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CONVERSION OF WASTE PLASTIC INTO A TRANSPORT FUEL

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ABSTRACT

Plastic materials are a type of material that cannot be decomposed easily in a short period of time. It has accumulated substantial portion in the natural environment and in landfills. We are surrounded by lot of plastic materials in our day to day life. As a result of the increasing level of private consumption of these plastic materials, in almost every field, huge amount of plastic wastes are discharged to the environment. . It is undesirable to dispose of waste plastics by landfill due to poor biodegradability. Since the plastic polymers are originated from the petroleum resources, the possible technologies of converting them in to fuel have drawn attention to meet the future fueled and. Thus, converting the plastic polymers into transport fuel through a cleaner combustion process will contribute to saving our environment and Mother Earth. Various thermo chemical recycling processes can lead to accomplish an effective recycling of the waste plastic polymers by converting them into transport fuel grade hydrocarbons. It has been observed that the thermal fuel conversion technology, known as thermolysis and the dissolution process of plastic polymers into an acceptable bio-solvent can lead to reduction of plastic wastes effectively. This paper presents a review on various themolysis processes used for converting waste plastic into a valuable resource.

Keywords- *Landfills, waste plastic, thermo chemical, recycling hermolysis.*

I. INTRODUCTION

Plasticsaresyntheticorganicmaterialsproducedbypolymerizationprocess.They are typically of high molecular mass, and may contain other substances like nitrogen, sulfur and chlorine besides polymers to improve performance and/or reduce costs[2]. Thesepolymersaremadeofaseriesofrepeatingunitsknownasmonomers.Linear polymers (a single linear chain of monomers) and branched polymers (linear with side chains) are thermoplastic that is they soften when heated. Cross-linked polymers (two or more chains joined by side chains) are thermo setting,that is, they harden when heated. The main components of municipal solid waste (MSW) are food waste,wood,paper,cardboard, plastics, rubbers, fabrics, and metals. Rapid urbanization and industrial diversification has led to generation of considerable quantities of municipal plastic waste. Improper disposal of waste often results in causing diseases and contamination of water bodies and soil. The impacts of this waste on the economy cannot be ignored and managing them has become a major problem. Used plastic often gets mixed with municipal solid waste reduces the composting efficiency by decreasing water permeability as well as air circulation. Plastics pose unique problem in municipal solid waste management due to the considerable amount of time required for degradation.

Because of the characteristics of the plastic we can not avoid them completely, but atleast for managing the waste generated from them we have to think differently.Because of the longevity of plastics, disposaltol and fill may simply bestoring problems for the future.Soultimately, we come to the strategy of converting this wastet of energy.

II. SOURCES OF PLASTICS WASTE

Plastic wastes represent a considerable part of municipal wastes; furthermore a huge amount of plastic waste arises as a byproduct or defected product from various industries like plastic industry, automotive industry etc. ThevarioussourcesofMSWplasticsincludesdomesticitems(food containers, packaging foam, disposable cups,electronic equipment’s cases, drainage pipe, carbonated drinks bottles, CD and cassette boxes, surface coatings,flooring cushioning foams, thermal insulation foams,etc.The MSW collected plastics wastes are mixed one with major components of polyethylene, polypropylene, polystyrene, polyvinyl chloride and polyethylene terephthalate.The percentage of plastics in MSW has increased significantly in the recent years.

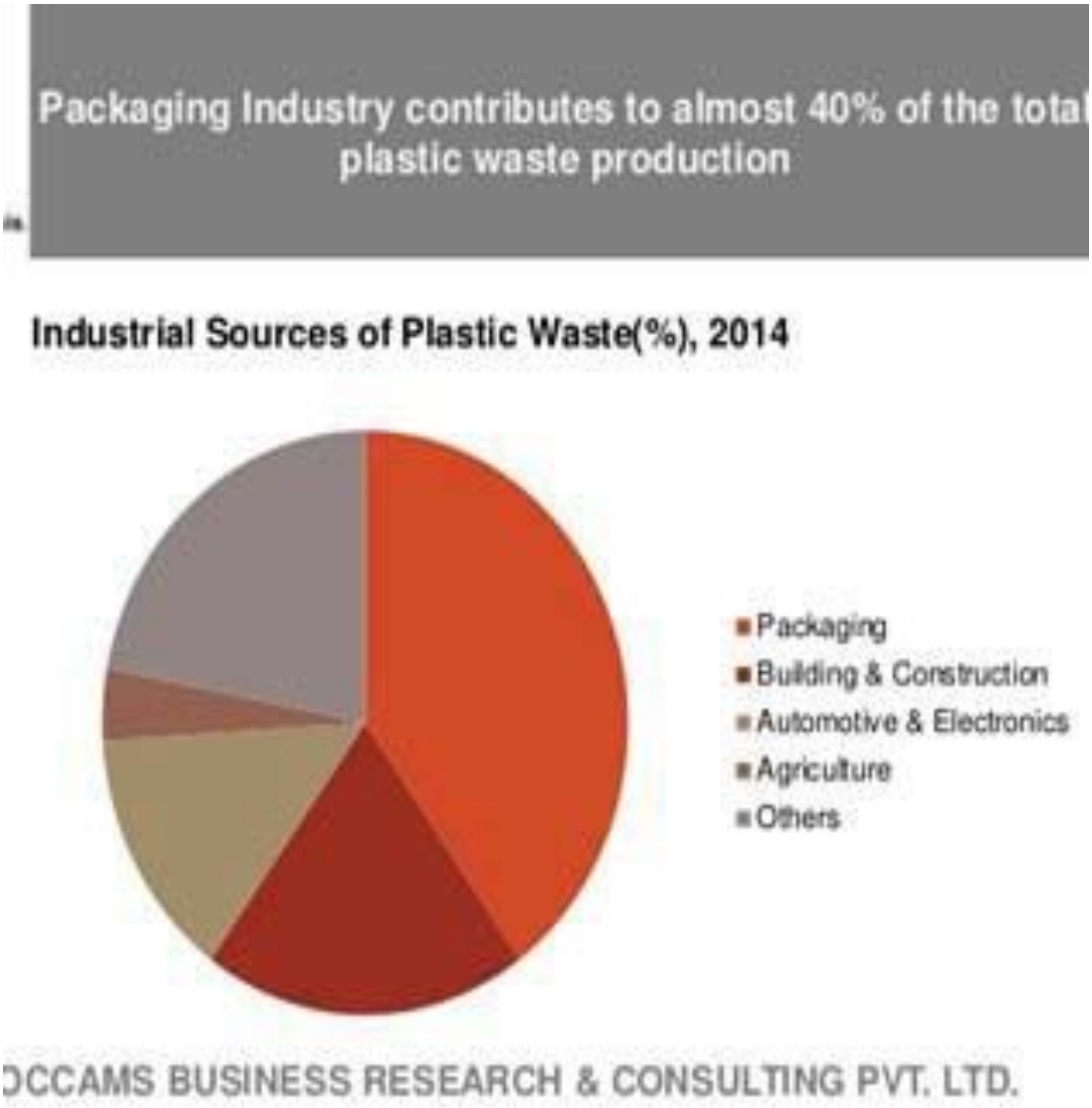

Fig.l:Industrialsourcesofplasticwasteforyear20l4.

III. WASTE TO ENERGY

Sinceplasticpolymersoriginatedfromthepetroleumresources, the possible technologies of converting theminto fuel will be the best option for the ir management.To produce energy from waste plastics, various methods can be used like catalytic cracking, non-catalytic cracking, steam degradation etc. Here some of the methods of waste to energy conversion are discussed.

1 PyrolysisProcess

Pyrolysisreferstothethermaldecompositionofamaterialinanoxygen-free orlimitedoxygen environment.The processofthermaldecompositionismodeledafternaturalgeologicalprocessesthatproducefossilfuels.Thermal decomposition breaks down complex polymer molecules into shorter hydrocarbon chains through a process known as depolymerization. Pyrolysisused for PTF (plastic to fuel)conversion involve introducing polymer material into a high temperature chamber ranging between 430-5500C to produce a vapor. Vapors arethencondensedintocondensable (synthetic crudeoil)andnon-condensable(syntheticgas)fractions.Dependingonthe technologyoffering,syntheticcrudeoilmaythenbefractionatedonsite,usuallybywayoffractionaldistillation,into a range of light, middle and heavy distillate fuel oils. If fractionation does not occur onsite, the liquidpetroleum product, typically classified as a light sweet synthetic crude oil, is sold to a refinery for further processing. Secondarybyproductscanincludechar, syngasandwax (Figure2).Outputqualityandquantityfromthepyrolysis processes depends on feedstock (quantity and composition) and the technology.

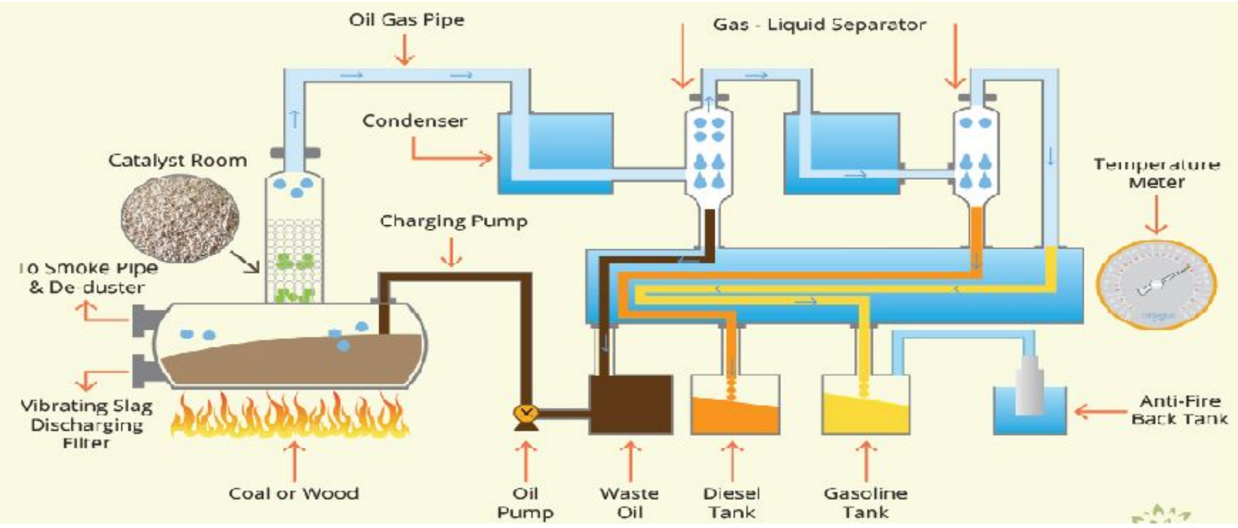

Fig. 2: Pyrolysis Process for Plastic to fuel conversion

2 Catalytic cracking

Catalytic material successfully covert polyolefin into liquefied fuels .The fuels obtained by this technique are of transport fuel grade annulling further requirement of chemical processing and are also eco friendly .most widely used catalyst are zeolite base catalyst like ZSM-%5 ,silica ,aluminum ,basic catalyst like $BaCO_3$,Bimetallic catalyst like Al-Zn composite ,and FCC catalyst .Most the Zeolite type catalyst are used with a ratio of polymer –to-catalyst as 1:1 . This process is advantageous due to lower reaction temperature, faster processing time, shorter residence timing ,and lesser volume requirement of reactor and controlling the formation of the unexpected products than those of thermal treatment without catalyst .FCC catalyst have been employed on an industrial scale in the petroleum refining industry and were developed mainly for cracking heavy oil fraction from crude petroleum into lighter and more desirable gasoline and liquid petroleum gas (LPG) fraction .The feedstock products fall under four major classes of Hcs : Paraffin ,Olefins ,Naphthalene's and Aromatics , (PONA distribution). Gasoline range fuels consist of Paraffin and olefins in the C5-C12 range. Within aromatic products of polyamine, especially polystyrene are group as BTX (benzene, toluene and Xylene)

The main effect of catalyst addition in plastics pyrolysis is as

- The pyrolysis temperature for achieving a certain conversion is reduced drastically and as the catalyst /plastics ratio is increase the pyrolsis temperature can be further lowered .
- More iso –alkanes and aromatics in the C5-C10 range can be produced which are highly desirable gasoline range hydrocarbons .
- The reaction rate is increase significantly.

  Catalyst may decrease the temperature of process, change the selectivity and the composition of the products, they may give more gas products, the catalysts are quickly deactivated and recovering and regeneration of them is not easy.

3 Thermal cracking

In the thermal catalytic cracking the reaction is performed within temperature range of 350 to 8000C and plastic material is degraded in absence of both air/ oxygen and catalyst . Various parameters of the process like type of plastic used ,temperature ,residence time, reactor, heating rate ,operating pressure etc. Gases, light oils ,and char are the main product of process depending on the governing parameter and needs further process to convert it to transport grade fuel like condensation ,hydro-treating , distillation etc. Typical pyrolysis process has some drawbacks like cooking of reactor wall, sticking of plastic to the reactor wall etc .Due to which there is reduction in heat transfer efficiency and reduced yield of bio-oil. Periodic cleaning is mandatory in this case. Thermal cracking process inspresence of nitrogen is called Pyrolysis and similar reaction in presence of hydrogen is called liquefaction.

IV. DISCUSSION

Worldwide the problem of plastic waste pollution is grabbing attention of engineers & environmentalist .land filling & incineration are also not proving that much effective from environment point of view. Plastic is posing serious health hazards among society.

Thermal liquefaction in presence of hydrogen gas can produce more liquefaction hydrocarbons than nitrogen based system. Catalyst cracking followed by thermal liquefaction can facilitate effective conversion of waste plastic to into liquid fuel. Only catalytic process causes production of more chars and wide range of hydrocarbons.

Thermal catalytic process can reduce process temperature .Liquefied and gaseous hydrocarbons can be easily mixed with the catalyst. Hence there is less expenditure on process.

V. CONCLUSION

Based on the reviewed articles of various application and technologies, it can be inferred that thre is potential advantage of converting waste plastic in to fuel. it can effectively reduce the hazardous impart of waste accumulation on the earth .thermal catalytic process is having potential of effective conversion of waste plastic to fuel. Various types of catalyst can be found effective in converting waste plastic to desired fuel category.

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