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# Evaluating of Refuse Derived Fuel (RDF) Production from Municipal Solid Waste

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**ABSTRACT:** In decades rising population is a matter of concern beside that increase in the demand of resource and generation of waste has increased tremendously. It has become need of the recent time for recycling the waste with a view to reduce its volume as well as to reduce the impact on environment. It also helps us to reduce the demand for natural resources. Now a day's collecting waste materials for recycling has become common practice in households, small businesses and large organizations worldwide. By now it is fair to say we are all aware of the issues and facts surrounding landfill but how much do you know about the alternative methods now being used? Well Refuse derived fuel (RDF) is one of such method to reduce the waste recent and to produced briquettes from domestic and business waste; RDF requires biodegradable material as well as plastics. Non-combustible materials such as glass and metals are removed, and the residual material is then shredded. Refuse derived fuel is used to generate energy at recovery facilities, many of them in Europe where they produce electricity and hot water for communal heating systems. These RDF briquettes are used in boilers, clinkers, or for creating electricity from steam.

**KEYWORDS:** — Municipal Solid Waste (MSW); Bio-drying; Refuse Derived Fuel (RDF); Waste to Energy, Swachh Bharat Mission, organic MSW, Source of Energy.

## I. INTRODUCTION

### What is RDF?

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. Refuse derived fuel is used to generate energy at recovery facilities, many of them in Europe where they produce electricity and hot water for communal heating systems.

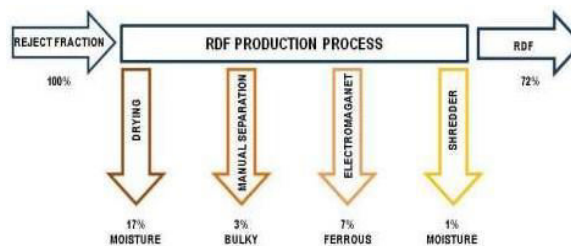


Figure 1.1: RDF Production Process

Solid waste management (SWM) and disposal is considered one of the main significant challenges facing urban communities around the world. The effective management of solid waste involves the application of several treatment approaches, technologies, and concepts to ensure the protection of public health and the environment. Over the past years, SWM has utilized many advanced technologies and strategies [1]. There is a wide range of alternative solid waste management options and strategies available for dealing with mixed solid waste to limit the residual amount left for disposal to the landfill.

There are several factors that contribute to making waste and waste management processes some of the most serious environmental problems, in line with population growth, current modern standards of living, rapid economic growth, the expansion of urbanization, the lack of suitable and well-designed sanitary landfills, and finally, political reasons, which include the huge influx of refugees caused by the conflicts in neighboring countries [4–6]. According to Jordan's Ministry of Municipal Affairs, interms of the generation and collection of MSW, about 2.7 million tons is generated by a population of 6.7 million [7], while in 2009 it was about 1.9 million tons for a population of 5.8 million [8]. However, the massive influx of refugees is the main reason for the remarkable increase in the recent generation rate with regard to MSW in Jordan. Therefore, waste and waste management have become some of the major challenges for the hosting regions [9–12]. In this context, it is worth mentioning that Jordan is not an oil producing country, with 96% of the energy supply in Jordan being imported.

## II. RELATED WORK

A comprehensive municipal solid waste management (MSWM) system includes some or all of the following activities:

- setting policies;
  - developing and enforcing regulations;
  - planning and evaluating municipal MSWM activities by system designers, users, and other stakeholders;
  - using waste characterization studies to adjust systems to the types of waste generated;
  - physically handling waste and recoverable materials, including separation, collection, composting, incineration, and landfilling;
  - marketing recovered materials to brokers or to end-users for industrial, commercial, or small scale manufacturing purposes;
  - establishing training programs for MSWM workers;
  - carrying out public information and education programs;
  - identifying financial mechanisms and cost recovery systems;
  - establishing prices for services, and creating incentives;
  - managing public sector administrative and operations units; and
  - incorporating private sector businesses, including informal sector collectors, processors, and entrepreneurs
- 
- Prevent the production of waste, or reduce the amount generated.
  - Reduce the toxicity or negative impacts of the waste that is generated.
  - Reuse in their current forms the materials recovered from the wastestream.
  - Recycle, compost, or recover materials for use as direct or indirect inputs to new products.
  - Recover energy by incineration, anaerobic digestion, or similar processes.
  - Reduce the volume of waste prior to disposal.
  - Dispose of residual solid waste in an environmentally sound manner, generally in landfills.

The purpose of the waste management hierarchy is to make waste management practices as environmentally sound as possible. The waste management hierarchy has been adopted in various forms by most industrialized countries. Its principal elements are also included in international conventions and protocols, particularly those dealing with the management of toxic or hazardous wastes, and in regional attempts to develop a coordinated policy on the reuse of various byproducts of waste management processes.

The hierarchy is a useful policy tool for conserving resources, for dealing with landfill shortages, for minimizing air and water pollution, and for protecting public health and safety. In many developing countries, some aspects of this hierarchy are already in place, since traditional practices revolving around waste prevention reuse, and recycling are prevalent.

At the same time, it should be recognized that all waste management practices have costs, as well as benefits. This means that the hierarchy cannot be followed rigidly since, in particular situations, the cost of a prescribed activity may exceed the benefits, when all financial, social, and environmental considerations are taken into account.



**III. PROPOSED ALGORITHM**

Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban center clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly. Experts believe that India is following a flawed system of waste disposal and management.

There has been technological advancement for processing, treatment and disposal of solid waste. Energy- from-waste is a crucial element of SWM because it reduces the volume of waste from disposal also helps in converting the waste into renewable energy and organic manure. Ideally, it falls in the flow chart after segregation, collection, recycling and before getting to the land fill. But many waste to energy plants in India are not operating to their full potential.

**III. PSEUDO CODE**

- To supply Municipal Solid Waste to the agency (Privateparty /NGO etc.) selected and responsible for MSW management contract of the city and / or process MSW to SCF/RDF.
- Review of infrastructure and machinery available at the waste processing facility to ensure SCF/ RDF can be



- To set up a review and monitoring mechanisms to ensure that SCF/ RDF to be supplied meets the standards notified by CPCB.
- To pay the operational and maintenance cost in form of tipping fees on per tonne SCF/ RDF produced basis quoted by the plant operator through competitive process.
- To bear the cost of transportation of SCF/ RDF to cement plant over 100 Km; up to 100 km to be provided by Cement manufacturers
- To provide land to RDF manufacturer to set up the unit To provide segregated minimum assured waste to RDF manufacturer



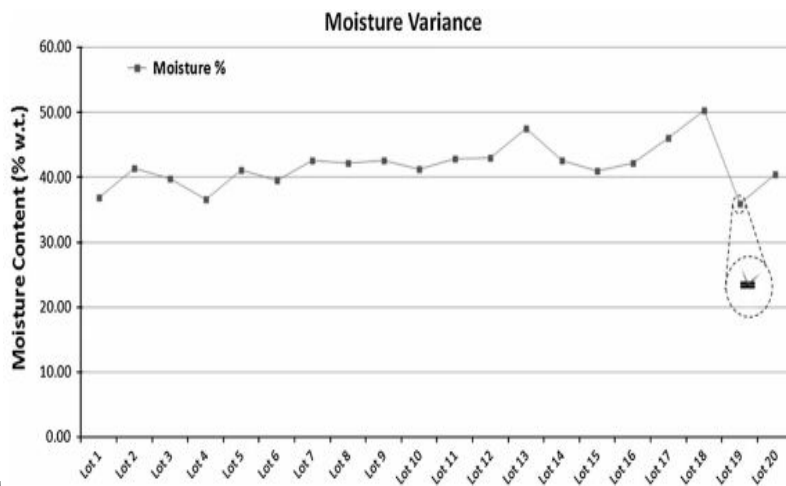
**Need for Standards for RDF in India**

The committee deliberated and considered the following factors pertinent to evolve the standards for RDF

- **Waste heterogeneity:** Indian MSW is highly heterogeneous (with non-existent segregation at source), and the RDF thus generated not only varies widely in quality but is often inferior quality. On the other hand, cement producers need RDF of consistent quality and quantity to ensure that cement quality, plant output, and compliance to regulations are not affected.
- Different requirements and capacities of cement plants: RDF of one quality required by a cement plant may not be suitable for another plant; every cement plant has specific requirements and therefore standards will help to categorize their requirements.
- **Business Prospects:** The standards will be helpful to enter into long-term agreements between cement and RDF plants.
- **Compliance to SWM Rules 2016:** Standards will enable the implementation of SWM Rules 2016, by defining the characteristics/qualities of RDF, so that cement producers cannot claim that the product of the nearby RDF plants is not standard RDF.
- **Market Development:** For a waste stream to be certified as RDF (after appropriate processing) would help the RDF plant better market their product and would increase the confidence of cement manufacturers in using RDF.

**IV. SIMULATION RESULTS**

**Moisture Variance**



Graph01: Moisture Variance

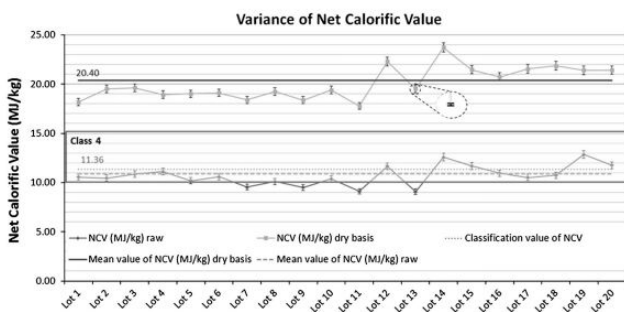


Taable01: Proximate analysis of RDF produced in EMA Plant

	Mean Value	SD
Moisture	41.67	2.87
Ash (Wt. % Raw)	9.70	1.33
Volatiles (Wt. % Raw)	46.26	3.61
Char (Wt. % Raw)	2.37	1.64
Ash (wt. % dry basis)	16.65	2.33

More specifically, from the pre-drying procedure followed for all of the increments of each sample, moisture was found to be more than 32 % in the majority of the samples. The maximum moisture found in a daily increment was 47.57 %, and the minimum was 31.60 %. The only sample that showed moisture of about 25 % was taken in the day after the yearly plant maintenance. High moisture content is the most important factor that must be coped with, among the properties of RDF, because it influences the heating value in a great degree. In Fig. 1, the mean value of moisture content is depicted for each sample lot gathered

Results for RDF and process improvement As described in the section materials and methods, the whole analysis is divided in two groups.



Graph02: Variance of Net Calorific Value

In the balancing of combustion plants, the calorific value of the used fuel represents an important requirement. In literature there are various so called calorific value formulas mentioned. The relationship between the fuel composition and the calorific value is formed through the following:

The calorific value of the individual fuel components or Through coefficients, with which the respective fuel components are involved in the total calorific value

The final classification of RDF according as far as the studied scenarios are concerned, the most economically efficient for the viability of “EMA” is the scenario where the recovery of three high added value materials is separately collected. Regarding the management of RDF, the most suitable scenario, based on the present situation in Greece, seems to the mass incineration scenario for electricity production that will be sold in the grid.

#### V. CONCLUSION AND FUTURE WORK

The intention to alternative waste management in developing countries is getting higher due to the impact traditional waste management practice (e.g. landfilling) to the environment become more serious by rapid growth population and economic development. The landfilling of MSW associated with the leachate and landfill gas emissions. Although landfill gas emissions will become negligible within decades, while leachate emissions will be continue to pollute the environmental for hundreds of years. This paper present a study of production and characterization RDF from high organic waste and moisture content of MSW, which nature MSW in the developing countries. The use of MSW to produced RDF can be an option waste management problem and simultaneously the energy shortage due to lack of natural resource for energy. The aim this study is to produce RDF from high organic waste contents, characterization and exploring the best composition of organic waste use for RDF production.

- The present MSW is suitable for an efficient bio-drying aimed to RDF generation;
- RDF can be an interesting substitute of conventional fuels in the industry;
- Global environmental balances can slightly vary depending on the characteristics of the MSW. - RDF can be an alternative to the present use of landfilling;  
An adequate local impact must be guaranteed supporting a correct development of the activities of the local environment agencies.

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