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PRODUCTION OF PLASTO – GAS FUEL FROM ROADWASTE PLASTICS AND UTILISING IT AS ENERGY SOURCE

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Abstract - *These days, polymers have already become part of our daily lives. Many plastic products are hurled out obviously just because of the ignorance of the masses, culminating in tons and tons of plastic pollution swirling all over the streets. The disposal of these plastic waste presents a critical problem for the conservationists. In general, this environmental issue is highly difficult and challenging and severe for developing nations as ours. Since polymers are usually considered to be non-biodegradable, it is a massive challenge to address problems such as the disposal of consumer products or the efficient recycling and reuse of polymers hurled out. In order to obtain an appropriate solution for the above-described issue and to obtain usable energy from ecologically menacing road waste polymers, we are now burning them in a controlled fashion in a chamber there by getting "plasto-gas" that could be successfully used as a non-traditional energy source for domestic and industrial purposes. This type of modern energy source will begin to develop the economic future of our nation.*

Key Words: ecological menace; plasto-gas; non-biodegradable; recycling; road waste plastics; incineration

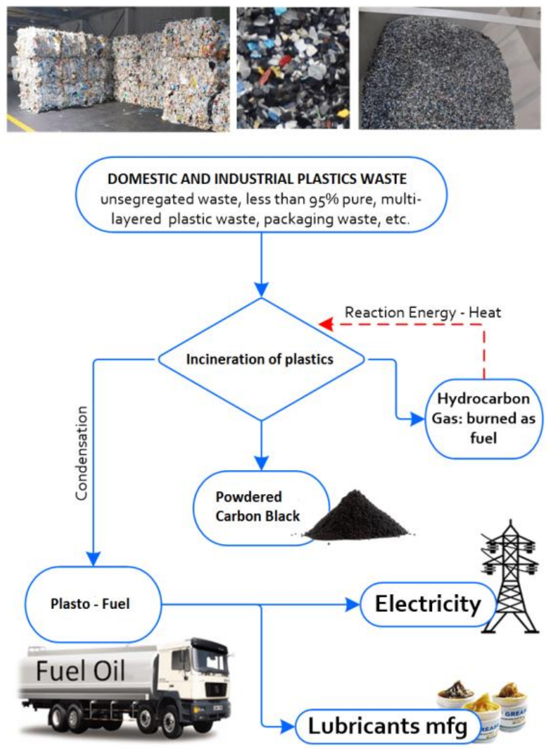
1. INTRODUCTION

The concept of generating "plastic gas "–fuel from landfill plastics emerges only to use road waste plastics effectively. And this concept is probably raised from biogas, as both gasses appear to contain the same content, i.e. methane. The idea is based on the apparently random de-thermal decomposition of waste polymers in the presence of a catalyst into liquid fuel. The whole process is carried out in a locked reactor vessel, accompanied by condensation, if required. Waste plastics are converted to liquid vapor during heating up to 270 to 300°C, which is gathered in a condensation compartment in the form of liquid fuel. The sludgy liquid waste is removed from the heating reactor vessel. The organic combustible gas is produced that is presently vented due to lack of storage facility, moreover, the plasto-gas could be utilized as fuel for generation of electricity and other purposes.

1.1 Methodology

The process includes following steps;

- Assortment & separation of plastics waste
- Storage of plastics waste
- Shredding of plastics wastes
- Loading into Hopper
- Passing of plastics wastes into heating vessel in presence of catalyst
- Tapping of liquid
- Movement of liquid-vapor into condenser
- Tapping of liquid fuel (as a product)



1.2 Environment Related Observations

There are no liquid industrial effluents and no floor washing as waste material is not washed. There is no organized stack and process emissions are let out. Odour of volatile organics has been experienced in the processing area due to some leakages or lack of proper sealing since, absolute conversion of liquid-vapor was possible into liquid, some portion of gas (about 20%) is connected to the generator. However, the process will be improved in full scale plant. PVC plastics waste is not used and if used, it was less than 1%. In case PVC is used, the chlorine can be converted into hydrochloric acid as a by-product. The charcoal (Charcoal is formed due to tapping of tarry waste) generated during the process has been analysed and contain heavy metals, poly aromatic hydrocarbon (PAH) which appears to be hazardous in nature. The source of metals in charcoal could be due to presence of additives in plastics and multilayer & laminated plastics. Monitoring of process fugitive emissions in the work area as well as emissions from the engines/diesel generator sets, where this liquid fuel is used, for various parameters such as CC, HCI, Styrene, Benzene, VOCs is necessarily required.

1.3 Recommendations of CPCB

With regard to technology, the process could only be used to transform waste from plastics to liquid fuel after consumption. The process can work well with the plastic waste chosen. Further research is needed for other categories of plastic waste. Technology must be developed to illustrate the use of post-consumer plastics to reduce the threat of plastic waste disposal along with the municipal solid waste (MSW). Unconverted gas should be used properly and should in no case be released freely. The use of PVC waste should be avoided as far as possible and, if used, converted to hydrochloric acid and no emissions allowed. Gas emissions can be tested for the use of liquid fuel for fumaces / boilers and generators. VOCs should be monitored in the processing area to check the concentrations of different hazardous air pollutants. Metal and organic concentrations in charcoal must be actually checked to determine their dangerous nature. The quality of the fuel can be checked by the agency concerned, such as Indian Oil Corporation Limited (IOCL), which can certify the quality of the liquid fuel according to the specifications and suggest its best use. With regard to the prescription of environmental standards, no standards for fluid effluents should be prescribed. For gaseous emissions, the entire process is to be closed and no leakages are expected. In working area, VOC standards could be worked out. No gaseous effluents are expected to be let out and if any, these are to use in generators. When PVC is used, complete conversion to HCI and no emission of HCI vapors could be stipulated. Further, disposal of HCI may also be ensured.

2. LIMITING OXYGEN INDEX TEST

The atmospheric air contains 21% of oxygen. So, each polymer requires a certain amount of oxygen for ignition. When plastics are subjected to heat, they produce variety of products at certain temperature such as combustible gases and non- combustible gases, charred solids, liquids and smoke etc., Ignition will occur when both combustible gases and oxygen are available in sufficient quantity. The amount of oxygen required for ignition varies from one polymer to another. The reason for different oxygen limitations for each polymer is, the higher the hydrogen to carbon ratio in the polymer, the greater is the tendency to burning. The limiting oxygen index test is quite fundamental. It does not characterize the burning behavior of the polymer.

Table -1: COI values of different plastics

S.NO.	POLYMER	COI (%)	IGNITION TAKES PLACE
1	POM	15%	YES
2	PMMA	17%	YES
3	PP	17%	YES
4	PE	17%	YES
5	PBT	18%	YES
6	PET	21%	YES
7	PS	18%	YES
8	NYLON-6	21-34%	NO
9	NYLON-6, 6	21-30%	NO
10	PPO	29-35%	NO
11	ABS	29-35%	NO
12	PSO	30%	NO
13	PVC	49%	NO
14	PTFE	90%	NO

2.1 Plasto-gas

An external heat source increases the polymer temperature to a point, where it begins to decompose and release combustible gases. Once the gases ignite, the temperature increases until the releases of combustibles are rapid enough for combustion to the self-sustaining so long as sufficient oxygen is available to support the combustion process. Some polymers such as Polystyrene (PS) Poly methyl meth acrylate (PMMA), the combustibles gases may be high in monomer because of thermally induced de-polymerisation of the polymer chains. Monomer breaks down further to lower molecular weight combustible products, including hydrogen, as it diffuses towards the flame where de-polymerisation does not occur, surface oxidation plays a role in generation of combustible gases.

2.2 Incineration

Many plastics can be burned as clearly as natural gas to produce emissions of Carbon dioxide (CO_2), Nitrogen dioxide (NO_2), and water vapour. As a pound of plastic produces 16,000 BTU when burned, more than twice the energy in a pound of coal, incineration can be used to generate energy, but not without serious attention to health issues. A small quantity of chromium and titanium, which are used as metal catalysts for some polyethylene products. The large groups of standard plastics (PE, PP, PS) are manufactured without use of metals. The uses of cadmium and lead chromate pigments have been reduced in recent years. Structurally the standard plastics are overwhelmingly hydrocarbon compounds containing no sulphur or chlorine i.e., from emission point of view, they are superior to coal, heating oil or natural gas. The assumption that these plastics are not responsible for the production of dioxins during combustion, if it takes place under controlled & mentioned conditions. There is no doubt that the wastes containing more or less chlorine that are responsible for the formation of dioxins and furans.

2.3 Environment point of view

The gaseous pollutants are oxides of sulphur, carbon monoxide, oxides of nitrogen, various hydrocarbons, chlorine, hydrogen sulphide, ozone, fumes of various acids etc., The smoke pollutants are dioxins & furans. It consists of mainly of carbonaceous particles which are very tiny in size. On environmental point of view, combustion of standard plastics produce hydrocarbons as that are present in the LPG & NATURAL GAS. So it does not produce any harmful causes to the human health, the gases that are produced can be tolerated by the human being. The plasto-gas does not produce the harmful hazards such as SO_2, Pb, dioxins, etc., since standard plastics molecule contains only carbon – hydrogen bond. While degradation it forms ethane, methane, propane, butane, etc., with some hydrocarbons that can be tolerated by the human, this is because the carbon, hydrogen, oxygen etc., are already present in the atmosphere for certain amount.

2.4 Calorific value

The municipal wastes contains varieties of waste such as paper fabrication, plastics, glass, metals and others such as organic wastes, fine waste, inert material, composites, sorting residue etc., All of these material has an average calorific value of ‘6’ while combustion in an incinerator. Plastics alone have calorific value of 34 approximately.

Table -2: Calorific values of different materials

WASTES	%	CALORIFIC VALUE	AS PROPORTIONAL AVERAGE
PAPER FABRICATION	14.9	16	2.38
METALS	3.8	0	0
GLASS	6.1	0	0
FINE WASTE	5.9	3	1.38
COMPOSITES	9.8	20	1.96
PLASTICS	6.8	35	2.38

2.5 Merits of current study

- There should be effective usage of road waste plastics.
- The conversion of waste into useful fuel.
- Value of road waste increases.
- It is good alternate fuel for the LPG.
- It is easily available.
- It is cheaper while comparing other source of energy.
- This terminates the life of the plastic and hence plastic component producers will go for the fresh raw materials and hence manufacturing of raw materials are increased.
- It would create knowledge to people about plastics and they would go for the separation of plastics from biodegradable wastes without any completion.
- Landfill technology can be prohibited through this method.
- We can create a clean and green environment through this study.

3. CONCLUSION

Disposing of plastic wastes pose a dangerous problem for the environmentalists. Particularly this ecological problem is highly challenging & acute for the developing country like ours. Since plastics are generally considered as non-bio degradable, tough challenge is ahead to cope up with the problems like disposal of plastic products or effective recycling and reusing of these thrown out plastics. The effective solution for the above-mentioned problem and to get useful energy from the environmentally threatening road waste plastics, is combusting them in a controlled chamber there by getting “Fuel” which can be effectively used as renewable energy source for domestic and industrial purpose. This type of a new source of energy will develops the future India. We need some more new source of energy for the future India and this idea of producing energy will be more useful for the domestic and industrial purpose. Thus the road waste plastics in to energy source we can make our mother nation India a clean, green and pollution free developed nation.

REFERENCES

[1] D. Yafeng, et al., “The research and design of a new type of waste plastic cracking reactor,” Machinery Design & Manufacture, no. 1, pp. 20–22, 2013.

[2] W. Chao, et al., "Study on effective thermal conductivity coefficient of plastic wastes pyrolysis process," Materials Review, vol. 27, no. 5, pp. 108–111, 2013.

[3] D. S. Scott, et al., "Fast pyrolysis of plastic wastes," Energy & Fuels, vol. 4, no. 4, pp. 407–411, 1990.

[4] W. L. Yoon, et al., "Optimization of pyrolytic coprocessing of waste plastics and waste motor oil into fuel oils using statistical pentagonal experimental design," Fuel, vol. 78, no. 7, pp. 809–813, 1999.

[5] D. S. Achilias, et al., "Chemical recycling of plastic wastes made from polyethylene (LDPE and HDPE) and polypropylene (PP)," Journal of Hazardous Materials, vol. 149, no. 3, pp. 536– 542, 2007.

[6] Y. Kodera, et al., "Novel process for recycling waste plastics to fuel gas using a moving-bed reactor," Energy & Fuels, vol. 20, no. 1, pp. 155–158, 2006.

[7] H.-T. Lin, et al., "Hydrocarbon fuels produced by catalytic pyrolysis of hospital plastic wastes in a fluidizing cracking process," Fuel Processing Technology, vol. 91, no. 11, pp. 1355–1363, 2010.