International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 7, Issue 1, January 2018)

RDF Is Best Technology for Generation of Electricity

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ABSTRACT-- The increase in socio-economic condition during the past ten years has also significantly increased the amount of solid waste generated. The growing amount of municipal solid waste (MSW) and the related problems of waste disposal urge the development of a more sustainable waste management practice. Waste-to- Energy (WTE) technologies – recovering energy in the form of electricity and/or heat from waste are being developed worldwide. The thermo chemical technologies for energetic valorization of calorific waste streams (WTE), with focus on refuse derived fuel (RDF) a processed form of municipal solid waste (MSW). The basic principles of the available technologies and process details of some specific technologies are summarized. Technologically advanced processes (e.g. plasma gasification) receive more attention, with particular focus on the potential for energy recovery (WTE) and material recovery (WTE). The review concludes with an argumentation of the advantages of processing RDF as opposed to MSW, and a comparison between the different technologies, stressing factors affecting their applicability and operational suitability[1]. A comparison of different parameters affecting Waste to Energy technology and a state-wise comparison was conducted along with comparative study of waste-to-energy plants in Jabalpur.

I. INTRODUCTION

Waste disposal is one of the vital problems. Millions of tons of municipal solid waste, hazardous/industrial wastes and agricultural wastes are handled daily throughout municipal areas. Each municipality confronts great challenges in disposing of its wastes in an efficient, cost effective and environmentally safe manner. Landfills in metropolitan areas are becoming full, and new ones are more difficult to open. Failure to effectively deal with these waste disposal problems could significantly impact the country's economy as well as the health and welfare of its people. Population growth creates waste disposal problems thus inadequate waste disposal creates health and environmental problems. Per capital solid waste disposal will continue to be high in municipal areas. Solid waste landfills are becoming a mounting problem – creating space limitations and significant health concerns[2]. In addition, the disposal of municipal solid waste (MSW) has become a critical and costly problem. The traditional landfill method requires large amounts of land and contaminates air, water and soil. Energy is one of the most basic of human needs and it drives human life and is extremely crucial for continued human development. Throughout the course of history, with the evolution of civilizations, the human demand for energy has continuously risen.

The accomplishments of civilization have largely been achieved through the increasingly efficient and extensive harnessing of various forms of energy to extend human capabilities and ingenuity. Providing adequate and affordable energy is essential for eradicating poverty, improving human welfare and raising living standards worldwide. The global demand for energy is rapidly increasing with increasing human population, urbanization and modernization. The growth in global energy demand is projected to rise sharply over the coming years and as such the world heavily relies on fossil fuels which are limited to meet its energy requirements. Therefore, other forms of energy which are sustainable need to be found. Energy is the driving force for development in all countries of the world[3]. The increasing clamour for energy and satisfying it with a combination of conventional and renewable resources is a big challenge. Another concern is that of urban waste accumulation. The rapid increase in population coupled with changing lifestyle and consumption patterns is expected to result in an exponential increase in waste generation of upto 18 billion tonnes by year 2020. While Indian urban growth has mushroomed, provision of urban services and amenities has fallen short, with the resultant urban sprawl giving rise to increased energy demand and environmental degradation. Therefore there is an urgent need to fulfill the energy requirements and to manage the waste that had been produced. Simultaneous solution to both the problems is Waste-to-Energy Technology. This work focuses on Waste-to-Energy scenario in India with a detailed study of Waste-to-Energy plants in the capital city Jabalpur. It also overviews the techniques used for obtaining energy from waste along with evaluating the environmental, technical and socio-economic performance of the technology. Different types of waste-to-energy projects along with their working status in different states and union territories of the country, and the differences in their input and output units are described in the present paper.

1.1 Status of Municipal solid waste (MSW) in India

In 2016 India generates 68.8 million tons / Year (1, 88,500 tons per day (TPD) of MSW at a per capita waste generation rate of 500 grams/person/day [23]. The rate of increase of MSW generated per capita is estimated at 1 to 1.33% annually. The per capita generation rate of MSW in India ranges from 0.2 to 0.5 kg/ day. Projected MSW quantities are expected to increase from 34 million tonnes in 2000 to 83.8 million tonnes in 2015 and 221 million tonnes in 2030.

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India generates about 62 million tonnes of Municipal Solid Waste annually, out of which, 82% is being collected and the remaining 18% is littered; out of the total collected waste, only 28% is being treated and disposed.

1.2 Waste-to-Energy in India

The objective of WTE combustion is treating MSW to reduce its volume and generating energy and electricity during this process. In India installation of various WTE plants has been witnessed in the recent past and several projects are known to be under pipeline. In India total 48 WTE plants are present including 32 proposed, 4 under construction and 11 are in operation as presented in Fig. below. One of the plants is shutdown due to some technical problems in the plant[4].

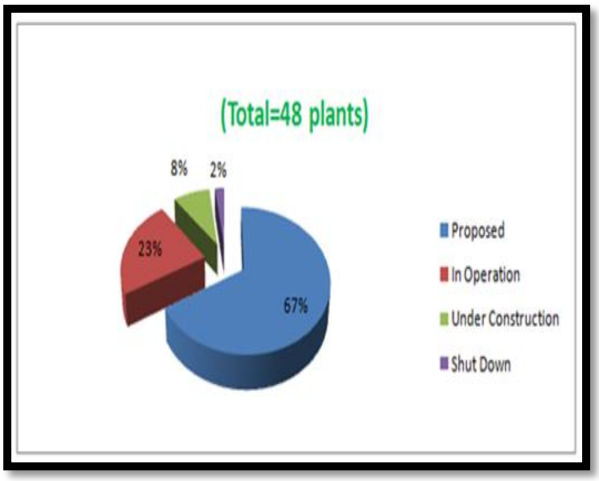

Figure 2: Status of WTE Plant in India [11]

1.3 Refuse Derived Fuel (RDF)

The purpose of the waste to RDF facilities is to produce improved solid fuel or pellets from waste which can be used for energy production by thermal combustion of RDF or as a cheap and efficient fuel in Industries and it can also be fired along with the conventional fuels such as coal.

RDF facilities can relieve the pressure on the landfills [8]. But operation of such thermal treatment systems involves higher cost and expertise [9]. High metal concentration in the RDF is a major problem which is encountered, which makes it essential to pretreat the waste. The RDF generation involves dehydration, shredding and palletization, which require a separate site, increasing the operational cost of the RDF facility.

1.4 Total Potential of MSW in Jabalpur City

Jabalpur is one of the four major cities in Madhya Pradesh (India) with a population of approximately above 24 lacks produces 1, 59,826 tons per annum and 600 tons per day of MSW.

This waste is disposed by open dumping site at the Ranital dumping site MSW problem is a major concern in major cities Jabalpur. The organic fraction of solid waste composition comprised about 71%. The waste generation rate has increased from 0.23kg/capita/day in 2004-05 to 0.50 kg/capita/day (500 g/c/d) in 2015 indicating an increase rate of 3.8% per year. MSW is the waste generated in a community with the exception of industrial and agricultural wastes. Hence MSW includes residential waste (e.g., households), commercial (e.g., from stores, markets, shops, hotels etc), and institutional waste (e.g., schools, hospitals etc). Paper, paperboard, garden and food waste can be classified in a broad category known as organic or biodegradable waste [5]

II. Materials And Methods

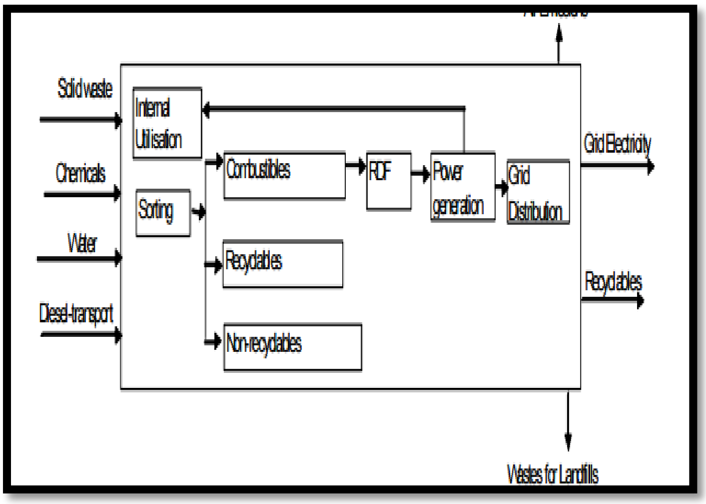

Figure 13: System boundary for the production of grid electricity

i) Combustion of RDF in Incinerator

First, MSW must go through pre-processing and prepare RDF to optimize its composition for efficient burn. After pre-processing, the RDF is sent to a "flame zone", in which it is broken down by flame into volatile molecular components. This process is highly endothermic, and many modern incinerators use energy recovery from later exothermic processes to help generate the energy for the pyrolysis to minimize the amount of new energy needed[6]. After the compounds have been broken before we begin the analysis of the incineration plant, it is imperative to understand the technology behind the various thermal treatment options for MSW.

ii) Energy Recovery

Most of the MSW incineration currently practice energy recovery in the form of steam, which is used either to drive a turbine to generate electricity or directly for heating or cooling.

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In the past, it was common to simply burn MSW in incinerators to reduce its volume and weight, but energy recovery has become more prevalent.

In waste-to-energy (WTE) plants, heat from the burning waste is absorbed by water in the wall of the furnace chamber, or in separate boilers. Water when heated to the boiling point changes to steam. At this point, the steam is used either for heating or to turn turbines to generate electricity. The amount of energy recovered from waste is a function of the amount of waste combusted, energy value of the waste stream and the efficiency of the combustion process[7]. The three basic types of waste-to-energy incineration are:

iii) Computation of Energy potential

Total MSW produce in Jabalpur city per day = 600 tons

Conversion efficiency MSW to RDF =60%

Total RDF production per day = 600 x 0.60 = 360 tons

Two methods applying for computation of Energy potential

1. Dulong's Formula
2. Net Calorific Method

i) Dulong's Formula: Heat Energy (Dulong's Formula) to calculated heat energy generated from RDF: The heat value of waste is directly proportional to the carbon content of the waste and inversely proportional to the ash and moisture content. The heating value of wastes can be calculated by using Dulong's *formula*:

Dulong's formula: HV (KJ/Kg) = 337(C) + 1419 (H_2 – 0.125O_2) + 93 (s) + 23(N)

ii) Net calorific Value method: Evaluation of Potential of Energy Recovery options from Jabalpur MSW considered here is incineration of RDF (Refuse Derived Fuel Fluff / Pallets). A rough assessment of the potential of recovery of energy from smaller size of the constituents aids in faster decomposition of the waste. Wastes of the high density reflect a high proportion of biodegradable organic matter and moisture. Low density wastes, on the other hand, indicate a high proportion of paper, plastics and other combustibles.

Net Power generation potential (KW) = 0.012 x NCV x W

III. Result And Discussion

Analysis of power generation potential and environment effects after the RDF production are defined below through Dolong's Formula for steam generation method and net calorific method for direct combustion method. The current operating Plant capacity is 11.5 MW under construction using direct dry MSW.

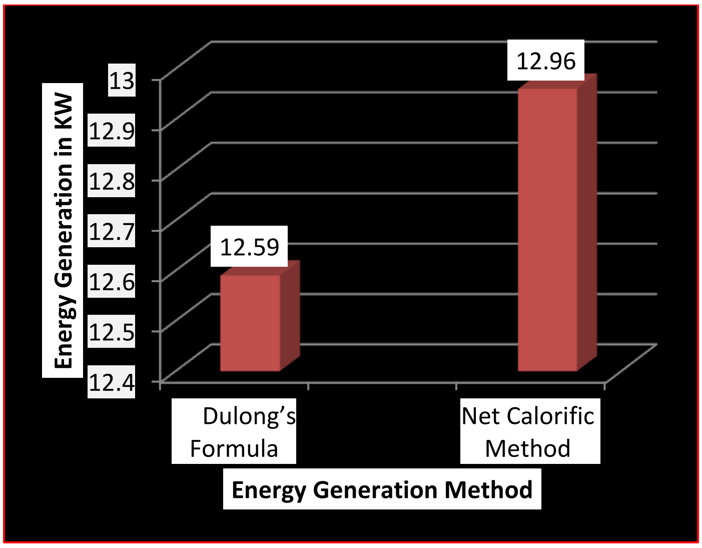

Figure 20: Graph show Power generation Potentials of two methods

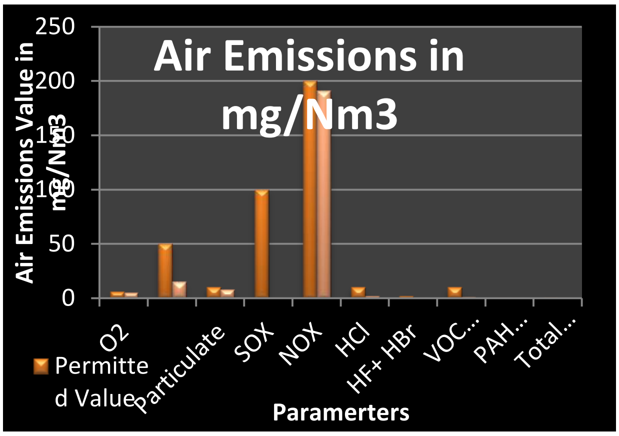

Figure 21: Graphs shows the air emission between permitted value and Expected Value

IV. Conclusion

An extensive economic analysis of an MSW management option has been carried out to evaluate the feasibility of integrating RDF production to RDF-to-energy facilities under current MSW generation in Jabalpur (M.P.). The economic feasibility of RDF-to-energy plant has been investigated by carrying out a capacity analysis as well as evaluating energy generation and also reduces the environmental impact. Sensitivity analysis of total air emissions in environments. The analysis showed that, with technological option considered, up to 12 MW power plant has attractive return on investment.

Under this scenario, majority of MSW will still be disposed of in landfills. Hence, environmental benefit is not realized to the full. To gain considerable environmental, social and economic benefits such as reduction of need for new landfill sites, prolonged existing landfill sites, clean air and less underground contamination, lower chance of disease spreading, new business and employment for recycling, government subsidies for the RDF to-energy project may be offered. These can be in terms of subsidized credits, partial public funding, etc. considering its social relevance in the framework of government waste management policy.

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