land being the primary requirement for life should be preserved in every product invention and technological innovation. The present study proposes a suitable technology that saves all the required land resources. The so far used plastics are said to be a dump threat to land resources and micro livesin it. The existence of plastic ban is a profound threat to water. Air is being polluted every day due to the exhaust of fuel and heaps of land fills. An alternative to plastics might be good invention but to recycle the already existing plastics are the real solutions to the plastics.

Thermoplastics make up 80% of the plastics and thermoset plastics make up of remaining 20 % of plastics produced today (Norburn., et al, 1988), etc.Plastics packaging totals 42% of total consumption and very little of this is recycled (Vogleret al., 1984), etc. Only 8 percent of the total plastic waste generated in 2011 was recovered for recycling (EPA, 2011).

Even in bigger cities, the current waste management systems mostly entail use of dumping sites and landfills, where the majority of the waste (Al-Salem S.M.,*et al.*, 2010) has been identified to be different classes of polymers namely: high density polyethylene (HDPE), low density poly ethylene (LDPE), poly vinyl chloride (PVC), poly propylene (PP), poly styrene (PS) and poly ethylene terephthalate (PET) (Singh et al., 2017).Plastics are typically organic polymers of high molecular mass and often contain other substances. They are usually synthetic, most commonly derived from petrochemicals. However an array of variants is made from renewable materials such as polylactic acid from corn or cellulosic from cotton linters. Having a strong chemical bond that makes them degrade very slowly, which creates environmental issues and makes the soil unfit for vegetation. Conversion of plastic into alternative fuel may require high investment in terms of energy. Thermal process of decomposing plastics by heating in absence of oxygen generating gaseous and liquids products which can be utilized as fuels.

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic's, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. The present project addresses the management of waste plastics into fuel by using solar free energy. It is also known as green energy, because it can't create any environment pollution. In this study, the progress system was created, that is named at G2F (Green to Fuel) System to produce the Pyrofuel from waste plastics.

MATERIALS & METHODOLOGY:

Collection of Waste Plastic:

The collection of waste plastic is quite an easy task as compared to other wastes; the plastic wastes are abundant and can be obtained in large quantities from the households, roadsides, hospitals, hotels etc. These plastics could be collected or usually purchased at Rs.10 to 15/kg after being shredded and washed properly.

PROCESS DESCRIPTION:

This process can be thermal or catalytic and is an alternative that allows the conversion of polymers into gas and liquid hydrocarbons. Shredded plastics is treated in a cylindrical reactor at temperature of 300ºC – 350ºC (Harshal et al., 2013).So as to obtain the end products in the form of liquid, ash and gas in absence of oxygen. In this temperature was obtained by using free energy, such as solar energy was used to produce the electricity.

In this process, the collected plastics are dumped in the steel vessel and it was sealed by a valve. The mouth of the vessel was connected to the condenser tube to condense the gas into liquid. The condensed oil like liquid was collected in a tank and it is stored in a room temperature. Once the raw fuel is obtained it is further subjected to distillation process so as to obtain the fuel i.e. diesel in its pure form by removing the impurities present in it which can be then tested into diesel engines for its efficiency. The collected sample liquid was again heated at 100ºC to separate the pure liquid at pale yellow color by the process of condensation. The percentage of liquid distillate is mentioned in terms of weight by volume (Raja A., et al, 2011).

G2f System:

The G2F System is used to produce the electricity by the way of solar free energy. In the energy produced system which contains some major components. They are,

i) The static bypass:

The online UPS has an internal static bypass circuit that is the first line of defense UPS system. In the event of a system failure, the static bypass automatically closes the circuit and allows the incoming power to divert around the rectifier, batteries and the inverter to supply utility grade power (unconditioned) directly to your load.

ii) The rectifier:

The rectifier has two main functions. One is to charge the batteries. Some manufacturers just trickle charge the batteries to keep them at the proper float voltage. Some manufacturers have a more sophisticated method (three steps) that has a fast charge to 90%, followed by a slow charge to 100%, and finally a turn off charger once the batteries are fully charged. The other job of the rectifier is to convert the incoming power from A/C to D/C.

iii) Step Down and Step Up Transformer:

Atransformer is static electrical equipment which transforms electrical energy (from primary side windings) to the magnetic energy (in transformer magnetic core) and again to the electrical energy (on the secondary transformer side). The operating frequency and nominal power are approximately equal on primary and secondary transformer side because the transformer is a very efficient piece of equipment – while the voltage and current values are usually different.

Essentially, that is the main task of the transformer, converting high voltage (HV) and low current from the primary side to the low voltage (LV) and high current on the secondary side and

vice versa. Also, a transformer with its operation principle provides galvanic isolation in the electrical system.

With those features, the transformer is the most important part of the electrical system and provides economical and reliable transmission and distribution of electrical energy.

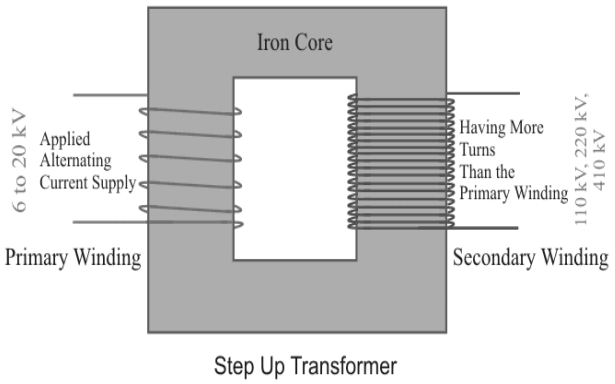

Fig1. Step up and Step down the Voltage by Step up& down Transformer

Green Energy:

The solar energy system includes solar panels, an inverter, equipment to mount the panels on your roof, and a performance monitoring system that tracks electricity production. The solar panels collect energy from the sun and turn it into electricity, which is passed through the inverter and converted into a form that you can use to power your home. The vast majority of residential solar energy systems are connected to the electricity grid (or "grid-tied").

Commercial photovoltaic (PV) systems are 10 to 20 percent efficient. Of these, the flexible panels are only in the 10 percent range and the solid panels are about 20 percent efficient. Multi-junction cell technologies are being tested that achieve efficiencies of 40 percent and higher. At 25°C (77°F), a high quality monocrystalline silicon solar panel produces about 0.60V open circuit (OCV). Like batteries, solar cells can be connected in series and parallel to get higher voltages and currents. The surface temperature in full sunlight will likely rise to 45°C (113°F) and higher, reducing the open circuit voltage to 0.55 V per cell due to lower efficiency. Solar cells become more efficient at low temperatures, but caution is necessary when charging batteries below freezing temperatures. The internal resistance of a solar cell is relatively high: with a commercial cell, the series resistance is typically one ohm per square centimeter (1Ωcm2).A solar charging system is not complete without a charge controller. The charge controller takes the energy from the solar panels or wind turbine and converts the voltage so it's suitable for battery charging. The supply voltage for a 12V battery bank is about 16V. This allows charging lead acid to 14.40V (6 x 2.40V/cell) and Li-ion to 12.60 (3 x 4.20V/cell). Note that 2.40V/cell for lead acid and 4.20V/cell for lithium-ion are the full-charge voltage thresholds.

The 12V/100 watts PV solar panel was taken and it was fixed in the roof. The generated power supply of 12V is directly connected to the 40 Amps Battery. The inverter was designed by the consisting of DC to AC oscillation board, 12V step up transformer followed by a battery. The sunlight which produces a current and it was stored in a battery for after usage.

The transformer has produces a AC voltage rated at 230V/1000 watts by battery. For this study, the heating mantle is used as a thermal chamber by consuming 300watts/230V. It is used to generate the heat at indirectly to the vessel. Due to heat generation in the bottom of the vessel, the

plastic material was heated at without oxygen condition. The overall process was taken at 30-45 minutes for obtaining the pure fuel for the first cycle.

Fuel Characteristics:

Fuels, as for any other type of substance, can be assigned some physical and chemical properties (e.g. density, thermal capacity, vapour pressure, chemical formula, etc. However, most of the times, combustion properties are also assigned to fuels, in spite of the fact that these properties depend on the oxidizer (e.g. air, pure oxygen) and the actual process (e.g. the explosion limits depend on the boundary conditions for a given fuel/oxidiser pair). Fuel price, availability, risk, and so on, could also be considered fuel properties (attributes).

Emission Characteristics:

Emissions measurement is the process of measuring the amount of pollutants, in a gaseous or particulate form, being emitted to the air from a specific source, such as an industrial process. Measurements of emissions can be used to understand the relative importance of a given source compared to other sources and in developing emissions inventories. Government or industry personnel use emissions measurements to assess the performance of control strategies. The gas stream can be measured before and after pollution control device to determine how efficiently it captures pollutants. Emission measurements also are used to determine compliance with regulations limiting the amount of pollution that a source may emit.

Measurements can be taken over a short time period (e.g., hours), often referred to as a source test, or with methods that measure on a continuous basis, often called continuous emissions monitoring. Either way, it is important obtain data from samples that are representative of the emission stream using methods that are reliable. The emission regulations specify the type, principle of operation used and generic construction of the exhaust gas analyzers which can be employed for emission certification of vehicles and engines.

Hydrocarbon Emission:

Hydrocarbons are a family of compounds with a combination of hydrogen and carbon molecules H_x C_y. The infra-red absorption as the measurement technique the particular calibration gas needs to be specified because different types of hydrocarbons are absorbed at different levels. The HC concentration is commonly written as ppmC. HC concentration measured as ppm propane is to be multiplied by a factor of 3 to convert it to ppmC. All classes of hydrocarbons i.e., paraffin, olefins, aromatics, etc. will show practically the same response to Flame Ionization Detector.

Hydrogen was mixed with helium in ratio of 40:60 to decrease flame temperature that increases flame stability. The FID analyzer is calibrated with propane or methane mixtures in nitrogen. For the measurement of hydrocarbons in diesel exhaust, sampling line and FID are heated to a temperature of 191± 11°C to minimize condensation of heavy hydrocarbons present in the diesel exhaust in the sampling system. By the use of sensor probe the HC level was measured at systematically.

Carbon Monoxide Emission:

Carbon monoxide (CO) is an important primary pollutant. CO measurements in exhaust are done routinely at many gas stations and IM test locations. These devices use a non-dispersive infra-red spectroscopic technique. These sensors detect CO in the parts per million range and typically last for several years. To date we have not found an inexpensive sensor that operates in the correct range for exhaust testing (0-15% by volume).

CO (exhaust) = CO (sensor reading) /Dilution factor

Dilution factor = Exhaust Flow/(Exhaust flow + Dilution flow)

RESULTS:

Collection Of Waste Plastic:

The collected plastic wastes are air dried to remove water content and dust particles. And also these plastics are crushed and stored at room temperature. The collection of waste plastic is quite an easy task as compared to other wastes, the plastic wastes are abundant and can be obtained in large quantities from the households, roadsides, hospitals, hotels etc.These plastics could be collected or usually purchased at Rs.10 to 15/kg after being shredded and washed properly.

G2f Process:

The collected plastics are dumped in the steel vessel and it was sealed by a valve. The mouth of the vessel was connected to the condenser tube for condense the gas into liquid. The condensed oil like liquid was collected in a tank and it is stored in a room temperature.The results revealed that 600-800ml of crude oil can be obtained from one kilogram of one time disposable plastics through G2F process at 15 minutes.

The raw fuel is obtained it is further subjected to distillation process so as to obtain the fuel such that diesel in its pure form by removing the impurities present in it which can bethen tested into diesel engines for its efficiency.

The collected sample liquid was again heated at 100^{o}C to separate the pure liquid at pale yellow color by the process of condensation. By this process, the pure fuel was separated by the process of distillation.

The G2F process of synthesizing useful chemical products uses a technique that is the opposite of the Fischer-Tropsh (F-T) process. In the F-T process, carbonaceous material e.g. coal, is first combusted in order to give syngas (CO + H2). The syngas is then synthesized into targeted higher molecular chain hydrocarbons e.g. petrol, diesel and paraffin. The G2F process starts with higher molecular chain hydrocarbons (polymers) and then break it down (cracking) using either heat, a catalyst or hydrogen gas (Al-Salem S.M. et al., 2010) into targeted smaller chain hydro-carbons e.g. liquid fuels. Since G2F is basically a thermal degradation process by using solar energy, it is essential to understand the effect of mixing feed material that has different melting points on the process. The other factors that affect the efficiency of a G2F process are pressure, type of reactor, temperature, residence time and cooling mechanisms.

G2f Energy:

The free energy was produced by the solar panel at the range of 12V/100Watts. The generated power was standardized by a panel controller. The corrected voltage was directly stored in the 12V DC battery. The stored energy was reused by a form of AC with the help of inverter. By the use of inverter 230V AC supply was produced. The energy is ranged at 1000watts. The time requirement is calculated at 3 hours for full charge of battery. When the battery is full charged condition, the charged battery produces the AC voltage, continuously. The inverter is designed on, it is worked at DC and AC supply.

Amount of energy in the form of heat and radiations called solar energy. It is radiant light and heat from sun that is natural source of energy using a range of ever changing and developing of technology such as solar thermal energy, solar architecture, solar heating, molten salt power plant and artificial photosynthesis. The large magnitude of solar power available makes highly appealing source of electricity. 30% (approx.) solar radiation is back to space while the rest is

absorbed by ocean, clouds and land masses. PV cells Convert Sunlight to Direct Current (DC) electricity. Charge Controller work as control the power from solar panel which reverse back to solar panel get cause of panel damage. Battery System act as storage of electric power is used when sunlight not available (i.e. night).From this system connected to inverter for convert Direct Current (DC) into Alternating Current (AC). It is save up to 20% of energy costs.

It can use in Remote Locations. Easy Installation (i.e. does not required any wires, cords etc.).Rooftop which means no new space is needed & every domestic or commercials user can generate their own electricity. It is widely available of sunlight with free of cost, eco-friendly, renewable resource

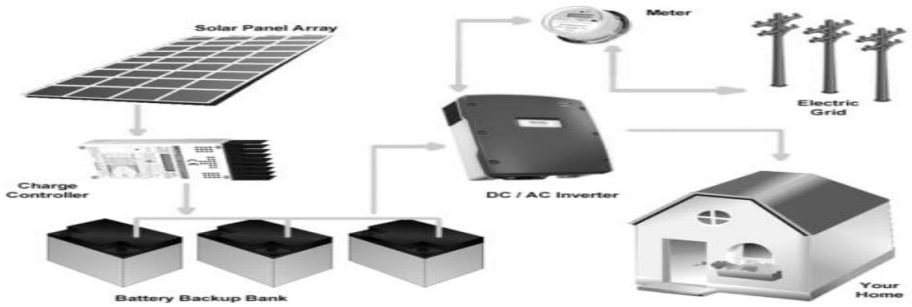

Fig2. Process to Power Supply Production

Fuel Characteristics:

The physical characteristics of fuel were measured by analytically at NDRL Lab, Salem. By this characterization, the density, specific gravity, calorific value, flash point and fire point were tabulated for the G2F Fuel.

Table 1.Physical Characteristics of G2F Fuel

Properties	G2F Fuel Value
Viscosity@ 40^{o}C	1.897
Density@ 40^{o}C	0.7566
Carbon Residue	0.47
Ash Content (%)	0.042
Sulphur Content (%)	0.276
Flash Point (^{o}C)	16
Pour Point (^{o}C)	<-15
Fire Point (^{o}C)	21
Calorific Value (kcal/kg)	9836.27

Emission Characterization:

Hydrocarbon Emission:

By the primary study, the emission characterization was tested on 4 stroke engine vehicle. The emission level was compared on commercially available fuel to G2F system. On the result,

the G2F system which emits the HC level at low ppm when compared to commercially available fuel emission.

Table 2.Pollution Report of Hydrocarbon emission for G2F system

Parameter	Regulation Limit	Actual Reading	
		Petrol	G2F
Hydro Carbon	9000 ppm	2400 ppm	2080 ppm
O_2 (% by Vol.)	-	1.49	1.14
CO_2 (% by Vol.)	-	13.44	12.66

The infra-red absorption as the measurement technique the particular calibration gas needs to be specified because different types of hydrocarbons are absorbed at different levels. The HC concentration is commonly written as ppmC. HC concentration measured as ppm propane is tobe multiplied by a factor of 3 to convert it to ppmC. All classes of hydrocarbons i.e., paraffin, olefins, aromatics, etc. show practically the same response to Flame Ionization Detector.

CARBON MONOXIDE EMISSION:

In our study, the emission characterization was tested on 4 stroke engine & 2W type of vehicle. The carbon monoxide emission level was compared on commercially available fuel and G2F system. At the result, the G2F system which emits the CO at low level when compared to the emission of commercially available fuel.

Table 3. Pollution Report of Carbon Monoxide emission for G2F system

Parameter	Regulation Limit	Actual Reading	
		Petrol	G2F
Carbon Monoxide	4.5%	2.958 %	2.499 %
O_2 (% by Vol.)	-	1.49	1.14
CO_2 (% by Vol.)	-	13.44	12.66

CO health impacts result from the fact that it binds to hemoglobin in blood and interferes with our bodies' ability to transfer oxygen to our cells (Koenig 2000). At a mixing ratio of 1000 ppmv1 (parts per million by volume) or 0.1 % (v/v), CO is toxic to humans, but even at much lower concentrations CO causes numerous health impairments. For this reason the U.S. Environmental Protection Agency has set the National Ambient Air Quality Standard (NAAQS) for CO at 9 ppmv for an 8 hour averaging period. In urban areas, the primary source of CO is auto exhaust [NRC 2001].

CONCLUSION

Paralysis has been found the most effective technique of conversion of waste plastic to fuels. It is noticeable that the fuel obtained by Paralysis is cleaner than conventional fuels. This study has investigated the technical and economic feasibility of a plastic waste pyrolysis process for the production of a heavy fuel oil substitute. The base case scenario considered is a plant with a capacity of 100kg/h of plastic waste, consisting of mixture of polyethylene, polypropylene, and polystyrene, which can effectively be converted into a wax/oil, as well as char and gases as value added products.

In this process was progressed by using of free energy such as solar energy. The solar energy is also known as green energy to environment. By the usage of this energy the thermal energy was produced to burn the waste plastics at without oxygen condition. The produced gases are condensed and it is used on fuel for vehicles. The G2F fuel which emits the CO and HC at low quantity when compared to the commercially available fuel.

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Conflict of Interest

None of the authors have any conflicts of interest to declare.