International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 03 | Mar -2017 www.irjet.net p-ISSN: 2395-0072

Kagal Solid Waste Treatment - A case study on an option for solid waste treatment in urban cities

Mr. Gandhar Abhay Pandit[1], Miss. Samruddhi Shivraj Jagtap[2]

[1]U.G. Student, Department of Environmental Engineering, KIT's College of Engineering, Kolhapur, Maharashtra, India

[2]U.G. Student, Department of Environmental Engineering, KIT's College of Engineering, Kolhapur, Maharashtra, India

---

Abstract - *Waste treatment and management has now become a crucial problem due to the inadequate and insufficient collection, disposal and treatment techniques, we are facing a severe problem of environmental pollution. It is the duty of the local governing authorities to provide proper solid waste treatment and management techniques in order to keep our city hygienically clean and environmentally healthy. Even though disposal of the solid waste has become a serious techno-economic problem for treatment, Kagal Municipal Council is working & planning towards making the city clean. One method used in order to reduce this grave problem of disposal is the conversion of the wet waste to electricity. This paper includes the technology adopted by the Kagal Municipal Council that involves the utilization of the solid waste generated as a resource for the generation of electricity. This paper includes everything right from the way collection of solid waste is done to the generation of electricity using the anaerobic digester.*

Key Words: Solid waste management, anaerobic treatment, methane, electricity, manure.

1. INTRODUCTION

Rapid urbanization and industrialization in India has led to the migration of people to towns and cities thus generating thousands of tons of Municipal Solid Waste (MSW) daily. According to the 2015, CPCB report, the estimated solid waste generation in the country is around 1.43 lakh tons per day. The report said that cities like Pune, Mumbai, Ahmedabad, Agra, Bangalore, Bhopal, Chennai, Delhi, Hyderabad, Jaipur, Kanpur, Kolkata, Lucknow, Nagpur and Surat, among others, have an estimated waste generation of more than 500 tons per day. Poor collection, inadequate transportation and insufficient space to treat the waste of entire city are responsible for the accumulation of MSW at every corner. Unscientific disposal and treatment has lead to an adverse impact on all components of the environment and human health. Solid wastes are usually defined as the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the first user. Rapid increase in population has lead to the increased rate in waste generated from several sources such as domestic wastes, commercial wastes, institutional wastes and industrial wastes etc.

Rapid population growth and increase in per capita waste generation have resulted in a 50% increase in the waste generated by Indian cities within only a decade since 2001. There are 53 cities in India with a million plus population, which together generate 86,000 TPD (31.5 million tons per year) of MSW at a per capita waste generation rate of 500 grams/day. Such a steep increase in waste generation has severed the stress on all available natural and budgetary resources.

1.1 Kagal Solid Waste Treatments

Kagal situated 12 km from Kolhapur city (16.58°N 74.32°E) is a historically rich city located in the south west of Maharashtra State. Kagal has the honor of having the first textile cluster (5star MIDC) in western Maharashtra. Kagal has been on the tourist map of India, both Hindu and Muslim pilgrims visit the famous Gaibee Peer. The Kagal Municipal Council is collecting 10 to 11 Tons MSW per day. The average waste generation is only 200gm per capita per day. The city is registering almost 15% extra growth rate compared to similar other cities in India. This is leading to rapid development of real estates, housing, complexes etc. Consequently the per capita MSW quantity has been estimated to reach 300 gm/day by 2016 as per DPR. The present population as per census 2011 is 35,075.

The population growth rate of the city during the last decade has been 35% according to this calculation the estimated population in 2016 will be 47,351 and by the year 2032 it will be 63,993. Keeping above facts in view the projected quantity of MSW is 10 TPD by the year 2016 and 22 TPD by the year 2032. KMC is doing collection & segregation on its own. Collection and transportation includes door to door collection of solid waste through Ghanta Gadi and transportation to Municipal Solid Waste Treatment Facility center. Solid waste is collected from 6000+ households in 17 wards of the city through 6 vehicles. Approximately 14-15 trips per day are done by these vehicles.

Table no. 1.1
No. of establishments covered by door to door service

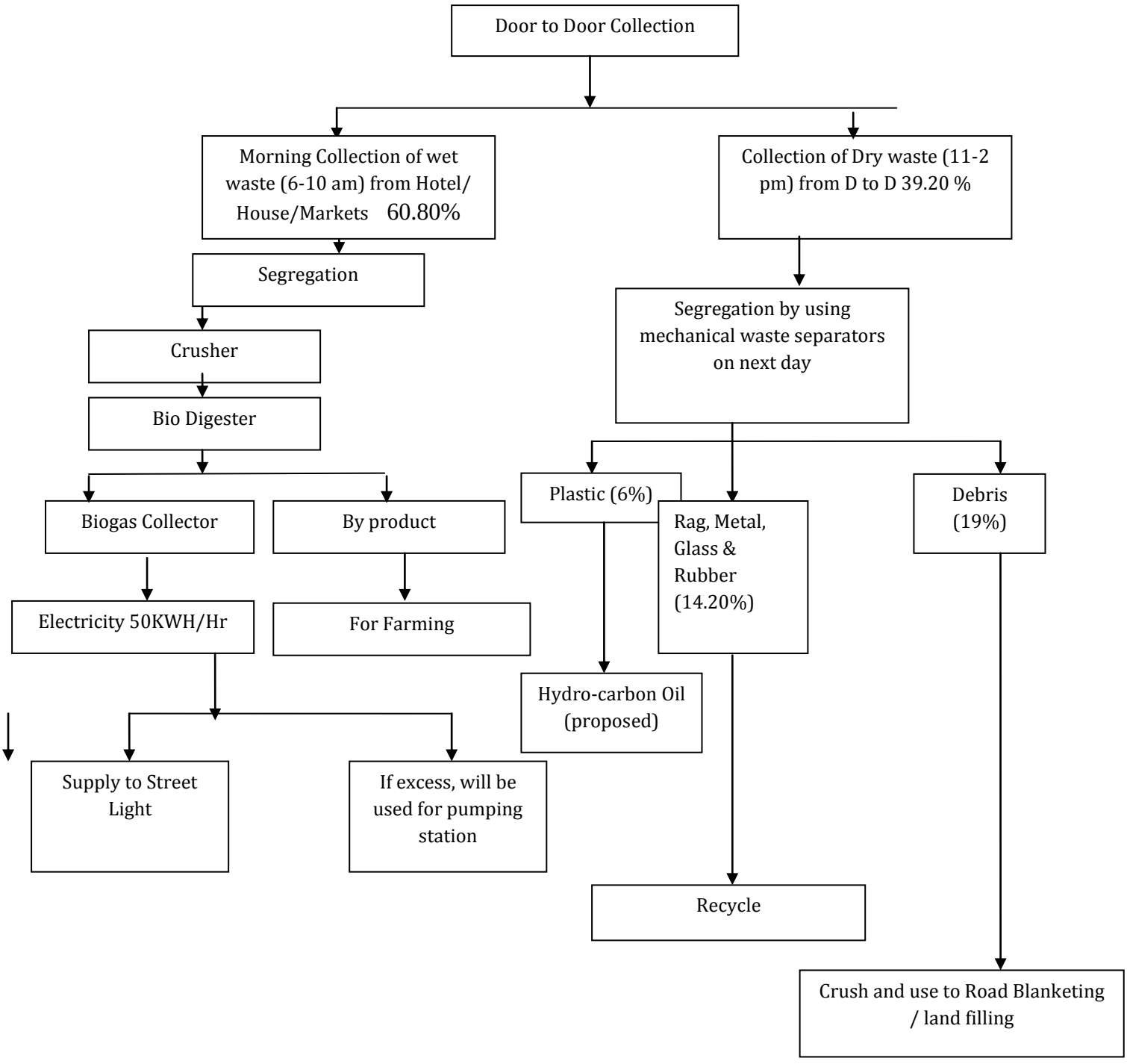
Sr. No	Establishment type	Total no.
1.	House holds	7200
2.	Hotels and restaurants	34
3.	Commercial establishments	--
4.	Temporary vegetable market	2
5.	Slaughter house (small)	1

Table no. 1.2
Details of Solid Waste Transportation Vehicles

Sr. No	Types of vehicles	Total No.	Capacity Tons
1.	Mini compactor	1	2
2.	Tractor trolleys	3	1
3.	Ape rickshaws	5	0.5

Considering quantity and composition of Municipal solid waste generation in Kagal, a composting plant was set up under the Kagal Municipal Council to generate compost and electricity from the city refuse. The plant is located about 2 Km from the Kagal Bus Stand within an area of 12.5 acres. The plant is being operated by Kagal Municipal council. The plant has the capacity to handle 63 KWH of energy per day. The remaining waste is being dumped besides the plant or is sending for recycling. The base of the project is PPP (Public Private Partnership). The municipal council share is 80% and private share is 20%. The total project cost is Rs.3.52 Cr. From this project Kagal Municipal Council becomes self dependent in electricity demand. The municipal council gets around Rs. 1.25 -1.50 lakhs per month income through recycling and composting of MSW.

2.0 Flow sheet



2.1 Stage 1 Collection

The solid waste is collected from all the houses in Kagal by means of truck. The door to door collection of the solid waste is done in two phases viz.

I. Bio degradable waste is collected during the morning hours
II. Non bio degradable waste is collected during the evening hours.

Separate collection for vegetable market waste is carried out on Monday and Thursday (60% wet waste). Hotel waste is collected in the morning and the evening (80% wet waste).Slaughter house waste (except feathers) is also collected.

2.2 Stage 2 Segregation

Here the separation of biodegradable waste and non biodegradable waste is done.

1. Bio degradable waste is segregated on table and sent to a crusher and then to green box of capacity two ton each. From this biodegradable waste about 280 m3 of biogas is generated that is stored in a balloon. Generally the lemon and onion peels are removed from the wet waste as they tend to fluctuate the pH.

2. Non biodegradable waste is separated by two sieve separators of capacity one ton each. Materials like plastic, rubber, etc are recycled and sold out. Some of the materials are also auctioned or given to the rag pickers.
3. The building debris is sent to a crusher unit after which it is used for road blanketing, landfill, etc.

2.3 Stage 3 Crushing

As the organic waste is in various sizes, it is shredded in the crusher to form fine slurry and water is added to this shredded waste in the proportion 1:1. The fine slurry helps the bacteria to consume the organic matter efficiently and in a short period. Apart from this the fine slurry of waste is easier to digest as compared to the regular waste particles.

2.4 Stage 4 Bio Digestions

The biodegradable waste is set to two Green Boxes where generation of biogas takes place. Green boxes are nothing but the bio digester which is air tight reactors in which organic waste is decomposed and transformed into biogas by a biological process called anaerobic digestion. It is like a mechanical stomach.

It is fed with waste slurry, which is broken down (decomposed) by micro-organisms (bacteria) is an oxygen-free (anaerobic) environment via a process called as anaerobic digestion, to produce biogas (methane and carbon dioxide) and other material that is mainly used as fertilizer. Anaerobic digestion is a four stage process consisting of hydrolysis, fermentation i.e. conversion of non soluble organic bio mass to soluble organic compounds, acidification i.e. conversion of volatile fatty acids to acetate and hydrogen gas and finally methane formation. The final product is a mixture of methane (CH_4), carbon dioxide (CO_2) and other trace gases.

In bio digester, the pH is generally kept in the range of 7.0 to 7.5 i.e. neutral ranges. A temperature of 38-41°C is maintained in the green box. Here cow dung (1:7) and water hyacinth (1:9) are added which helps to accelerate the growth of culture and in order to provide necessary nutrients to the micro organisms present in the green box. There are two green boxes each of 2 tons.

2.5 Stage 5 Gas Separators

After the decomposition of the waste in the green box, the gas which is produced from the process needs to be separated from the waste. So gas separators are provided in order to separate the gas from the by product. The gas is further sent to the generation of electricity and the left over by product from this separator is sent to manure beds for preparing vermin compost.

2.6 Stage 6 Gas Collectors

After the gas separator, the generated gas is sent to gas collection balloons. There are two balloons of 60m3 capacity each. Generally out cuff valves are provided for safety purpose. Once the gas is filled in the balloons up to desired level, the valves are automatically closed and the excess gas is burnt off in order to avoid air pollution due to methane. Minimum of 3 bars and maximum of 5 bars pressure is maintained in the balloons. This gas includes around 65% of methane, moisture, CO_2 and H_2S. CO_2 and H_2S are separated by using a scrubber whereas moisture is removed by means of moisture separator.

2.7 Stage 7 Electricity generators

A 63 KV generator has been installed for generation of electricity from the gas. The electricity generated is about 500kw/day which is used to illuminate 3 km street lights and existing Underground Street light. Also 900 street lights of 35 vat CFL/metal halides are laminated and the remaining electricity is supplied to the pump house.

2.8 Stage 8 Composting

The by product from the gas separator is used for making the vermin compost. The by product is mixed with the cow dung and is kept in layers along with earth worms for 26 days in moist condition. After 26 days, the product is again kept from stabilization without earth worms for the next 28 days. After 28 days the dried waste forms good quality manure which is then sieved and stored in the plastic bags. The 10% manure generates daily from 4 ton of wet waste containing 3 times more nitrogen than other organic manure.

Table no.1.3
21 days study observation table

Date	Total Feeding (kg)	KWH
1	-	57.5
2	535	57.6
3	-	58.4
4	580	58.6
5	-	58.9
6	-	58.9
7	925	59.0
8	-	59.6
9	-	59.7
10	-	59.9
11	495	60.0
12	-	60.3
13	-	60.6
14	521	60.7
15	-	60.9
16	510	61.3
17	-	61.8
18	-	62.0
19	524	62.1
20	650	62.2
21	-	62.8

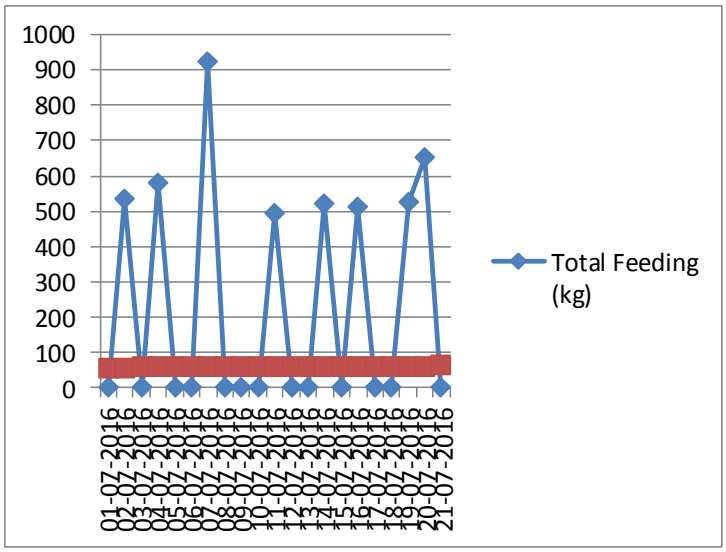


Chart 1.0.
21 days study observation table

3. CONCLUSIONS

- Kagal Municipal Council's waste treatment plant proves to be one of the efficient ways of treating the solid waste. It provides an epitome of the treatment for cities having low population. Thus the small cities can easily replicate the model in order to have efficient waste management system.
- Other objectives like employment generation and aiding the economy is accomplished. Usually the compost prepared from the project is sold to the nearby famers at rate of ₹5 per kg. It generates revenue as well as helps in reducing the burden on the local authorities by the treatment of waste generated.
- This treatment system requires less area as compared to other treatment options, it maybe a feasible option in case of metro Politian cities. Such type of plants can be executed for two or three wards or for group of buildings. It is a good and proven example of Solid Waste Disposal & Treatment Plant.

ACKNOWLEDGEMENT

We would like to express our gratitude to **Mr. Nitin Kamble**, Sanitation Officer, Kagal Municipal Council for permitting & supporting us for the carrying out a case study at one of their Solid Waste Management plants without which this work would not have been possible.

We also express our sincere thanks to **Prof. R. A. Nikam**, H.O.D., Dept. of Environmental Engineering, and KIT's College of Engineering, Kolhapur and **Mrs. Manjusha Sarnobat**, Asst. Professor in Dept. of Environmental

Engineering, KIT's College of Engineering, Kolhapur for their valuable support directly & indirectly in the successful completion of this case study as well as for their constant encouragement throughout the work.

REFERENCES

1. Ministry of Urban Development, Government of India, "*Manual on Municipal Solid Waste Management*", 2000 Edition.

2. Getahun T[1], Gebrehiwot M, Ambelu A, Van Gerven T, Van der Bruggen B"*The potential of biogas production from municipal solid waste in a tropical climate."* Environ Monit Assess. 2014 Jul;186(7):4637-46. doi: 10.1007/s10661-014-3727-4. Epub 2014 Apr 4.

3. MOMOH, O.L. YUSUF; NWAOGAZIE, L. Ify *"Effect of Waste Paper on Biogas Production from Co-digestion of Cow Dung and Water Hyacinth in Batch Reactors "*J. Appl. Sci. Environ. Manage. December, 2008 Vol. 12 (4) 95 – 98

4. A. Apte, V. Cheernam, M. Kamat, S. Kamat, P. Kashikar, and H. Jeswani ." *Potential of Using Kitchen Waste in a Biogas Plant".* International Journal of Environmental Science and Development, Vol. 4, No. 4, August 2013

5. http://www.iitk.ac.in/3inetwork/html/reports/IIR 2006/Solid_Waste.pdf

6. http://www.nswai.com/DataBank/Reports_pdf/reports_aug15/A%20PROPOSAL%20FOR%20SOLID%20WASTE%20MANAGEMENT.pdf