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Status and Challenges in Solid Waste Management: A case study of Aligarh City

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Abstract: **Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. Estimation on the quantity and characteristics of municipal solid waste and its forecasting over the planning period is the key to a successful management plan. A case study of Aligarh city is carried out to know its solid waste management systems. This study also presents the estimation on the quantity and characteristics of municipal solid waste and its sustainable management options in Aligarh city. Study has revealed that the amount of municipal solid waste collected by the private body in Aligarh city is of the order of 300 tons per day. Segregation of waste at source is neither practiced by the residents nor by the private collectors. It was found that the collection efficiency of the private operator & Aligarh Municipal Corporation is about 80%. The energy value is not utilized or captured as organic wastes are in higher amount in total waste. Present Practices of SWM in Aligarh city are very weak. Approximately 80% of the collected wastes are disposed as open dumping. There is no sanitary landfill in Aligarh City. So finally the design of sanitary landfill for Aligarh city was carried out for future years.**

Keywords: Municipal solid waste, Solid Waste Management, Aligarh, Sanitary landfill

1. INTRODUCTION

A solid waste management (SWM) system includes the generation of waste, storage, collection, transportation, processing and final disposal. Solid waste management (SWM) is a basic public necessity and this service is provided by respective urban local bodies (ULBs) in India. SWM starts with the collection of solid wastes and ends with their disposal and/or beneficial use. Proper SWM requires separate collection of different wastes, called source separated waste collection. Indian cities are still struggling to achieve the collection of all MSW generated. Metros and other big cities in India collect between 70-90% of MSW. Smaller cities and towns collect less than 50%. The benchmark for collection is 100%, which is one of the most important targets for ULBs at present. This is a reason why source separated collection is not yet in the radar.

The aim of this work was to analyze the present status and future challenges of solid waste management system in India. Within this aim, Aligarh city was examined for its solid waste management system. A sanitary landfill was also designed for Aligarh city since it does not have any sanitary landfill.

2. STATUS AND CHALLENGES OF SWM

The Census of India classifies cities and towns into 4 classes, Class 1, Class 2, Class 3, and Class 4, depending upon their population. Waste generation rate in Indian cities ranges between 200–870 grams/day, depending upon the region's lifestyle and the size of the city. The per capita waste generation is increasing by about 1.3% per year in India However the average per capita waste generation in Urban India is about 0.5 kg/day. Table 1 shows the per capita waste generation rate depending upon the population size of cities and towns.

A major fraction of urban MSW in India is organic matter (51%). Recyclables are 17.5 % of the MSW and the rest 31% is inert waste. The average calorific value of urban MSW is 7.3 MJ/kg (1,751 Kcal/kg) and the average moisture content is 47%(Sharholy et al., 2007; Shekdar,2009). It has to be understood that this composition is at the dump and not the composition of the waste generated. The actual percentage of recyclables discarded as waste in India is unknown due to informal picking of waste which is generally not accounted.

In India, some of the future challenges for the management of solid waste are increasing quantities and changing composition, increasing severity of adverse impacts, increasing cost of waste management, limited policy framework and lack of political priority.

A CASE STUDY OF ALIGARH CITY

Aligarh city is situated in the western part of Uttar Pradesh on Delhi-Kolkata Railway link and historical Grand Trunk (GT) road. It is situated at a distance of 130 km southeast of Delhi, the capital city of India. The Aligarh District has an area of about 5014 sq. km with city occupying an area of about 34 sq km. The population of Aligarh city is about 8, 72,575 as per census 2011 which makes it medium-sized as per Indian statistics. The population density in the district is 1007 per Km^2 and in the city 14115 per Km^2. The city lies at 185 m above the mean sea level (MSL) in a low-lying area in between plains of two major plains, Ganges and Yamuna.

A Haryana based private agency A2Z had got the contract from of Aligarh Municipal Corporation on a BOOT basis for a period of 30 years. The company has been awarded contracts to handle 220 TPD of MSW. The total project cost of Rs.34.17 crores is to be partly funded by debt, partly by equity and balance by way of capital subsidy from the Municipal Corporations. The company had tied up for a debt of Rs.11.50 cr and operations was effected from February 2011.

The scope and operations of Private Company include door-to-door Collection (D2D), Transportation, Resource Recovery and Disposal of Remnants in Landfill. Private company came into existence in Aligarh in May 2010 and D2D collection started in June 2011. However this firm did not achieved its aim and in January 2014, due to financial problem this firm had limited their work of SWM from 7 zones to only 2 zones. Remaining 5 zone of the city is covered by AMC for its MSWM from January 2014.

Currently AMC & A2Z both are working together for SWM and they are only collecting the wastes from the city. Presently Aligarh has no proper disposal method. The wastes are being openly dumped onto low lying areas in the outskirts of the City. The disposal sites of Aligarh city were located within 5 Kms from the city limits. Some of the disposal sites are Chilkora, Quarsi, Mathura Road and Goolar Road. Table 2 shows the average quantity of MSW generated per day in Aligarh city.

Table 1: Per capita waste generation rate based on the population of cities and towns (NEERI, 2010)

Original Classification	Classification for this study	Population Range (2001 Census)		No. of Cities	Per Capita Kg/day
Class 1	Metropolitan	5,000,000	Above	6	0.605
	Class A	1,000,000	4,999,999	32	0.448
	Class B	700,000	999,999	20	0.464
	Class C	500,000	699,999	19	0.487
	Class D	400,000	499,999	19	0.448
	Class E	300,000	399,999	31	0.436
	Class F	200,000	299,999	58	0.427
	Class G	150,000	199,999	59	0.459
Class 2	Class H	100,000	149,999	111	0.445
Class 3		50,000	99,999	6	0.518
Class 4		20,000	49,999	4	0.434
		10,000	19,999	1	0.342
	Total			**366**	

Table 2: Average quantity of MSW generated per day in Aligarh city

Types of Waste	Quantity in tons / day	Item	Percent by weight	Parameters	In % except pH and calorific value
Domestic	280	Organic Content	55.2	pH	6.4 – 8.3
Commercial Waste	45	Inert/ Stones / Ashes	19.6	Moisture Content	15.0 – 25.0
Institutional Waste	65	Paper	12.8	Volatile Matter	28.0 – 30.0
Industrial Waste	10	Plastic	4.5	Ash	40.0 – 45.0
Street Waste	15	wood	0.6	Fixed Carbon	10.0 – 12.0
Total Waste = 415 tons/day		Bones	2.3	Calorific Value	1500 – 1800 (Kcal / Kg)
		Metal	1.8	Compostable Matter	13.0 – 15.0

3. DESIGN OF SANITARY LANDFILL FOR ALIGARH CITY

The landfill is envisaged for necessary lining system, using the locally available clay after compressing, named as Engineered Sanitary Landfill.

Quantity of solid wastes/day= 451,000kgs = 451tonnes

As per BIS

Thickness of clay liner = 0.5 m

Height of the each lift = 3.0 m

No. of lifts provided = 1.0 m

Thickness of cover between lifts= 0.2m

(0.15 m to 0.3 m)

Diameter of lateral and main drains provided = 0.15 – 0.2m

Thickness of top cover = 0.65 m (0.6 m- 0.8 m)

Assume total height of landfill = 4.5 m

Volume of solid wastes to be dumped/day =

Weight / Density

3.1. Landfill capacity for first five years (2014–2019)

Rate of solid waste generation = 451 tonnes per day

Out of which only 16 percent of solid waste (i.e. 72.16t/day) is to be disposed by land fill.

Take density of solid waste as 0.75 t/m^3

Volume of waste/day =72.16 t/day/ 0.75 t/m^3= 96.21 m^3 / day

Volume of waste per annum = 96.21 x 365 = 35117.86 m^3/year

Reduction in volume due to settlement = 0.1 x 35117.86 m^3= 3511.79 m^3

Volume of liner and cover systems = 0.25 x 35117.86 m^3= 8779.47 m^3

Total volume of landfill = 35117.86 + 8779.47 – 3511.79= 40385.54 m^3 / year

Assume height of landfill as 4.5 m,

Area required = 40385.54 m^3 / year / 4.5 m= 8974.56 m^2 / year

Similarly landfill capacity can be calculated for next five years & so on.

4.2. Liner and leachate collection system

(a) The liner system will comprise of the following layers below the waste:

0.3m thick drainage layer comprising of coarse sand or gravel, 1m thick clay-layer / amended soil layer.

(b) *Leachate collection pipes.*
Diameter of perforated pipes = 15 cm
Spacing of pipe required = 32 m
(c) *Leachatetreatmentplant*

1. Collectionsump(2.5m diameter,3.5mdepth)
2. On–linelimedosagesystem
3. On-linepolyelectrolytedosagesystem
4. Clarifier(3mdiameter,3.5mdepth)
5. Clarifiedwatersump(2.5mdiameter,3.5mdepth)
6. PressureSandFilter(0.45mdiameter,2.15mdepth)
7. PressureCarbonFilter(0.3mdiameter,2.15mdepth)
8. On-linechlorinedosagesystem

4.3. Cover systems

The cover system will comprise the following layers above the waste:

1. 0.45m thick gas collection layer comprising of gravel (stone dusts with no fines)
2. 0.6 m thick barrier layer (sandy soil + 5 percent bentonite)
3. 0.3m thick surface layer of local top soil for vegetative growth. Passive gas vents 1m high (above GL), will be provided at a spacing of 32m x32m.

4.4. Landfill infrastructure and layout

1. Site fencing: all around the landfill
2. Weigh bridge (computerized): 50t capacity with office
3. Administrative office: 10m x 5m building
4. Equipment workshop and garage: 30m x 20m building
5. Temporary holding area: 20m x 10m (To hold one month waste)
6. Leachate treatment facility: 20m x 10m tentative
7. Surface water drain: Adjacent to arterial road
8. along periphery
9. Leachate collection pipe: Adjacent to arterial road along periphery
10. Access roads Main access road: 7m wide from main road to landfill area
11. Arterial road: 3.5m wide all along the periphery

Figure 1 shows the layout of engineered sanitary landfill.

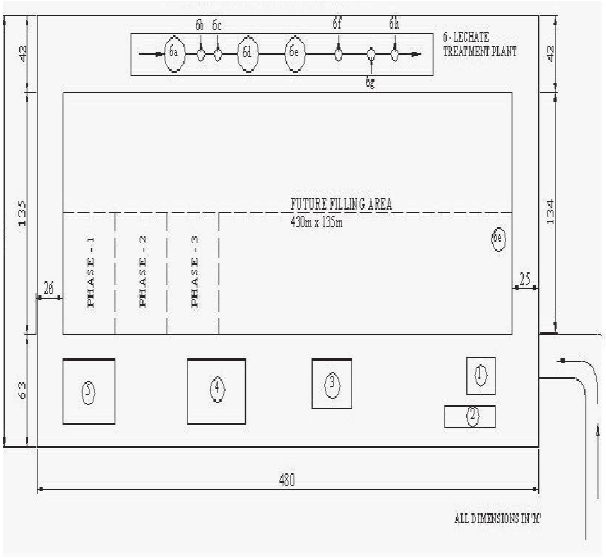

Fig. 1: layout of engineered sanitary landfill

1. Weigh bridge (10m x 10m),
2. Office room (10m x 5m),
3. Inspection / screening facility (10m x 10m),
4. Equipment workshop (30m x 30m),
5. Temporary holding area (30m x 30m),
6. Effluent treatment plant, 6a-Collection sump (5m dia, 7m depth), 6b-on-line lime dosage system, 6c-onlinepolyelectrolytic dosage system, 6d-clarifier (6m dia, 7m depth) 6e-clarified water sump (5m dia, 7m depth), 6f-pressure sand filter (0.90m dia, 4.3m depth) 6g-pressure carbon filter (0.60m dia, 4.3m depth), 6h-on-line chlorine dosage system,
7. Phase I, Phase II etc.

5. CONCLUSIONS

- Aligarh MSW has a very similar composition to that of other medium-sized Indian cities. Organic content in the waste was found highest (55.20%), Inert (19.60%), paper (12.8%), plastics (4.5%), clothes (2.8%), bones (2.3%), metals (1.8%),wood (0.6%) and others (0.4%).
- Study has revealed that collection efficiency of the private operator & AMC is about 80%. Except in some areas or colonies, the waste was not found in the road-side bins or open dump sites after their collection hours.
- The energy value is not utilized or captured as organic wastes are in higher amount in total waste.

- Present Practices of SWM are very weak in Aligarh. Wastes are not collected and transported effectively.
- Approximately 80% of the collected wastes are disposed as open dumping.
- Study shows that that solid waste management of Aligarh city has been significantly improved after the involvement of private sector.

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