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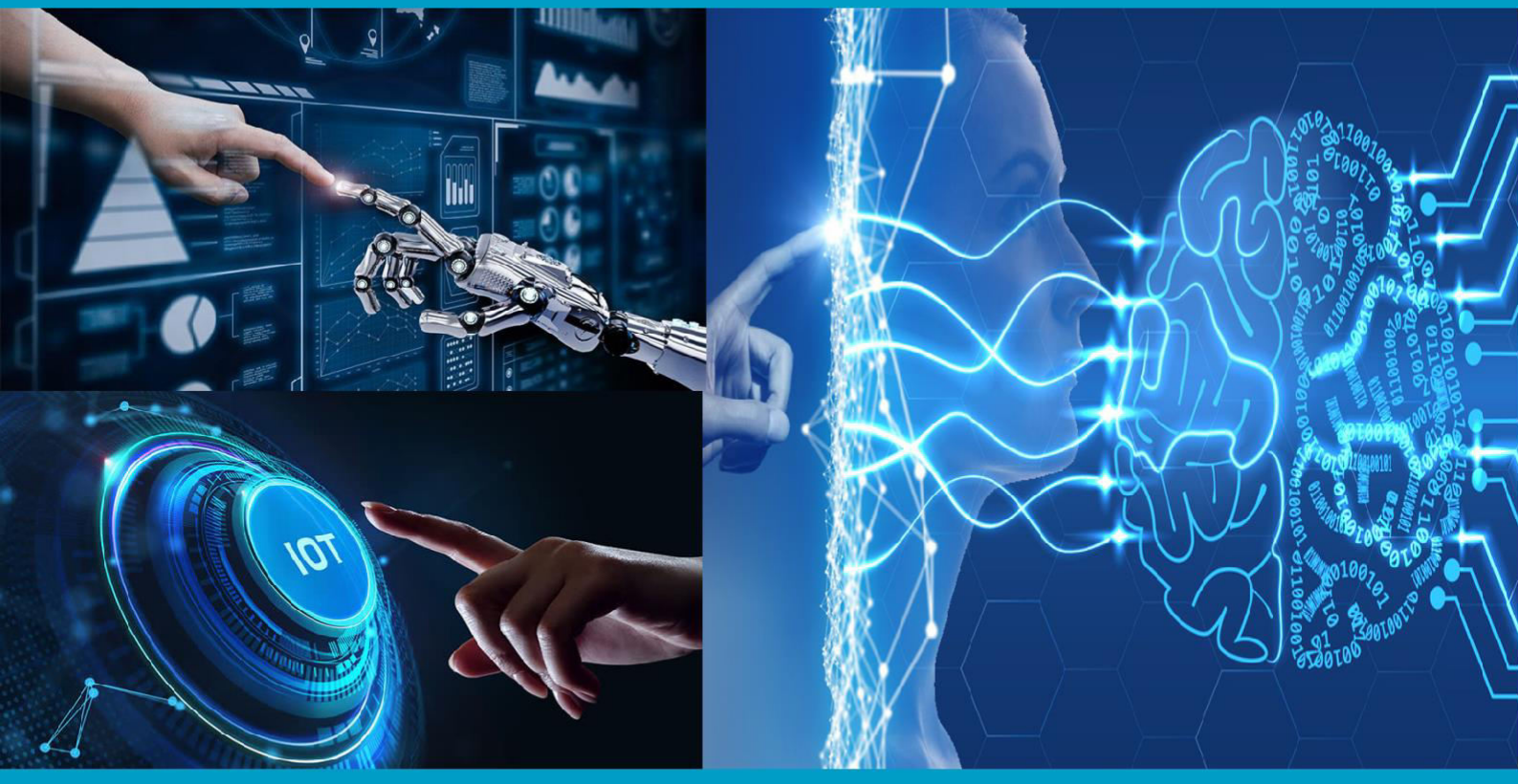

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Refuse Derive Fuel

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ABSTRACT- If we focused on solid waste management (SWM) the waste produced was collected and dump in dump yard which causes many environmental pollutions and health hazards. In solid waste management land filling is a major problem. Many difficulties arise while extending the land for land filling. In order to overcome those problems Refuse-Derived Fuel (RDF) is one of the best options. Refuse-Derive Fuel is obtained from municipal waste and it is one of the alternative fuels. It is the process of converting waste into useful energy. By doing so the problem with solid waste management get reduces and RDF can be substituted for coal in boilers. This project deals about the manufacturing and application of RDF in India. The production of RDF involves several steps, including bag splitting/shredding, size screening, magnetic separation, air classifier (density separation), coarse shredding, and refining separation by infrared separation.

KEYWORDS: Refuse Derived Fuel (RDF), Solid Waste Management (SWM), Alternative fuel.

I. INTRODUCTION

At present municipal solid waste (MSW) in India is generally unsegregated with high moisture content, low calorific value, odour and a wide range of particle size. According to a planning commission task force report in 2014,1 of the 62Mt of MSW generated in urban India, 12Mt is combustible fraction which can be potentially converted into refuse-derived fuel (RDF), thereby replacing 8Mt of coal. Currently, more than 30 per cent of India's population live in cities and this figure is projected to rise to 50 per cent by 2050. To dump 62Mt of MSW without treatment, 1240ha per year of precious land is required. With a projected MSW generation of 165Mt by 2031, the land requirement for creating landfill space for 20 years (considering a 10m-high waste pile) could be 66,000ha. Until the reporting year 2013-14 of the Central Pollution Control Board (CPCB) study,2 there are 22 RDF plants in operation. A CPCB study in 20163 revealed that presently 90 per cent of MSW is collected and 25 per cent is processed or treated. Urban local bodies spend about 60-70 per cent of total expenditure on street sweeping, 20-30 per cent on transportation, and less than five per cent on final disposal of waste.

The objective of Prime Minister Narendra Modi's 'Swachh Bharat Abhiyan' or 'Clean India Mission' is to achieve 100 per cent scientific management of MSW in selected towns across the country. To deliver on the promises of this mission, RDF production and RDF utilisation in the cement industry offers a sustainable waste management option.

The principle of RDF production is recovering quality fuel fractions from the waste, particularly through the removal of recyclable particles such as metal and glass, and converting the raw waste into a more usable form of fuel with uniform particle size and higher calorific value than raw MSW.

Refuse derived fuel (RDF) is produced from domestic and business waste, which includes biodegradable material as well as plastics. Non-combustible materials such as glass and metals are removed, and the residual material is then shredded.

Waste-derived fuels can include fossil fuels such as waste oil, plastics, or solvents; biomass such as dried sewage or impregnated saw dust; or fractions of both fossil fuels and biomass such as municipal solid waste or tires.

The SWM Rules 2016 in India defines RDF as "fuel derived from combustible waste fraction of solid waste like plastic, wood, pulp or organic waste, other than chlorinated materials, in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting of solid waste".

RDF consists largely of combustible components of such waste, as non recyclable plastics (not including PVC), paper cardboard, labels, and other corrugated materials. These fractions are separated by different processing steps, such as screening, air classification, ballistic separation, separation of ferrous and non ferrous materials, glass, stones and other foreign materials and shredding into a uniform grain size, or also pelletized in order to produce a homogeneous material which can be used as substitute for fossil fuels in e.g. cement plants, lime plants, coal fired power plants or as reduction agent in steel furnaces. If documented according to CEN/TC 343 it can be labeled as solid recovered fuels (SRF).

- **To Produce Electricity**: RDF can produce electricity in power plants. The waste is burned, and the heat generates steam. The steam turns into a turbine, which produces electricity.
- **To Produce Heat**: RDF can also produce heat. The waste is burned, and the heat generates steam. The steam can then be used to heat buildings or for other purposes.
- **To Make Cement**: RDF can make cement. Waste is burned, and the resulting ash produces cement.
- **To Replace Fossil Fuels:** RDF can act as an alternative to fossil fuels, which are non-renewable resources that produce greenhouse gas emissions.

Materials Used in RDF:
Several materials can create RDF. The most common materials include:

1. Municipal Solid Waste (MSW)
MSW is the waste material collected from households and businesses. This can include paper, cardboard, food waste, metals, plastics, and other types of refuse.

2. Construction and Demolition Waste (C&D)
C&D waste is produced when buildings or other structures are demolished. This can include concrete, wood, drywall, asphalt, and other materials.
3. Industrial Waste
Industrial waste includes materials like metal shavings and scrap plastics from factories.

Advantages of Using RDF:
There are many benefits to using RDF, including its ability to reduce greenhouse gas emissions and increase energy security.

1. Reduced Greenhouse Gas Emissions.
RDF helps to offset fossil fuel consumption by reducing greenhouse gas emissions. This can help to mitigate climate change and carbon emissions.

2. Increased Energy Security
In a world with a declining reliance on fossil fuels, RDF can help to ensure access to essential energy resources. This makes it a necessary resource for countries that depend on imports for their energy needs.

3. Sustainability and Environmental Benefits
By diverting waste from landfills, RDF reduces the need for new landfill space to dispose of trash. This helps to protect the environment and promote sustainable waste management practices.

II. LITERATURE REVIEW

[1] Refuse Derived Fuel to Electricity (2013)
If we focused on solid waste management (SWM) the waste produced was collected and dump in dump yard which causes many environmental pollutions and health hazards. In solid waste management land filling is a major problem. Many difficulties arise while extending the land for land filling. In order to overcome those problems Refuse-Derived Fuel (RDF) is one of the best options. Refuse-Derive Fuel is obtained from municipal waste and it is one of the alternative fuels. It is the process of converting waste into useful energy. By doing so the problem with solid waste

management get reduces and RDF can be substituted for coal in boilers. This paper deals about the manufacturing and application of RDF in India.

[2] Assessment of Municipal Solid Waste Management in Kochi City (2021)

Considering the case of Kochi City (Ernakulam, Kerala), Solid waste management is a major issue. Improper Management of MSW (Municipal Solid Waste) leads to air, water and soil pollution. Kochi City have been facing issues related to the collection, treatment and management of solid waste. Therefore, there is an urgent need for an improved planning and implementation of comprehensive solid waste management system for upgrading the environmental scenario of the city. For proposing an Integrated Solid Waste Management system in the city, primary and secondary data were collected. Also physical and chemical analysis of the waste, population forecasting of Kochi city were conducted. All the main problems related to the waste management are identified. Assessing the main problems and considering all the alternatives, recommendations in each stage for the MSWM are suggested. This paper suggests an integrated municipal solid waste management plan for Cochin City. Future studies should be carried out for checking the efficiency of the proposed methods. This study introduces various alternatives for the MSWM. The most economical and viable methods can be used for treating the waste from the city. The physical and chemical characterization of the waste indicates that the wastes are rich in biodegradables and plastics. The population forecasting details show that the waste produced in the future years are much higher and it keeps on increasing. Through the combined efforts of individuals from household and a proper MSWM system, Kochi city will be able to dispose waste generated and in future, piling up of legacy waste can be avoided.

[3] Solid Waste Management: A Case Study of Nagpur City (2022)

The objective of this paper is to examine the waste management of Nagpur city. Nagpur is one of the largest market place in India with population of 24, 05, 665 NMC has divided Nagpur in total of 10 zones for proper administration. Due to factors like industrialization and urbanisation it is the fastest growing city leading to increase in waste generation. This present case study aims to analyse current MSW management practices and its status and it also discusses the issues related with collection, transportation, treatment and disposal. The goal of this study is to help in minimizing the waste generation and to reduce its impact on humans. It also suggests ways to improve the administration of NMC. It is discovered From December fifteen to thirty one of the year 2021, the town generated over 21,100MT garbage. Out of this, around 12,700MT mixed garbage has been transported and droped at Bhandewadi. This means, around 55% people are still handing over the mixed garbage to non-public agencies engaged in door-to-door trash collection. The NMC has not been able to accomplish the goal of stopping waste merchandising in Bhandewadi. Atomic number 47 surroundings has collected 10,459,41MT garbage from Laxmi Nagar, Dharampeth, Hanuman Nagar, Dhantoli andstatesman Nagar zones. Rather than lifting solely divided garbage, it transported largely 6,067. 09MT mixed garbage. BVG India, that provides services in Gandhibagh, Satranjipura, Lakadganj, Ashi Nagar and Mangalwari zones, collected 6,635.16MT mixed garbage out of totalten,689.02MT. Of the 1,567 trips, it created 978 journeys with mixed garbage that is discarded at Bhandewadi.

[4] Waste to Energy Solution in Antiquity and Ibadan (2014)

Waste to energy solution, the technology that converts municipal solid waste to energy has been discussed by several ancient and modern scholars. Several other authors have identified the types of waste as well as energy derived from such wastes, the various types of processes and the consequences of waste to energy technology in some other countries. This study examines waste to energy solution in antiquity, and proposes a modern equivalence for the sprawling metropolis of Ibadan. The paper further argues that turning waste to energy has environmental and health implications for the society. The argument being put forward in this discourse is that since ancient Greeks and Romans could take recourse to renewable energy, albeit in a rudimentary manner devoid of modern technology, it is therefore pertinent that this technology, which has become modern, be adopted to address the waste problem of Ibadan, and provide renewable energy from waste for the city. Further studies may examine how the technology can be adopted and simplified for individual personal structures, and other parts of the country. The idea of converting waste to energy may have been borne out of man's desire to move from one stage of development to another. This stage is to discover and invent methods to solve the problem of air pollution that cause diseases as a result of accumulated and decomposing waste. Therefore the theory of social development explains this phenomenon.

[5] Energy Efficient Refuse Derived Fuel (RDF) From Municipal Solid Waste Rejects: A Case For Coimbatore (2014)

In this paper production of energy efficient Refuse Derived Fuel (RDF) from municipal solid waste rejects was carried out during August 2012 – April 2013 in Coimbatore City India. Municipal Solid wastes rejects (paper, plastics with exception of polyvinyl chloride, textiles) were collected from waste dump yard of Coimbatore City. Sawdust, coir dust, water hyacinth and rice husk were mixed with the collected wastes at a fixed amount of 20 percent. After grinding, cassava starch was used as a binder to produce RDF briquettes with the help of uniaxial piston briquettes making

machine. Physical, chemical and thermal characteristics of the RDF were studied to assess their potential use as energy efficient material. The analyses were divided into three categories namely, physical, proximate and ultimate analyses. Results indicated that, under physical and proximate analyses; impact resistance index (IRI) for all the RDF samples were 200, density were less than 1 kg cm3, moisture were less than 10 % wt, ash content varied from 2.8 to 9.2 % wt, whilst volatile mater had mean value of 83.1 % wt and fixed carbon which is by subtraction ranged from 1.4 to 9.2 % wt. With respect to Ultimate analysis, Oxygen, carbon, hydrogen varied from 27.01 to 39.78 % wt, 44.8 to59.7 % wt, 5.9 to 8.1 % wt respectively. On the other hand nitrogen, sulfur and chlorine ranged from 0.18 to 0.87 % wt, 0.27 to 0.71 % wt and 0.339 to0.521 % wt respectively. Calorific values (high heating values) ranged from 5085 to 6474.9 kcal kg-1 . The results were compared with Energy research Centre for the Netherland database and noted that with exception to moisture, fixed carbon and hydrogen other parameters had a significant lower or higher differences. From the study, RDF from municipal solid wastes rejects along with the additives produced high energy efficient materials.
Keywords: Municipal Solid Waste, Waste to Energy, RDF, Calorific value.

III. PROPOSED METHODOLOGY

3.1 MANUFACTURING PROCESS

Municipal solid waste (MSW) is processed through five important steps for manufacturing Refused Derived Fuel. The major steps involve preliminary liberation, size screening, shredding, magnetic separation and Pelletizing.

A. Preliminary Liberation: Preliminary liberation involves separating the municipal waste into Bio-degradable, Glass, Rags, Paper, Plastic, Leather and Rubber, Metals and other domestic hazardous, Inert. Form those to manufacture RFD the main particles involves Bio-degradable, Paper, Plastic, Leather and Rubber.

B. Size Screening: Size screening involves separating the municipal waste based on the size and shape of the particle. It helps in material handling comfortably.

C. Shredding: Shredding involves the process of destructing the large amount of solid waste into smaller pieces by crushing and cutting. The process converts the larger particles of municipal waste into smaller particles for easy handling and transporting.

D. Magnetic Separation: Magnetic separation is a process in which magnetically susceptible material is extracted from a mixture using a magnetic force. This process is useful in separating the metal particles from the crushed particles. Because metal particles are not suite for RDF.

E. Pelletizing: After magnetic separation the RDF particles are added with binders such as calcium hydroxide and then it is mixed thoroughly. Then it is converted into pellets into required size and shapes normally 30mm capsules. A refuse derived fuel (RDF) pellet having about 11% or more particulate calcium hydroxide which is utilized in a combustion able mixture. The pellets are used in a particulate fuel bring a mixture of 10% or more, on a heat equivalent basis, of the RDF pellet which contains calcium hydroxide as a binder, with 50% or more, on a heat equivalent basis, of a sulphur containing coal. Combustion of the mixture is effective to produce an effluent gas from the combustion zone having a reduced SO.sub.2 and polycyclic aromatic hydrocarbon content of effluent gas from similar combustion materials not containing the calcium hydroxide.

F. Overall review of manufacturing of RDF: The process involves collection of garbage and put it on material recycling conveyor where recyclable waste and non recyclable waste are getting seperated. The non recyclable waste are collected by trommel and putting into shredding machine where the waste is crushed and cutted into small pieces. Then the pieces are putting into pelletizing machine along with calcium hydroxide as binder then it is converted into pellets of RDF. It is estimated that 750 ton of municipal waste is collected per day and putting into the machine gives upto 120 – 192 ton of RDF per day in the ratio of 5:1.

IV. RESULTS & DISCUSSION

Table 4.1.1 Characteristics 0f RDF Pellets

Size	dia 8/20/30 mm, length 8-40 mm
Calorific value	4000 Kcal / Kg (minimum)
Bulk Density	0.7 MT per cu.m.
Density	1.3 gm per cc. (minimum)

Ash Content	< 15%
Moisture	10% (approx.)

Table 4.1.2 Proxomate Analysis of RDF Pellets

Moisture	**3-8%**
Ash Content	12-20%
Volatile matter	50-65%
Fixed carbon	12-18%

Table 4.1.3 Ultimate Analysis of RDF Pellets

Moisture	**3-8%**
Mineral matter	15-25%
Carbon	35-40%
Hydrogen	5-8%
Nitrogen	1-1.50%
Sulphur	.20-.50%
Oxygen	25-30%

Table 541.4 Gross Calorific Value

With binder	**4000-45000 Kcal/Kg**
Without binder	3500-3700 Kcal/Kg

V. APPLICATION OF RDF IN INDIA AND ABROAD

RDF has many applications in India as well as in abroad. By using RDF we can able to generate electricity, RDF can be use instead of coal in boilers of power plants, RDF is used in boilers instead of fire wood and RDF is used in boilers instead of furnace oil. RDF also used in cement industries for heating purpose of limestone. 5MW power plant is installed in Lucknow which uses RDF as fuel. SELCO industries which are one of the power generators installed 7MW power plant in Hyderabad. RDF plant in Rajkot handles about 300Tones of MSW per day. RDF plant in Mumbai also produces RDF from 80 tons of MSW. AAPL infrastructure private limited has invested about 25 cores for setting up RDF plant in Thirunelveli of Tamil nadu. As per Vellore District is considered there are about 120MT of solid waste is generated per day. With that we can able to generate 30MT of RDF per day and able to generate electricity of about 2.5MW of electricity per day. And recently in Arcot they adopt selfsufficient scheme of producing electricity of 265 to 285 units per day by running 30kV generator to produce electricity from municipal solid waste. It can able to light up to 100-150 street lights in Arcot.

VI. CONCLUSION

All the main problems related to the waste management are identified. Assessing the main problems and considering all the alternatives, recommendations in each stage for the MSWM are suggested. This paper suggests an integrated municipal solid waste management plan for Nagpur City. Future studies should be carried out for checking the efficiency of the proposed methods. RDF is considered as one of the green fuels and leads to green environment. It resolves both problems exist with Municipal waste and energy requirement. Refuse-derived fuel, or RDF, is a type of fuel that can make cement and replace fossil fuels. It is created by processing different types of refuse, including municipal solid waste (MSW), construction and demolition waste (C&D), and industrial waste. The production of RDF involves several steps, including bag splitting/shredding, size screening, magnetic separation, air classifier (density separation), coarse shredding, refining separation by infrared separation, and comparing it to landfill. RDF offers several primary advantages compared to landfills, including reduced greenhouse gas emissions, increased energy security, and environmental benefits, such as reduced landfill space requirements.

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