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Extraction of Liquid Fuel from Waste Plastic

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ABSTRACT

*An **energy crisis** is remarkable bottleneck in the supply of energy resources to an economy. There has been an ever increasing global demand for fuel in recent years. The demand of the fuel especially from liquid fuels is very high and the limited resources of fuel production have created bottleneck and which in results an energy crisis. There is a ringing a bell of conventional fuel. This has led to exploring alternative resources for fuel production, one of which is waste plastic. Being a non-degradable source, plastics disposed off in the open environment as wastes pose a threat to the biosphere. The fuel can be manufactured from the waste plastic. The work in this paper describes an attempt to manufacture liquid fuel from the waste plastic and validation with the diesel.*

Keywords: Waste plastic, Diesel, Specific gravity, Calorific value.

INTRODUCTION

Economic growth and changing consumption and production patterns are resulting into rapid increase in generation of waste plastics in the world. Due to the increase in generation, waste plastics are becoming a major stream in solid waste. After food waste and paper waste, plastic waste is the major constitute of municipal and industrial waste in cities. Even the cities with low economic growth have started producing more plastic waste due to plastic. Packing material, plastic shopping bags, bottles and other goods/appliances which use plastic as the major component. This increase has turned into a major challenge for local authorities, responsible for solid waste management and sanitation.

Management of plastic waste has become big challenge in India. According to Central Pollution Control Board (CPCB), India, there is plastic waste annually around 5.6 million tons and approximately only 60% of collected plastic waste is going to be re- cycled [1]. Tons of Plastic waste is dumped on land and huge amounts are disposed into the water.

PLASTIC EFFECTS ON ENVIRONMENT

“The situation is so bad that, the Times of India reports, two Supreme Court justices have weighed in, saying plastic bags are a more serious threat to future generations than is posed by nuclear weapons.”

All of us are watching how our lakes, ponds and urban sewerage systems are getting choked by plastic bags. A rough estimate shows more than 100 million water pouches are thrown all over the cities and towns.

Due to government neglect across the country, animals particularly cows and bulls are ingesting plastic from garbage dumps and plastic bags are littered across the landscape and oceans. The ingestion of plastic bags chokes the stomach of cows and up to 60 kg of plastic bags were found in the stomachs of cows. What appears to be a healthy cow is in fact a plastic-choked cow or a cow full of plastic. Apart from the plastic completely choking the digestive system of the cow and causing excruciating pain to the animal, plastic residues enter the human food chain through dairy and animal products.

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LAND

Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem. This can cause serious harm to the species that drink the water. Landfill areas contain many different types of plastics as shown in figure 1. In these landfills, there are many microorganisms which speed up the biodegradation of plastics. The microorganisms include bacteria such as Pseudomonas, nylon-eating bacteria, and Flavobacteria. These bacteria break down nylon through the activity of the nylonase enzyme. When biodegradable plastics are broken down, methane is released, which is a very powerful greenhouse gas that contributes significantly to global warming.

Fig 1: Plastic dumping

OCEAN

In 2012, it was estimated that there was approximately 165 million tons of plastic pollution in the world's oceans as shown in figure 2. One type of plastic that is of concern in terms of ocean plastic pollution is nurdles. Nurdles are manufactured plastic pellets (a type of micro-plastic) used in the creation of plastic products and are often shipped via cargo ship. A significant amount of nurdles is spilled into oceans, and it has been estimated that globally, around 10% of beach litter consists of nurdles. Plastics in oceans typically degrade within a year, but not entirely. In the process, toxic chemicals such as bisphenol A and polystyrene can leach into waters from some plastics. Polystyrene pieces and nurdles are the most common types of plastic pollution in oceans, and combined with plastic bags and food containers make up the majority of oceanic debris.

One study estimated that there are more than 5 trillion plastic pieces (defined into the four classes of small micro-plastics, large micro-plastics, meso- and macro-plastics) afloat at sea.

Fig 2: Plastic causing problem in whales

EFFECT OF PLASTIC ON ANIMALS

Plastic pollution has the potential to poison animals as shown in figure 3, which can then adversely affect human food supplies. Plastic pollution has been described as being highly detrimental to large marine mammals, some marine species, such as sea turtles, has been found to contain large proportions of plastics in

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their stomach. When this occurs, the animal typically starves, because the plastic blocks the animal's digestive tract. Marine mammals sometimes become entangled in plastic products such as nets, which can harm or kill them.

Entanglement in plastic debris has been responsible for the deaths of many marine organisms, such as fish, seals, turtles, and birds. These animals get caught in the debris and end up suffocating or drowning. Because they are unable to untangle themselves, they also die from starvation or from their inability to escape predators. Being entangled also often results in severe lacerations and ulcers. In a 2006 report known as Plastic Debris in the World's Oceans, it was estimated that at least 267 different animal species have suffered from entanglement and ingestion of plastic debris. It has been estimated that over 400,000 marine mammals perish annually due to plastic pollution in oceans. Marine organisms get caught in discarded fishing equipment, such as ghost nets. Ropes and nets used to fish are often made of synthetic materials such as nylon, making fishing equipment more durable and buoyant. These organisms can also get caught in circular plastic packaging materials, and if the animal continues to grow in size, the plastic can cut into their flesh. Equipment such as nets can also drag along the seabed, causing damage to coral reefs.

Fig 3: Cows eating plastic

EFFECTS ON HUMANBEING

Due to the use of chemical additives during plastic production, plastics have potentially harmful effects that could prove to be carcinogenic or promote endocrine disruption. Some of the additives are used as phthalate plasticizers and brominates flame retardants. Through biomonitoring, chemicals in plastics, such as BPA and phthalates, have been identified in the human population. Humans can be exposed to these chemicals through the nose, mouth, or skin.

Although the level of exposure varies depending on age and geography, most humans experience simultaneous exposure to many of these chemicals. Average levels of daily exposure are below the levels deemed to be safe, but more research needs to be done on the effects of low dose exposure on humans. A lot is unknown on how severely humans are physically affected by these chemicals. Some of the chemicals used in plastic production can cause dermatitis upon contact with human skin. In many plastics, these toxic chemicals are only used in trace amounts, but significant testing is often required to ensure that the toxic elements are contained within the plastic by inert material or polymer. It can also affect humans in which it may create an eyesore that interferes with enjoyment of the natural environment.

CLINICAL SIGNIFICANCE

Due to the pervasiveness of plastic products, most of the human population is constantly exposed to the chemical components of plastics. 95% of adults in the United States have had detectable levels of BPA in their urine. Exposure to chemicals such as BPA have been correlated with disruptions in fertility, reproduction, sexual maturation, and otherhealth effects. Specific phthalates have also resulted in similar biological effects.

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- Thyroid Hormone Axis
- Sex Hormones. Etc.

INCINERATION

Up to 60% of used, plastic medical equipment is incinerated rather than deposited in a landfill as a precautionary measure to lessen the transmission of disease. This has allowed for a large decrease in the amount of plastic waste that stems from medical equipment. If plastic waste is not incinerated and disposed of properly, a harmful amount of toxins can be released and dispersed as a gas through air or as ash through air and waterways. Many studies have been done concerning the gaseous emissions that result from the incineration process.

Plastic pollution involves the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat, or humans. The prominence of plastic pollution is correlated with plastics being inexpensive and durable, which lends to high levels of plastics used by humans. Plastic pollution can unfavorably affect lands, waterways and oceans. Living organisms, particularly marine animals, can also be affected through entanglement, direct ingestion of plastic waste, or through exposure to chemicals within plastics that cause interruptions in biological functions. Humans are also affected by plastic pollution, such as through the disruption of the thyroid hormone axis or sex hormone levels. Plastic reduction efforts have occurred in some areas in attempts to reduce plastic consumption and pollution and promote plastic recycling.

To overcome this threatening situation and hazardous problem caused by plastic waste there was a need to convert waste plastic into useful resources. Several researchers and scientists have found that waste plastic can be treated by thermal pyrolysis and is converted to useful diesel.

There is a need to make a device which operates on the principle of pyrolysis and converts waste plastic to usable fuel in efficient way which can substitute petroleum products such as kerosene and diesel. The device must be portable and easy to use so that conversion can be done on small scale in masses.

MODELLING AND FABRICATION OF SETUP

The proposed assembly of the experimental setup was modelled in Solid Works software with certain specifications. The need of different components was determined by the layout and was modelled based on the holding capacity of the heating chamber. The parts have been marked according to the parts list as shown in figure 4.

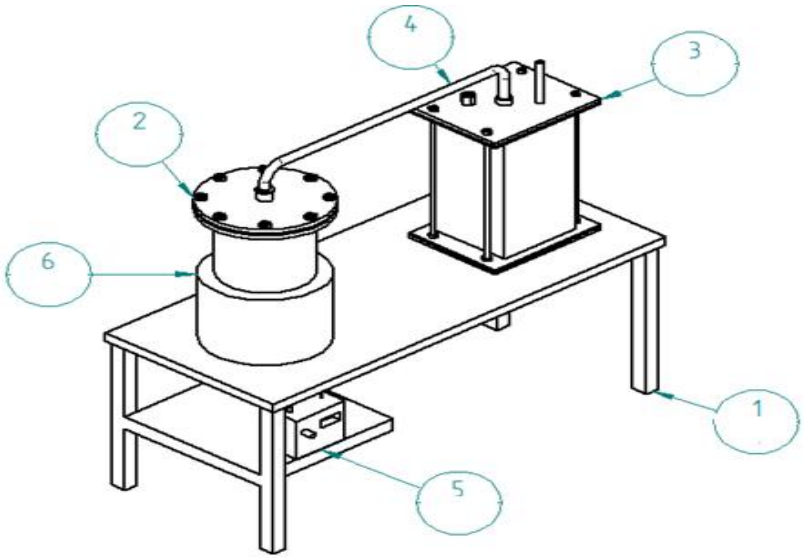

Fig 3: Isometric view of assembly

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Table 1. Parts list of setup

Part number	Name of Part	Quantity
1	Table	1
2	Reactor	1
3	Condenser	1
4	Piping	1
5	Controller	1
6	Heater	1

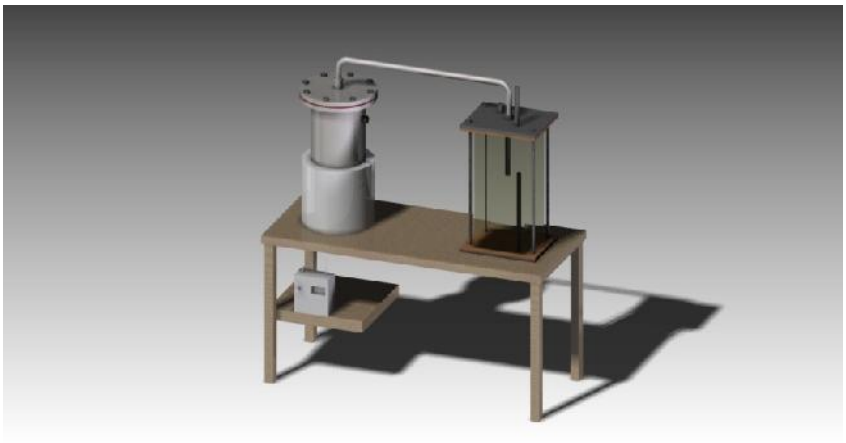

Fig 3: 3D model

Fig 3: Fabricated Set up.

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PROCEDURE

- Water is filled in the condenser till the mark and the water level is adjusted using water removing cock once the experiment is started.
- Waste plastic is filled in the reactor, engine packing paper ring is placed in alignment with lid holes and all the 8 bolts are tightened using Allen key.
- Thermostat is switched on and ambient temperature is noted. Burner is lightened, and flame level is adjusted using knob. Till 150°C flame length is full and after that flame is shortened to heat steadily and have more control over the process.
- After crossing 200°C bubbles are observed in the condenser. After certain time the evaporated plastic condenses and oil layer is formed on water surface in condenser the oil level increases gradually.
- Once the Bubbling reduces and gases are vigorously formed in condenser, the process is stopped to prevent dry heating of reactor and hence improve its life and efficiency.
- Water level is raised by pouring water till the oil reaches the red mark and then water is poured slowly; collector vessel is placed below the diesel cock to collect the fuel.
- After collecting the remaining oil, water in the condenser is drained off and fresh water is poured inside.
- Once the reactor reaches the ambient temperature lid is removed and un-reacted plastic in the form of wax is removed and reactor is cleaned so that the residue does not affect the pyolysis of different samples of plastic.

RESULTS AND DISCUSSION

The setup is fabricated for performing experiments with different grades of plastic. Experiment is conducted with waste plastic and following results were obtained.

Table 2. List of Experimental results

Sl. No.	Property	Waste plastic oil (polystyrene)	Waste plastic oil (polyethylene)	Diesel
1	Specific Gravity	0.835	0.830	0.840
2	Gross Calorific value kJ/kg	42,340	42,400	43,000
3	Kinematic viscosity,cSt at 40°C	3.4	3.5	3.0
4	Cetane Number	51	52	55
5	Flash appoint, °C	45°C	42°C	50°C
6	Fire point °C	48°C	45°C	55°C
7	Ash content %	0.00023	0.00021	0.045

CONCLUSION

From the above experiments it is concluded that the waste plastic pyrolysis oil represents a good alternative fuel and therefore must be taken into consideration in the future for transport purpose. This plastic oil has compositions similar to the existing primary hydrocarbons (i.e. diesel and gasoline). Possible these oil products can be use directly for energy generation or in a refinery for reprocessing.

Using the machine waste plastic can be easily converted to liquid fuel at par with diesel. One kg of plastic yields 0.8 liter of oil. The Percentage of ash content in oil is less compared to that of a diesel, where as kinematic viscosity of oil is higher than that of a diesel. Extracted oil from the waste plastic has better properties than kerosene and almost equal to diesel hence it can substitute kerosene as well as diesel.

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