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Research Article

Advance in Environmental Waste Management & Recycling

Transformation of Municipal Solid Waste into Fuel Pellets Case Study of Newai, Rajasthan

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Abstract

The municipal solid waste is generating on a rapid pace not only in India but on a global scale with the increase in population and life style of people on a time scale. Such a huge quantity of waste is posing a serious threat to human health and also on environment as a whole. Many cities in India do not have any treatment and scientific disposal of such wastes thereby developing big hills of municipal solid wastes causing ground water contamination through the process of leaching, generation of mosquitoes leading to various diseases, nuisance and odor problems etc. With an alarming problems being witnessed, the authors of present paper have attempted a case study of small tehsil Newai, district, Tonk in Rajasthan, India wherein the population is forecasted to 2051 and waste generation is estimated on a time scale. A lab study has been conducted by one of the authorto transform municipal waste in to fuel pallets with calorific value of 6000 kcal / kg as an alternate fuel. Such a solution not only facilitate in improving the quality of environment and restriction of pollution but also provide environmentally sustainable approach by providing economic benefits to make the system sustainable.

Keyword: Municipal solid waste, sustainability, case study, fuel pallets, transformation of waste into value added products, economy.

Introduction

The world is flecked with multiple issues concerning the environmental degradation which have a direct relation with the increasing population and connected urbanization and industrialization. As the world is advancing in the direction of the urban future, the rate of generation of the municipal solid waste is faster in comparison to the rate of urbanization, which is already increasing as a drastic rate. Municipal solid waste produced is considered to be a combination of commercial and household remains which is produced by humans [1]. Adhering to the facts and figures stated by the amount of waste generated in many emerging cities such as Shanghai, Mexico, Rio de Janeiro produce more than 1000 tonnes of waste per day. They have predicted that by the year 2025, the amount of waste generated will be equivalent to a 5000 km long truck which implies that issues such as disposal of waste, pollution and hence environmental damage are going to exponentially increase [2].

According to the facts published by Times of India the approximated waste generation of 2.01 billion tonnes of waste is generated in the year 2016 and is projected to escalate by 70% by the year 2050.The reports have also defined that India, the largest growing economy in the world is the largest producer of municipal solid waste leaving behind China. The increasing living standards of people in the various towns or cities, migration of people from rural areas to urban areas, economic advancement are few parameters which result in the enormous generation as well as increase the complexity of the produced solid waste [3,4].

The improper management of the waste in India has resulted in

the development of the waste as the new pollution sources which causes detrimental impacts on both the environment and humans [5]. The waste generation causes all air, soil and water pollution. The waste dumping at this alarming rate leads to contamination of both ground as well as surface water. [6].Furthermore, the dumping of the wastes in the landfill areas results in leachate and gas generation issues due to the microbial actions and changing climatic conditions [7].

The current study aims at quantifying the amount of waste generated in a small town of Rajasthan, Newai. The quantification of waste generation till the year 2050 involves the population projection as the most important tool. The amount of waste is increasing at such an enormous rate and hence, we must need to re-think as to if the waste is actually a waste or not. Increasing global warming and depletion of conventional sources such as coal has forced us to find alternatives to it. The authors have aimed to convert the waste into pellets which can be used as an alternative to coal due to the caloric value. This can be a viable and sustainable solution to coal as a fuel.

Study area

Newai is a tehsil in the Tonk district which is located in Rajasthan, India. The location of Newai in the map of Rajasthan is depicted in the Figure1. The increase in the population for the decade 2001-2001 was around 17%. The rate of development in Newai is at a slower pace in comparison to other indian metropolitan cities but definitely for the coming decades the population, demand for the basic amenities and waste production will increase.

Figure 1: Location of Newai on the map of Rajasthan

Method of transformation

The method that was utilized for the conversion of Municipal Solid Waste to fuels pellets involved numerous processes such as waste collection, drying of waste, segregation of waste, shredding, screening, followed by palletisation and drying of pellets. The processes are described as follows:

- **Waste collection**

The freshly generated solid waste was collected from the landfill site in order to carry out further processing and convert it into the pellets.

- **Drying**

The time period of drying for the freshly collected waste was approximately 48 to 72 hours by placing the waste in the direct sunlight which helped in the removal of maximum moisture absorbed in the waste.

- **Segregation**

In this particular step, the waste was segregated into various categories which involve plastic, rags and metals. Some amount of plastic was left into the waste so that there can be some amount of substance that can act as binder in the formation of pellets.

- **Shredding**

This step involved the conversion of the segregated waste material to the much smaller size using the industrial grade hammer mill so that palletisation can be carried out with much more ease.

- **Screening**

A 2mm sieve was utilized for screening the waste collected from the dumping site and then grinded which was used for the further processing. For the industrial purpose, it has been suggested that approximately 70-80% of screened material and 20-30% of remaining material on the sieve which acted as a binder should be used.

- **Homogenization**

Binders were added to the collected waste inorder to enhance the pelletization process. Approximately 10% of Bentonite clay in the powder form along with almost 2% of oil and 4-5% of water was added with the raw material so as to prepare a mixture. It was very important to mix the raw materials thoroughly so as to create a proper homogeneous mixture.

- **Pelletisation**

The homogenised raw material after being thoroughly mixed was fed into the palletisation machine which contains a circular dye rotating at 300 rpm and the pellets were produced with a diameter of 6 mm.

- **Pellets drying**

After the pelletization process, the pellets were exposed to the sunlight for approximately 5-6 hours which helped in the removal of the absorbed moisture. The generated pellets can be used as a substitution of coal.

Case Study of Newai, Rajasthan

Population projection and forecasting trends:

The population projection is a fundamental step that has to be adopted by every government inorder to forecast the population which is increasing at an alarming rate. The other parameters such as industrialization ,urbanization,migration patterns can be carefully studied after projecting the population for the coming decades. This tool can also help us in forecasting the food as well as energy requirements, forecasting global warming and hence, the impacts on the environment can also be projected [8].

In this paper, the population of Newai from 1951-2011 was collected and then the arithmetic mean, geometric mean and incremental increase method were used for the projection of the coming four decades which is clearly shown in Table 1 and Table 2. Figure 2 and figure 3 depicts the graphical representation of the information collected.

Table 1: Population Data

Year	Population
1951	59,580
1961	73,295
1971	95,863
1981	1,23,376
1991	1,60,352
2001	2,03,340
2011	2,45,787

Table 2: Population forecasting

Year	Arithmetic Mean Method	Geometric Mean	Incremental Increase Method	Average
2021	276822	310759	282568	290049
2031	307856	392905	325095	341952
2041	338891	496766	373369	403008
2051	369925	628081	427389	475132

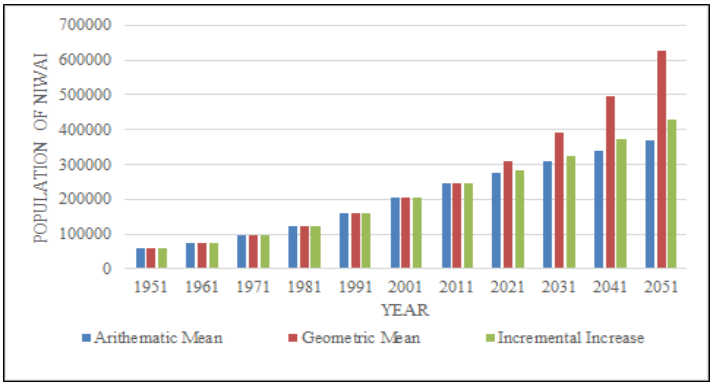

Figure 2: Population of NewaiForeasted till 2051

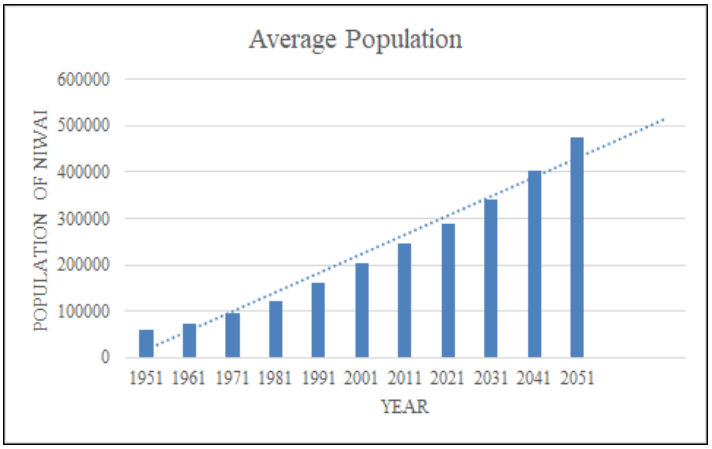

Figure 3: Average Population of NewaiForeasted till 2051

Solid waste generation projection and trends:

The projection of population has a direct relation with the projection of waste produced at a particular place. 1kg/capita/day is the amount of waste production that has been assumed for the decade 2011 as depicted in Table 3. The waste production increases by 0.1 kg/capita/day for the subsequent decades. The pie chart in figure 4 shows the waste production from 1951-2051.

Table 3: Projection of waste production by the year 2051

Year	Population	Assumed Waste Production (kg/capita/day)	Waste Production per day (in tonnes)
1951	59580	0.3	18
1961	73295	0.4	29
1971	95863	0.5	48
1981	123376	0.6	74
1991	160352	0.7	112
2001	203340	0.8	163
2011	245787	0.9	221
2021	290049	1	290
2031	341952	1.1	376
2041	403008	1.2	484
2051	475132	1.3	618

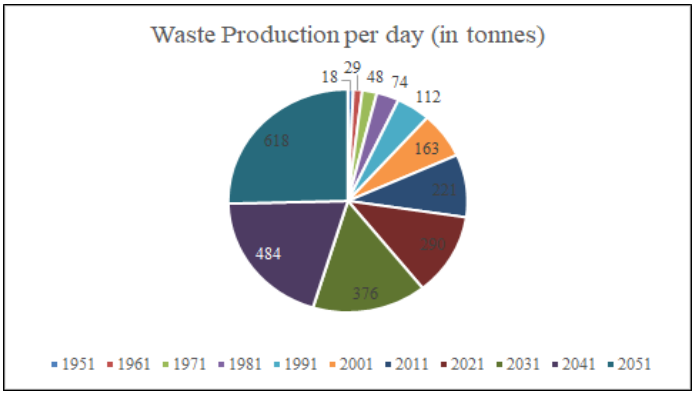

Figure 4: Waste production from 1951-2051

Pellet production-An Alternative to conventional Fuel

As per the research conducted at LD College of engineering, Ahmedabad by one of our authors, it was confirmed that if 40kgs of municipal solid waste is taken to produce 15kg pellets with 2800kcal/kg of calorific value. But, during lab studies, lignin oil was added which enhanced the calorific value to 6000kcal/kg . Thus, such fuel pallets can be used as alternate fuel and may likely to produce environmentally sustainable results. Accordingly, taking this into consideration, an attempt has been made to estimate total pellets productionfrom municipal solid waste at Newai, Rajasthanfor 2021-2051(9).

Ministry of housing and urben affairs published report on reuse of derived fuel in industries at October 2018, as per the report they mentioned RDF price with respect to calorific value. Calorific val-

ue of sample RDF is 6000 kcal/day so smaple RDF is in class 1 category is reflected in table4 below. The ministry's report says calorific value of industrial coal ranges 3000-4200 kcal/day so comparison of sample RDF with industrial coal their is huge quantity of calorific value of sample RDF, so it's used as alternative fuel. Ultimate-proximate analysis of sample RDF is done at laboratory, the results are shown in table no.5 below. Sample RDF is fullfill all the criteria of Standard RDF and also their is less chance to air pollution. The pellets are assumed to have selling price of approximately 35 INR in the market for the year 2021 and addition of Rs. 10 every decade assumed to be considered whichthe basis of calculating the economic value as is reflected in table 6 below.

Table 4: Grade of the RDF based on calorific value

GRADE OF RDF	Calorific value (kcal/day)	Maximus Rs/ tonnes (assumed @ Rs 0.8 per kcal/ day)
Class -1	>4560	3600
Class -2	3750	3000
Class -3	3000	2400

Table 5: comparison of proximate-ultimate analysis of sample RDF with standard RDF

PARAMETERS	Class -1	Class -2	Class-3	SAMPLE RDF
Sulphur	<1.5%	<1.5%	<1.5%	0.30%
Moisture content max permissible	<15%	<20%	<30%	3.72%
Ash	<10%	<10%	<15%	<15 %

Table 6: Quantification of pellet production

Year	Pellet production (in tonnes)	Per kg cost	Economic Value (in INR)
2021	1088	35	38,080000
2031	1411	45	63495000
2041	1814	55	99770000
2051	2361	65	153465000

Conclusions

The present paper explains a research study at laboratory scale for conversion of municipal solid waste into fuel pallets as an alternate fuel partly to address environmental pollution caused on account of such wastes and partly to give environmentally sustainable solution with economic benefits. In the present context, a case study has been taken for Newai, Tonk District of Rajasthan, India. The authors have predicted the population up to the year 2051using different forecasting methods and estimated municipal solid waste generation on a time scale to provide long term vision and sustainability. The study tends to reveal that an economic value worth 38 million rupees can be generated from the waste generated in Newai during 2021 which is likely to be increased to 153 million by 2051. However, authors strongly feel that such studies should be conducted on bigger scales on periodical level and should then be applied in practice at different places to address the growing problem of municipal waste generation and its disposal. All such studies should be encouraged at all levels.

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