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Energetically Favorable Municipal Solid Waste Management in Indian Cities- A Proposed Management Strategy

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Abstract—*Improper management and disposal of municipal solid waste (MSW) is a major environmental concern today. Methodologies currently employed for solid waste management are either unscientific or almost inefficient. Besides, such outdated technologies often inflict serious health hazards on the local community.*

With an eye on solid waste treatment together with renewable fuel generation, the current study proposes the conversion of segregated plastic waste into pyrolysis oil. It further investigates the feasibility of coupling microalgae cultivation with the leachate and waste water (serving as nutrients for microalgae) generated during the process. The remaining biodegradable wet waste thereby derived would be ideal for composting and biogas production. The aforementioned process begins with pre-screening which involves metallic-nonmetallic separation through magnetic separator. The waste line is then directed to a trommel screen to obtain wet and dry waste streams. The dry waste can be further subjected to air density separation for removal of certain inert components. Efficient segregation of plastics and rubber tires is a must for they find value in pyrolytic treatment for oil production. Activated carbon/ tar is generated as a byproduct of the pyrolytic reaction which itself finds multiple uses in the industry. An energetically favorable waste management is therefore proposed for sustainable development that incorporates maximum resource recovery in a cyclic process. The study ponders over the efficiency of the process which the local authorities may find encouraging enough for the adoption of the technology in this regard.

Keywords*: Municipal solid waste, Pyrolysis, Microalgae, Biogas, composting.*

1. INTRODUCTION AND BACKGROUND

With rapid economic growth, massive urbanization and rise in community living standards, acceleration in the municipal solid waste (MSW) has been witnessed. Every year, about 55 million tonnes of municipal solid waste is generated in the metropolitan cities of India **[1]**. The composition of MSW streams varies depending upon socio-economic factors, geographical locations, climate, population density and level of industrialization. In addition, it is estimated increase in waste generation in India will increase at a per capita approximately 1 to 1.33 percent annually **[2]**. Accumulation of solid waste with higher biological stability of long-term emission potential is one of the major problems faced by many developing countries. Several Asian cities are facing serious problems in solid waste management practices including severe water and air pollution. The MSW amount is expected to increase significantly in the near future and therefore needs proper attention for collection, transportation and disposal. Energy generation from waste appears promising considering its immense potential to generate jobs in rural and urban landscapes especially for the youth. For efficient collection of waste, cooperation among municipal corporations and NGOs/CBOs/RWAs is mandatory **[3]**. The separation of plastic and tires can also be done manually from the dry waste. Municipal corporation must appoint the multiple vehicles for waste collection. Tipping fee must be determined by the urban local body or any state agency authorized by the state government to be paid for every unit collection of segregated waste. This is necessary as segregation of waste is one of the most important parameter for its efficient utilization. Organic fraction of MSW after composting gives organic fertilizer which has no harmful effect on human beings and environment. The two stage thermophilic-mesophilic digestion process for biogas production process is very helpful to remove pathogens from MSW, and efficient biogas production **[4]**. Even waste water is being utilized for cleaning the inert material present in the waste before dumping into the environment. The waste water effluent is then being used for microalgae production. Micro algae have high lipid content in it and can be used for biodiesel production. Micro algae are also being utilized as high protein nutrient supplement for medicinal purposes **[5]**. Pyrolysis byproducts oil and carbon black/tar has its own industrial value and can be used as a replacement of diesel in electric generators, boilers, diesel pumps, furnaces etc. Use of rotary drum for composting provides ease of operation, higher efficiency and lower retention time **[6], [7]**.

2. MATERIALS AND METHODS

Segregation of MSW is done on the basis of the physical properties i.e., size, density, etc. The metallic waste is separated through a magnetic separator and can be directly sent for sale. The screened material is fed to the trommel mill for drying and the wet waste is transferred to the composting/biogas plant. Composting is done using rotary drum composter. Biogas production is being achieved by multi stage anaerobic digestion process in which thermophilic and mesophilic conditions are achieved separately in different reactors. The dry waste can be further screened using air density segregation to remove inert particles. The inert material that is collected contains some sticky organic fractions that are removed using pressurized waste-water spraying. The leachate produced is transferred to a leachate collection tank. The leachate and waste water effluent pipeline is connected to algal bioreactor. Thereby pyrolysis of the plastic is to be performed at 400-500°C for 90 minutes in oxygen free environment. The overall project proposal is given in figure 1.

3. RESULTS AND DISCUSSION

The final product of the overall process provides us with metallic scrap, pyrolysis oil, compost, biogas, microalgae and treated water. Metallic scrap segregated can be sold in the market for recycling. The pyrolysis is a proven process that can directly convert the plastic and tires to pyrolysis oil and other valuable by-products. The pyrolysis oil has characteristics comparable to diesel and has high market value. In this process, the plastics and tires are subjected to high temperature. The main product of pyrolysis are pyrolysis oil and carbon black. Pyrolysis oil can be used as a replacement of diesel after blending. The solid by product from pyrolysis gives small amount of tar/carbon black.

Compost acts as a very good soil conditioner. Energy can be recovered from the organic fraction of waste as biogas or the wet solid can be directly converted to compost which has a high NPK value. Anaerobic digestion is another biological eco-friendly process for conversion of organic biomass into biogas. Biogas has high calorific value and can be used for generating electricity. Co-digestion of MSW with cattle dung helps to achieve the biological process in less time and with higher efficiency. In both the processes the MSW is mixed with cattle dung to achieve a high degree of bioconversion to valuable product. Biogas can be utilized for cooking and generating electricity. Biogas is a renewable source of energy which is very much handy when fossil fuels are depleting. Microalgae can be used for biodiesel production and also as a nutrient source in many pharmaceutical industries. The treated water can be used for domestic and irrigation purposes.

4. CONCLUSION

With increase in technological advancement, industrialization and rise in living standards, a large amount of energy is required. Environment problems are also increasing at an alarming rate. Sustainable energy management is therefore need of the hour. MSW as a source of energy promises a huge potential which can sustain world energy needs. Cost effectiveness issue can be reduced by coupling of multiple processes together to generate minimum waste. This would be helpful in reducing diseases and environmental hazards. Co-utilization of different components of MSW can leads to multiple benefits- firstly energy production in terms of pyrolysis oil and microalgal fuel, secondly environmental cleaning as well as waste utilization and revenue generation from waste. This technology is both environments friendly and economically viable.

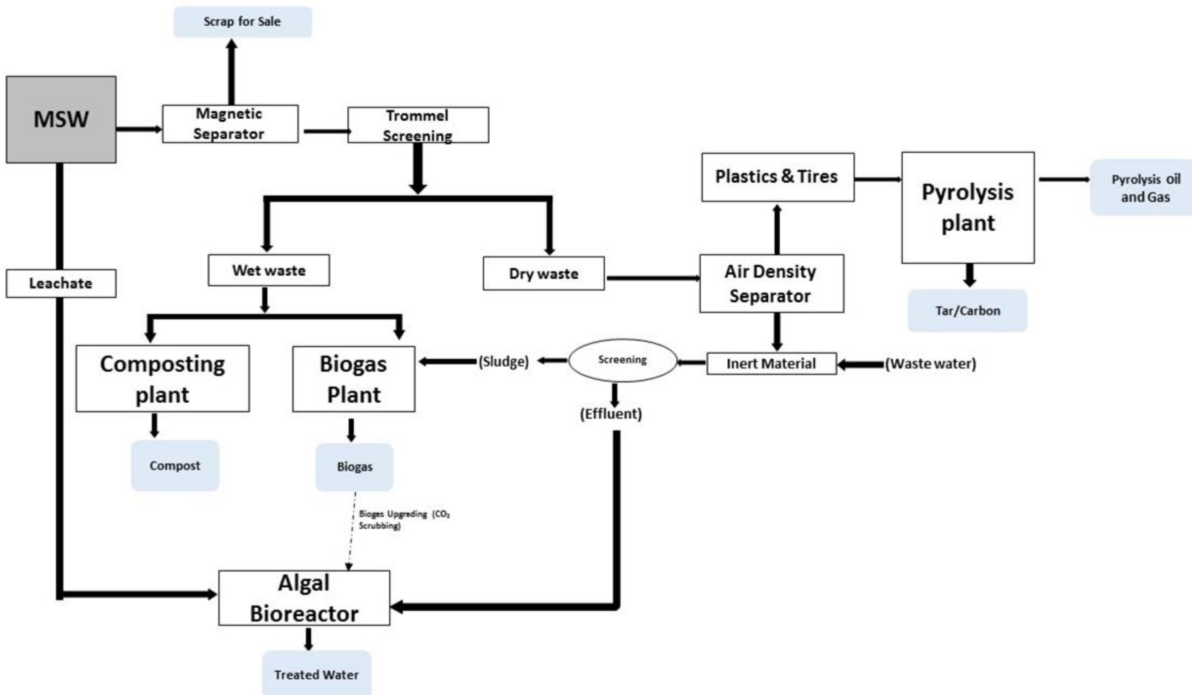

Fig. 1: Schematic illustration of the proposed project

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