DESIGN AND FABRICATION OF MUNICIPAL SOLID WASTE (MSW) TREATMENT MODEL FOR THE RECOVERY OF CLEAN ENERGY

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Keywords

'Waste to Energy', 'MSW', 'Pyrolysis', 'WtE', 'Fast Pyrolysis'

Introduction

Solid waste management is a global issue which has been affecting lives and the environment. Globally, most waste is currently dumped or disposed of in some form of a landfill. Projected waste generation is expected to be 2.59 billion tons by 2030 and 3.40 billion tonnes by 2050.Rapid industrialization and urbanization, population explosion, and economic growth in India led to the migration of people from villages to cities, which resulted in thousands of metric tons of MSW generated daily. A developing country like India relies on deficient waste infrastructure, the informal sector, and disposal of wastes, and therefore has issues in the waste management industry, including waste legislation, waste technology selection, and the availability of adequately qualified workers along with a lack of consciousness, unsuitable technical expertise, insufficient finance, and lack of responsibility. The optimum solution for MSWM is waste segregation combined with energy and biogas recovery, according to experts. Waste to energy (WtE) methods prevent the potential loss of resources from MSW, which hurts the environment and the economy. The promising WtE conversion technologies are thermal conversion methods (incineration, pyrolysis, and gasification), biochemical conversion, and landfill. Incineration is an established waste treatment technology around the world, although it has a low success rate in India. Several initiatives in India have failed due to the deployment of waste-to-energy technologies from China, Europe, and other nations without adaptation to Indian conditions. As a result, a holistic approach to MSWM is required.

Objective

(a) Life cycle assessment, challenges and resource recovery from Municipal Solid Waste
(b) Analysing energy supply chain of Municipal solid waste
(c) Design and Fabrication of MSW Treatment model for the production of Clean Energy

to ameliorate Global Warming

(d) Efficiency study of the designed model and its applications in the management of municipal solid waste

Methodology

(a) A systematic review of the existing literature on the life cycle of Municipal Solid waste, the challenges with respect to it and assessment of the kind of resources that can be extracted from it.

(b) Analysis and thorough study of the energy supply chain of MSW i.e., from the obtainment of waste to, waste getting converted into energy.

(c) A simulation model will be created to show the working of the proposed model followed by the fabrication of the proposed model

(d) The final step is to prove the efficiency of the model and the energy while focusing on its applications in the management of waste and different fields.

Results and Conclusion

The The MSW feedstock breaks down in the reactor with constant heating; then gets converted to thermal energy, the thermal energy becomes the producer gas which later condenses into bio-oil. 1000 grams of Municipal Solid waste composed of Biomass, Plastic, and Paper was fed through the waste inlet and 200 ml of bio-oil, approximately 365 ml of producer gas, 435 grams of Char was observed as an output with 241 grams as residue.
The thermal efficiency of the reactor was calculated by –

$\eta_{Rth} = 1 - \theta_p/\theta_r * 100$

Where η_{Rth} is the reactor thermal efficiency, θ_p is the Product temperature, θ_r is the Reactor temperature. After considering the various values of product and reactor temperature, the average thermal efficiency of the reactor was calculaed to be **92.61%.**
The noted reasons for a thermally efficient system were also the dimensions of the condenser. The condenser measured about 31cm in length and 20cm in diameter usually a larger dimension for a condenser relatively which could hold up to 6 times more coolant than a normal condenser. Due to which it helped in converting the vapors into a liquid state quickly and also kept the coolant's temperature a little above the room temperature and letting it recycle for the entire process.

Conclusion:

The world is currently facing several environmental challenges due to municipal solid waste generation and inadequate waste collection, transportation, treatment, and disposal due to the inefficient current systems, policies and technologies. The obstacles and challenges are enormous, but so are the opportunities. One such opportunity is to convert MSW into various energy forms, using different technologies. Pyrolysis was one of the most popular technologies among the others because it is likely to be more cost-effective and environmentally friendly. Pyrolysis is the process of converting biomass (in this case, MSW)

into bio-fuel, char, and producer gas without the use of oxygen. Pyrolysis of MSW was chosen for energy recovery for the project, so a pyrolysis model was designed and developed that includes main components such as a pyrolysis reactor (MSW is heated in the absence of oxygen) and a condenser (condenses vapours into bio-oil). The efficiency was found to be such that with every 1000gm of MSW input, 200ml of bio oil was produced, and the average thermal efficiency was found to be 92.61%. Bio-oil, char, and producer gas were the end products of the trials conducted with the model. Bio-oil, on the other hand, must be filtered, processed/further treated for using in different applications. Further treatment of bio oil can provide products like – Chemicals, Transport fuels/blends, Heat. Some literature also considers bio-oil as a potential replacement for diesel since it has characteristics similar to diesel; It can mostly be used in low speed diesel engine with relatively high compression ratios but blending the bio-oil with methanol could be used in high speed engines.

Future Work

The visual As per realistic estimates, potential of waste to energy projects in India can produce 32,890 tons of RDF each day which can currently support 88 power plants of 5 MW each in a foreseeable future of 5-7 years based on incineration, gasification or pyrolysis technologies. The existing model provides energy in the form of bio-oil from the pyrolysis of MSW. Although the bio-oil is obtained, the further treatment, storage, better safety and further applications paves way for further studies. There is a lot of research and development(R&D) opportunities that exist mainly focusing on how to further increase the resource recovery potential by targeting biofuel market. These R&D opportunities represent technologies that could be implemented in next generation MSW processing models or facilities, but they require further development or risk reduction before being adopted by industry. Production of biofuels and bio products from these MSW feedstock are both promising and at a much earlier stage of technological development – which provides future scope of how to utilize the obtained bio oil.