Comparative study of Coal and Refuse Derived Fuel – produced from Municipal Solid Waste in Rewa city (M.P.)

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ABSTRACT-The Refuse Derived Fuel technology is an economically sustainable way to reduce fuel costs and reduce landfill. It produces beneficial effects on air permeability and ash residue when used as fuel and creates a more evenly mixed fuel at higher temperatures making it easier to control combustion. Rdf has a high calorific value, poor ash and moisture and can be treated in one place and then transferred to other places for burning. It has the ability to last a long time and be heated on a variety of existing boilers, liquid bed dryers, and cement panels without repair, or only a small amount, required.

Key Words: Calorific value, Coal, Municipal solid waste, RDF, Waste to energy.

INTRODUCTION

Municipal solid waste refers to the materials or items rejected in the urban areas for which local authority/municipalities are usually accountable for collection, transport and final disposal. MSW includes domestic garbage, institutional refuses, street sweepings, as well as construction and demolition wastes. Solid waste generation in India is approximately 1,15,000 tons per day, and an estimation of an annual increase of about 5% (CPCB, India, 2013). Solid wastes management manual reveals that Indian cities produces 0.2 - 0.6 kg waste / capita / day (CPHEEO, 2000). According to this figure India will be generating more than five times the current phase up to 2047.

In accordance with the Pollution Control Board (CPCB), the normal formation of MSW in various Indian municipal companies, 35-40% of solid waste is easily damaged, 15-20% of solid waste burns (long-term damage), 15-20 % of solid waste can be reused / combustible and other substances that contribute to 20-25% (Sheth, 2016). Part of this solid waste is reused, recycled or reprocessed. There are a lot of waste management problems and processes found in many Indian cities. Solid municipal waste from Indian cities contains a high percentage of organic matter and is moist. A total diagram of the solid waste generated, 1,41,046 tons per day based on available data for 2013-2014 in our country (CPCB 2016, Government of India).

Solid municipal waste contains a large amount of valuable materials such as paper, plastic, metal and glass waste, which, if properly recovered, can reduce the amount of waste that has to be collected and, at the same time, generate significant savings and resale costs. In addition, better recycling strategies will help conserve valuable natural resources and turn waste into productive products. The process of choosing the right way to dispose of solid waste is complicated by the diversity of urban waste, but the proper choice can save money and run away from municipal problems. The direct method of disposal should provide opportunities for recycling and should not contaminate air, ground or surface water or soil. It is clear that Indian cities continue to produce solid waste and the increase in waste in our country is increasing. The main purpose of solid waste processing is to reduce the amount of solid waste by recycling and disposal in a way that does not disrupt conservation. The waste produced is disposed of directly after intermediate treatment. Quick treatment is an effective and important procedure designed to reduce the amount of waste, strengthen it and make it safer. An advanced emerging technology, the Refuse derived fuel (RDF) process refers to the high-calorie component of processed municipal solid solid waste (MSW) used as steam / electricity or other fuel-fired fuels in industries or boilers.

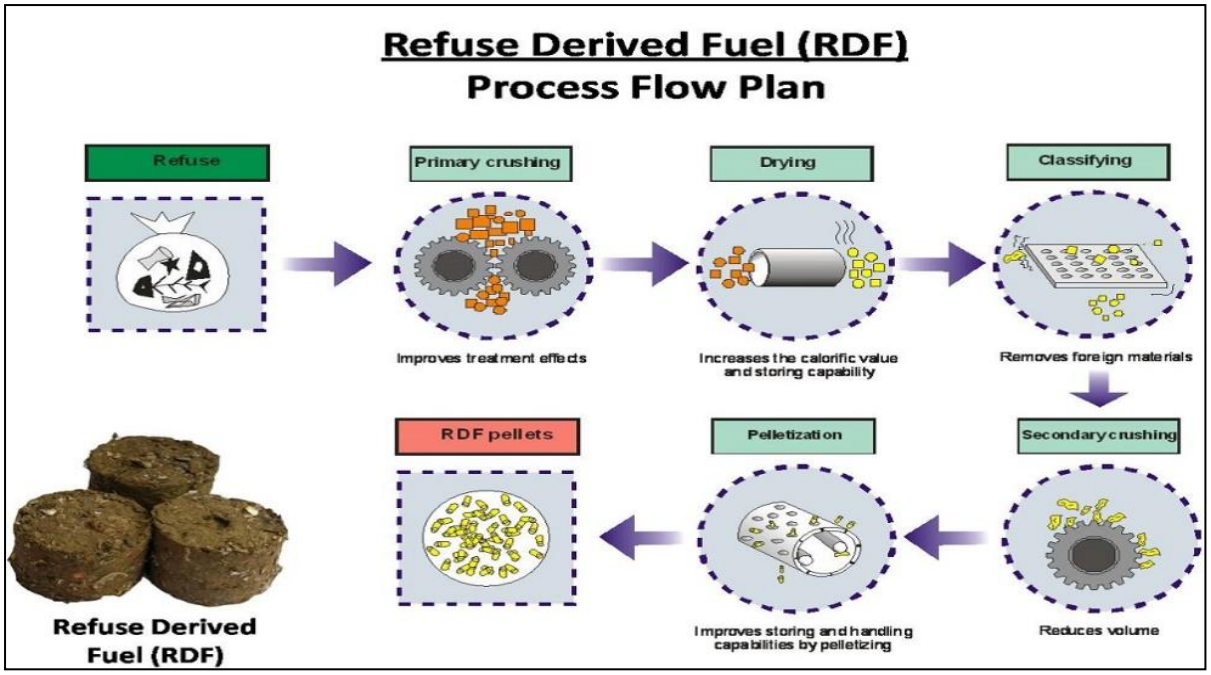


Figure 1 : Process flow plan of Refuse Derived Fuel

Refuse derived fuel (RDF) will play a major role in reducing the municipality's large amount of solid waste (MSW) and contribute to another source of renewable energy in the near future. RDF is a clean, environmentally friendly and intelligent way to produce energy. RDF plants in some Indian and MP provinces are shown in table 1 and 2.

Table 1- Number of energy recovery plants in some states.

State	No. of RDF plants/ waste to energy plant /Biogas (BG)	State	No. of RDF plant/ Waste to Energy Plant/Biogas (BG)
Andhra Pradesh	3-RDF	Delhi (UT)	1-RDF
Chandigarh (UT)	1-RDF	Gujarat	2-RDF
Chhattisgarh	1-RDF	Kerala	2-BG
Maharashtra	19-BG	Madhya Pradesh	1--RDF

Source: CPCB (2013).

Table 2: Solid waste management by Biogas/RDF/Energy/MRF (TDP) plant in M.P.

S. No.	Regional office	Name of Towns	Quantity of MSW being utilized for Biogas/RDF/ Energy/MRF (TDP)	Installed capacity of Biogas/RDF/Energy/MRF (TDP)	Production of Biogas/RDF/Energy/MRF (TDP)
1	Bhopal	Bhopal	Bio Gas - 15	Bio Gas - 15	Bio Gas – 15
2	Indore	Indore	MRF – 500	MRF – 500	MRF – 500
3	Ujjain	Ujjain	RDF - 25	RDF – 25	RDF – 25
4	Jabalpur	Jabalpur	462	600	Electricity Generation – 42757350 kwh

Source : Action plan for MSWM (UD&HD) MP, 2018

To establish responsible waste management programs, public education programs should be developed to encourage accountabilities for all. Once the problem becomes a shared burden, people can find solutions by working together and solving this great environmental problem.

RDF is a renewable solid fuel that is used to generate energy. The RDF could be used in the cement industry; steel furnaces; power stations, substituting coal and oil; or be incinerated in energy-from-waste plants. RDF production technology contributes to the "waste to energy" approach, reduces the carbon footprint and is essential for diverting waste from landfill. To produce a standard solid waste fuel, waste goes through a range of processes.

MATERIAL & METHOD

Study Area :
Rewa is a city in Madhya Pradesh (MP) in the Indian state. It is a large city located 131 miles south of Prayagraj. The city of Rewa produces part of the plateau of Vindhya in the province of Madhya Pradesh and is irrigated by tons of water.

Sampling of the study area:
The Rewa Municipal Corporation has 45 wards. In this case, the study area is broad hense sampling is mandatory. For sampling the ward population, ward area, ward distribution and waste generation have been considered. 07 sampling point was selected for the sampling of municipal solid waste in the Municipal Corporation of Rewa.

Separation of municipal solid waste:
Manual separation:
Bulky items such as large pieces of wood, rocks, long pieces of cloth, etc. are removed by hand before mechanical processing begins. Equipment involved in manual separation usually includes a sorting belt or table. Handpicking of refuse is perhaps the most prevalent MSW handling technique; it is also the only technique for removal of PVC plastics.

Air separation:
In this step, fans are used to create a column of air moving upwards. Low-density materials are blown upwards, and dense materials fall. The air carrying light materials, like paper and plastic bags, enters a separator where these items fall out of the air stream. The quality of air separation depends on the strength of the air currents and how materials are introduced into the column.

Pre-shredding:
Shredding is a process for size reduction of solid waste using hammer mill or shredder. This removes the large bulky material from the municipal solid waste.

RESULT & DISCUSSION

The element of fossil fuels (RDF) is strongly influenced by near-term analysis. In the near analysis it includes moisture content, ash and

Rotary drying:
Drying process reduces the moisture content of waste and prevents the leachate production. Rotatory drum dryer is used for drying of MSW. It is composed of slightly inclined from horizontal through which the municipal solid waste to be dried and the hot air are passed simultaneously.

Mechanical screening:
Solid waste is passed through a screening machine to separate sand/grit (below 8 mm) and mixture of materials of different sizes. The basic aim of screening is removal of under-sized and over-sized materials. A trommel screen, also known as a rotary screen, is a mechanical screening machine used to separate waste materials into several size fractions.

Density separator:
For the separation of light materials the dried and screened garbage is then passed through an density separator in which the light combustibles and dense fraction like paper and plastics get separated.

Magnetic separation:
Magnetic materials present in garbage is passed over a magnetic separation unit to remove such type of items.
Grinding:
The light combustible materials are grinded to 10-15 mm particle size.

Production of RDF:
Once all of the separating and size reduction steps are complete, the final RDF product can be formed into bricks or pellets or can be left as fluff. The additives/binders mix before pelletizing like agricultural husk and passed through a pelletizing machine that converts the waste into pellets.

STATISTICAL ANALYSIS

Statistical Analysis of raw data perform by using different statistical methods.

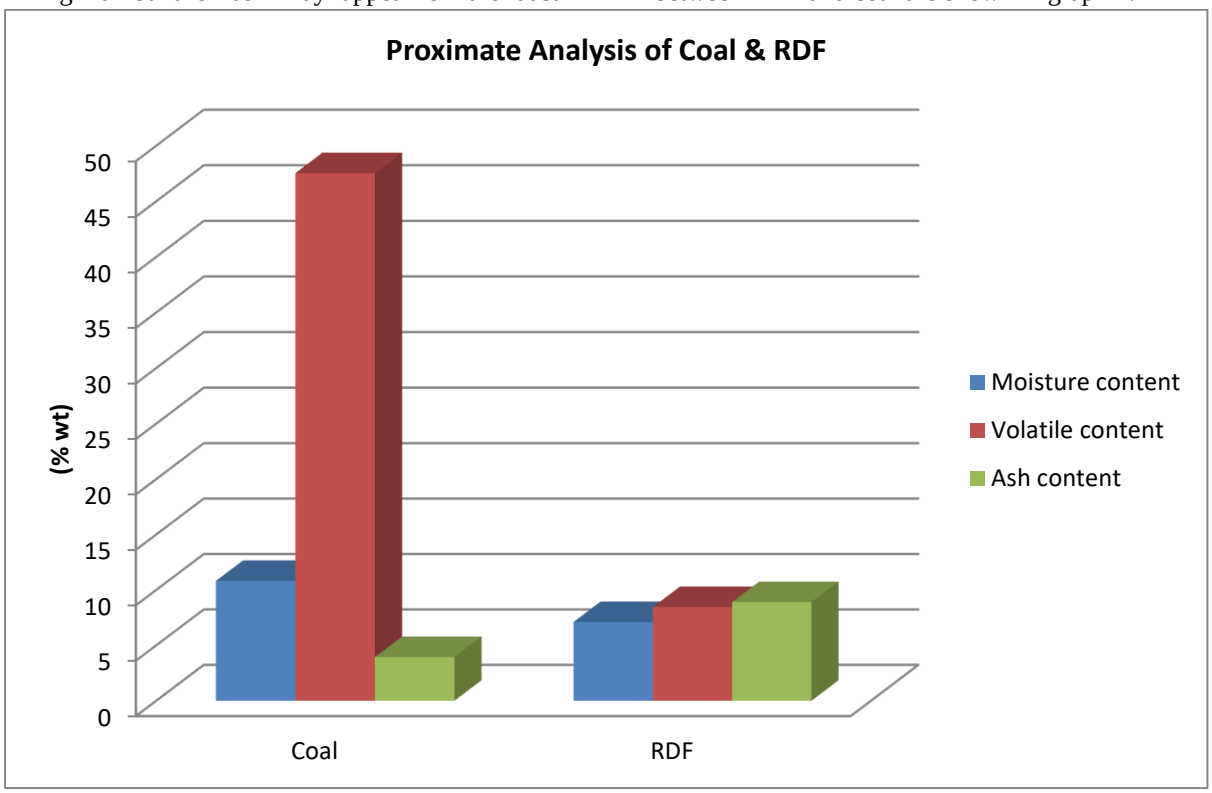
flexible content on the other side including C, H, N, O, S, etc. The RDF was therefore analyzed and compared with the low level of coal used in cement clinics and other industries are indicated in table 3.

Table 3: Proximate and Ultimate analysis of RDF and low-quality coal.

Fuel type	Proximate analysis (% wt)			Ultimate analysis (% wt)					Calorific value (MJ/kg)
	Moisture content	Volatile content	Ash content	C	H	N	O	S	
Coal	10.81	47.53	3.94	54.08	5.7	2.11	35.67	0.32	20.86
RDF	7.1	8.45	8.9	40.15	10.01	9.77	25.54	2.33	23.77
MEAN	8.96	27.99	6.42	47.11	7.86	5.94	30.60	1.33	22.32
SD	2.62	27.63	3.50	9.85	3.05	5.42	7.16	1.42	2.06
SEM	1.85	19.54	2.48	6.97	2.16	3.83	5.06	1.00	1.45
CV	29.30	98.73	54.63	20.90	38.80	91.18	23.40	107.27	9.22

Proximate analysis:

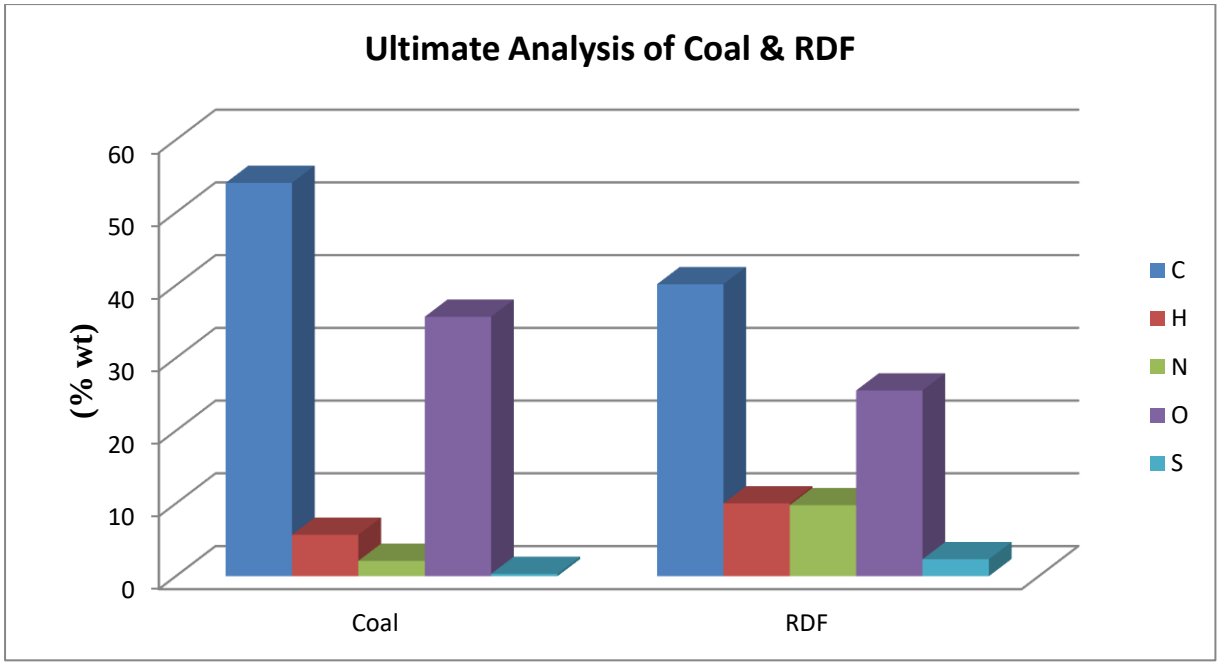
Proximate analysis of waste-based fuels (RDF) and coal shows that the humidity and volatile content of RDF is lower than that of coal. In contrast, the content of RDF ash is higher than that of coal fuel. A high amount of ash may appear on the dust particles of the street waste, while in coal ash is essentially a contaminant contained in the coal. Coal pollution should be less than solid municipal waste, so coal is the same color compared to MSW. Differences in humidity, flexible and ash content between RDF and coal are shown in graph 1.



Graph 1 : Variation in Proximate analysis of RDF and low quality coal

Ultimate analysis:

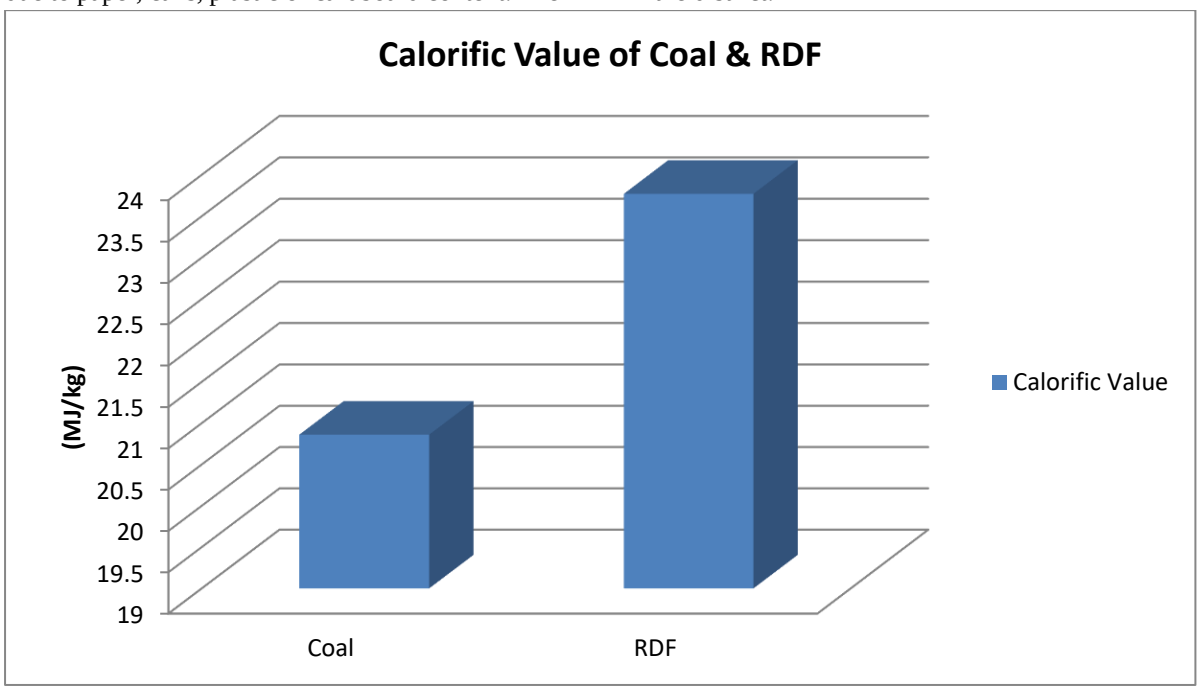
The final analysis of the RDF and old fuel coal was analyzed. The result shows the C and O content of the RDF is lower than coal. Although, the amount of H, N and S of fuel found in the garbage is higher than coal. A comprehensive analysis of these fuels is essential for fuel consumption in various power generation industries. The difference between coal and RDF is shown in graph 2.



Graph 2: Variation in Ultimate analysis of RDF and low quality coal

Calorific value:

Garbage found in waste has a high calorie content of approximately 23.77 MJ / kg compared to low quality coal. The calorie value difference is shown in graph 3. The reason for the high calorific value is due to paper, cans, plastic or cardboard content. The structure of the RDF varies greatly from city to city and district to state within India. The results indicate that RDF from Rewa municipality waste may be commercially viable and used to close the coal-fired power plant and another industry was located near the district.



Graph 3: Variation in Calorific value of RDF and low-quality coal

CONCLUSION

Refuse derived fuel (RDF) is a effective way to properly manage MSW. In this process MSW flammable material is used to produce RDF. The process involves various steps such as separation, pre-immersion, drying, filtering, grinding and the final product of the rdf can be made into bricks or

pellets or can be left as fluff. MSW combustible materials with high calorific value, replace conventional fuel consumption such as coal in various industries. The calorie value of RDF was high compared to low-grade coal. The caloric value of RDF resulted in a temperature range of between 18 to 35 MJ / kg. RDF can be used to replace coal used in the cement industry. The waste derived technology (RDF) provides an alternative to solid city waste disposal in a safe and environmentally friendly manner. This technology provides another source of energy. Numerous studies indicate that RDF could be a viable alternative to coal. Along with power generation, solid waste management is another problem solving. A pilot of the hydroelectric power plant in MSW is underway to reduce dependence on fossil fuels. Using RDF technology will help achieve the goal of a clean and healthy city.

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