ECO-FRIENDLY MANAGEMENT OF INSTITUTIONAL SOLID WASTES IN PROOF & EXPERIMENTAL ESTABLISHMENT AT CHANDIPUR OF ODISHA

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ABSTRACT

Similar to any other institution considerable quantity of both Biodegradable and Non-biodegradable wastes are produced during routine official activities at Proof & Experimental Establishment (PXE), an ISO 9001 : 2008 certified premier establishment of Defence Research & Development Organization (DRDO). After carrying out a survey for quantifying the waste materials following four options are adopted for management of solid wastes at PXE instead of older practice of open burning or dumping in low lying field for filling up the areas : (a) Non-biodegradable but sellable wastes such as fired ammunitions, & their used cartridges, fuzes and primers; condemned metallic stores, unserviceable MT vehicles and their parts; hard plastic covers of different parts of ammunitions; unserviceable instruments, etc. which are sold to outside vendors by auction through Metal Scrap Trading Corporation (MSTC), Visakhapatnam, (b) Non-biodegradable but non-sellable waste materials such as broken glasses, used plastic sheets / bottles / packets, thermocole packing materials, rubber scraps, leather goods and small metallic items, damaged electronic parts like computer floppies, CDs, printer ink, ribbon, different instrument's defective parts, etc. are dumped being hazardous and toxic in nature inside the soil pit away from the office area, (c) Biodegradable wastes like used paper, cardboard, damaged book, condemned office files, old brochures, small and unimportant reports, flower garden wastes, lawn cuttings, sweeping wastes and packing materials made of jute, cloths and straw, etc. are collected and vermicomposted using *Eisenia foetida* earthworms, and (d) Canteen wastes is converted to biogas for its utilisation in cooking in canteen, thus saving costly LPG. Vermicompost, being good quality organic manure, is used in arboriculture gardening. These techniques together have helped to maintain pollution free hygienic environment in the institute premises.

Keywords : Biodegradable wastes, Biogas production, Dumping of wastes, Environmental pollution, Institutional solid wastes, Non-biodegradable wastes, Vermicomposting

Introduction

Scientific management of solid wastes is a matter of great concern to all management authorities as solid waste not only pollutes air, water and soil during burning or dumping openly in low land but also encourages animal menaces like dog biting, snake biting, killing of stray animals and spreading of animal borne deadly diseases like plague, malaria, dengue, etc. Human beings, whether present within houses or in the offices or in

the markets, produce a considerable quantity of solid wastes during day to day activities. Rapid advancement in technologies, economic liberalization & globalisation and modern comfortable life styles help to generate a considerable quantity of electronic wastes (e-wastes) in the form of obsolete or defective televisions, radios, stereos, computers, servers, monitors, CD players, telephones, cellular phones, pagers, calculators, printers, scanners, copiers, fax machines, electric lamps, microwave ovens, refrigerators, air conditioners, washing machines, automobile catalytic converters, sensors, alarms, sirens, DVDs, CDs, floppies, tapes, printer cartridges, printed circuit boards, etc. About 146,180 tons of e-wastes are produced every year in India while USA and Germany generate about 2,124,400 and 1,100,000 tons e-wastes per annum respectively (Sannigrahi, 2011). Municipal Solid Wastes (MSW), the wastes generated in the municipality area, usually include Residential wastes, Institutional wastes, Commercial wastes of market areas, Street sweeping wastes, Construction & demolition wastes, Dead animals & slaughter house wastes, Electronic wastes and vehicular wastes. Both Industrial wastes and Hospital Bio-medical wastes, though dumped sometimes in the dustbin of municipalities, are not considered as MSW since both 'Hazardous wastes (Management and Handling) Rules, 1989 & 2000 and Bio Medical Waste (Management and Handling) Rules, 1998 of India have separate guidelines to manage those problematic wastes. According to the Central Pollution Control Board of India (CPCB, 2012), the Municipal Solid Waste (MSW) generation in 59 cities of India has increased to 50,592 tons per day in 2010-11 from 30,058 tons per day during 1999-2000. Kumar et al., (2009) recorded that the average per capita per day MSW production varied from 0.21 to 0.50 kg in India. In a survey in Chandipur Defence residential quarters during 2005 it was found that about 200 to 770 g biodegradable solid wastes were generated per day by a family of 3 to 4 members, more generation in Officers' quarters who had higher purchasing capacity and also on weekly market days (Saha and Sannigrahi, 2013). Instead of dumping all wastes in dustbins of municipality / Estate Management Unit (EMU) if different wastes are segregated at the source as biodegradable and non-biodegradable wastes, then biodegradable wastes can be composted for preparing good quality organic manure essential for plant growth, sellable non-biodegradable solid wastes can be sold to Scrap dwellers for their recycling & reuse and non-sellable non-biodegradable wastes can be put in dustbins for their dumping either in landfill or in safer places inside soil. This type of processing will not only reduce the MSW load but also help the authority to keep the area clean and hygienic by disposing this reduced quantity of MSW effectively and to save considerable expenditure on transportation of MSW (Sannigrahi, 2002).

Details on PXE activities

Proof & Experimental Establishment (PXE) started functioning on the coast of Bay of Bengal at Chandipur in Orissa since 1895 for test and evaluation of weapons and ammunitions produced by Ordnance factories in its crescent shaped acquired range of 19.5 km in length and 3 km in width. For the last 120 years this establishment has grown from strength to strength with substantial progress in state-of-the-art instrumentation facilities. It was brought under the aegis of Defence Research and Development Organization (DRDO) in 1958 for performance test and evaluation of various naval and field guns, tanks, mortars, rocket launchers and various types of ammunitions, fuzes, primers, etc. either designed and developed by DRDO or produced by Ordnance Factories of India or procured from Foreign countries. During low tide the sea water goes back to about 3 km away from the coast and the vast area of this plain sea bed is used as Test Range where fired projectiles are not damaged due to soft cushioning effect of sea water &

wet sand and easily recovered for examining the strength of design. Each high tide fills up all craters formed on the sea bed due to landing of projectiles or its recovery and provides a level sea bed ready for fresh firing. Today PXE is an ISO 9001 : 2008 certified world class Test Range where approximately 1000 personnel (both civilian and service) work hand in hand, at times braving the scorching sun, high salinity coupled with humidity and intense monsoons for critical examinations and accurate recording of ballistic parameters which ultimately helps to build confidence among Indian Army and Navy to obtain safe and secured armaments regularly.

Types of solid wastes generated at PXE

Institutional solid wastes are both biodegradable and non-biodegradable wastes produced regularly within the campus during working in the government, private or corporate offices, educational institutes and research laboratories (Sannigrahi, 2007). PXE being an Armament Test and Evaluation Laboratory generates a huge quantity of non-biodegradable metallic scraps in the form of fired & recovered projectiles, cartridge cases, ammunition packing boxes of steel, aluminium made dummy missile targets, Instrument spare parts, unserviceable steel cupboards, racks, etc. Certain packing materials like polythene sheets or packets, thermocole materials, etc; electronic wastes, broken glass materials and different unserviceable parts of vehicles are also generated as non-biodegradable wastes. Biodegradable institutional solid wastes are paper wastes such as used papers, computer papers, carbon papers, condemned files, old newspapers, cartoon boxes, damaged books, reports, journals and magazines, etc; garden wastes like weeds, grasses, uprooted withered flower plants, lawn cuttings, etc; sweeping wastes such as dust particles and dry leaves of avenue trees grown within institute premises; wet canteen wastes like vegetable peels and cuttings, rotten vegetables, left over foods, used tea leaves, crushed bones, broken egg shells, etc. (Sannigrahi, 2007).

Unhygienic environment due to Faulty disposal Techniques

Except sellable scrap materials other non-sellable non-biodegradable solid wastes and biodegradable solid wastes were disposed of either by open burning or by dumping in low lying areas with a purpose to fill up the land. Highly poisonous dioxins and furans gasses were produced along with large quantity of smokes, carbon monoxide and carbon dioxide gases during open burning of plastic wastes, paper wastes and sweeping wastes together (The Hindu, 2000). Toxic Dioxins and Furans are responsible for immune dysfunction, cancer, hormonal changes and development of abnormalities. Smoke causes difficulty in breathing, dry throats and burning eyes. Open dumping of solid wastes containing food wastes makes stinky environment; attracts pigs, rats, snakes, dogs and flies; pollutes air, water and soil with heavy metals and harmful microorganisms; and spreads diseases like TB, cholera, dysentery, liver diseases, etc. (Kamalamma and Rajarajeswari, 1996; Sannigrahi, 2007).

Scientific management of solid wastes is an important part of Environmental Management System (EMS) of every organization generally concerned for providing a pollution free and healthy environment to its employees. A survey was carried out as a case study to find out the quantity of different types of solid wastes generated and also for adopting some scientific disposal system to avoid any pollution inside the premises.

Data collection

PXE has taken the help of a contractual service for hygiene maintenance inside the technical campus for regular sweeping the rooms, verandas of each building, roads, etc;

cutting of grasses and weeds from lawn, flower gardens and unused areas of the premises and collection of different wastes in weekly intervals. Data on monthly generation of different bio-degradable wastes were collected for one year to estimate the annual generation of those wastes at PXE.

Due to daily armament firing activities huge quantities of scrap materials are generated, maximum portion of which are sellable type and sold through auction tender by Metal Scrap Trading Corporation (MSTC), Visakhapatnam. Condemnation board is constituted every year in February – March for condemning the unserviceable and non-usable stores after completion of inventory stock taking activities. Data were collected from Material Management Division on sale proceeds of scraps and amount of revenue generated by PXEduring last five years.

In wet canteen of PXE about 100 people take their breakfast & tea and 350 people have their lunch daily. The quantity of canteen wastes generated daily was also estimated for finding out a viable solution.

For maintaining cyber security the disposal procedure of obsolete and unserviceable computer outlined by DRDO is strictly followed at PXE and those have not been taken into account during this survey.

Results and Discussion

Non-biodegradable but sellable scrap materials collected from PXE were generally separated into 9 different groups for their auction tender through MSTC. Details are mentioned in Table 1. Steel / iron scraps were fired ammunitions collected after recovery from sea bed, fired steel plates, cartridge cases, iron made condemned office items like cupboards, shelves, racks, etc. Steel boxes were the boxes used for carrying various ammunitions and their valuable parts. Brass scraps were different type of brass made cartridge cases ejected out of guns after firings. Wood scraps were the dead or storm broken trees and the long thick wooden boxes used for packaging gun barrels. These four types of scraps were generated in large quantities every year. Miscellaneous items were equipment / instruments / machineries beyond of their useful life.

Table 1 : Categorisation of non-biodegradable but sellable scraps

Sl. No.	Scraps	Collected as	Cost (Rs/kg)
1	Steel/Iron scraps	Fired plates, Used plate holders, Fired ammunition shells, Fired cartridge cases, Unserviceable MT vehicle parts, Workshop scraps, etc.	27
2	Steel Boxes	Ammunition carrying boxes, Ammunition packing cylinders, etc.	20
3	Brass scraps	Fired cartridge cases, Defective Fire fighting hose pipe fittings, etc.	354
4	Aluminium scraps	Used Dummy missile targets, Fired cartridge cases, etc.	100
5	Mixed metal scraps	Steel cup with ammunition primers	75
6	Hard plastic scraps	Fuze cases and other different ammunition parts carrying cases	20
7	Wood scraps	Dead trees, Trees broken by cyclonic storms, Pruned tree branches, Gun barrel carrying boxes, etc.	04
8	Miscellaneous Scraps*	Yearly Condemned store items including defective unserviceable instruments, Mini generator, UPS without battery, Xerox machines, printers, LCD desktop projectors, Cupboards, racks, Environmental chambers, Microwave test equipment, tarpaulin cover of vehicles, Jute and cotton cloth targets, Galvanized tins, ammunition carrying tin boxes, etc.	-
9	MT unserviceable items	Condemned vehicles, trailers, batteries, Tyre, tube, flaps, etc.	-

*Sellable metallic scraps were considered as iron scraps, some portion was also sold sometimes as particular items or as tin scraps, lead scraps, etc. Non-sellable miscellaneous items were dumped inside the soil pit.

The last five years' collection as mentioned in Table 2 shows that on an average, yearly about 52.3 ton steel / iron scraps, 31.8 tons steel boxes, 23.6 tons brass scraps, 18.7 tons wood scraps, 4.2 tons of mixed metal scraps, 1.1 tons aluminium scraps and 0.7 tons hard plastic scraps were generated. By selling above items revenue about Rs 4.5 crore was collected in the last five years with a yearly average Rs 90 lakhs and deposited into Government Treasury through MRO.

Table 2 : Quantity of sellable scraps collected and sold during 2009 - 2014

Sl. No	Scraps	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14	Total	Avg.
1	Aluminium scraps (tons)	2.6	1.7	0.4	0.2	0.4	5.3	1.1
2	Brass scraps (tons)	31.4	26.1	8.1	19.7	32.5	117.8	23.6
3	Hard plastic scraps (tons)	1.5	-	2.0	0.2	-	3.7	0.7
4	MT vehicular wastes (Nos.) a). Vehicles b). Battery c). Tyre d). Tube e). Flaps	 1 - 46 198 554	 - 45 - - -	 1 - 136 - -	 5 30 177 - -	 5 35 65 - -	 12 110 424 198 554	 - - - - -
5	Mixed metal scraps (tons)	2.8	7.9	-	-	10.5	21.2	4.2
6	Steel Boxes (tons)	51.6	33.6	10.9	-	62.7	158.8	31.8
7	Steel / Iron scraps (tons)	25.6	67.6	19.6	20.4	128.2	261.4	52.3
8	Wood scraps (tons)	61.6	16.1	13.3	-	2.5	93.5	18.7
Rs	Revenue Earned (Lakhs)	77.95	74.26	37.12	84.44	176.08	449.85	89.97

It was also recorded that during one year 140.3 quintal sweeping wastes (mainly the dry leaves of avenue trees), 17.0 quintal waste papers, 12.1 quintal garden wastes (mainly old flower plants, weeds and grasses obtained during cleaning the surroundings of buildings) and 55.9 quintal canteen wastes were produced in PXE premises as biodegradable wastes while 237 kg waste plastic / polythene (packets, bottles, sheets, etc), 27 kg thermocole packing materials, 89 kg broken glasses and about 200 kg condemned stores (instrument spare parts, defective calculators, used toners, printer cartridges, damaged CDs, floppies, etc.) were generated as non-sellable non-biodegradable wastes.

Generally sweeping wastes, garden wastes, paper wastes and plastic wastes were burnt earlier on daily basis, food wastes were thrown into drain during washing of dishes & canteen utensils and non-sellable condemned stores were dumped every year by digging a pit. But author demonstrated earlier that by mixing together sweeping wastes, paper wastes, garden wastes and canteen wastes along with one-fourth quantity cow dung more than one metre high aerobic composting heaps could be prepared on weekly basis and after two times mixing at 15 days interval good quality vermicompost could be prepared from that partially decomposed materials using epigeic earthworm, *Eisenia foetida* under a shade (Sannigrahi, 2007).

Chemical analysis of vermicompost prepared from biodegradable institutional solid wastes at PXE recorded the presence of 1.10 – 1.23 % total nitrogen, 0.15 – 0.31 % total phosphorus, 0.43 – 0.58 % total potassium (Table 3). The quality of vermicompost generally depends on the quality of resource materials from which it is made. However, these vermicompost prepared from biodegradable institutional solid wastes at PXE was

found not at all inferior in quality to other vermicomposts prepared earlier by the author from other type of biodegradable wastes (Saha and Sannigrahi, 2013; Sannigrahi, 2002; Sannigrahi, 2008; Sannigrahi, 2009; Sannigrahi and Chakrabortty, 2004).

Table 3 : Quality of vermicomposts prepared from different biodegradable wastes

Biodegradable wastes	Total Nutrient Contents (% dry basis)		
	Nitrogen	Phosphorus	Potassium
Institutional Solid wastes	1.10 – 1.23	0.15 – 0.31	0.43 – 0.58
Dry leaves of trees	*0.9 – 1.9*	*0.5 – 1.2*	*0.9 – 2.5*
Kitchen wastes	*1.2 – 1.7*	*0.7 – 1.0*	*1.4 – 2.0*
Residential wastes	*0.7 – 1.2*	*0.3 – 0.7*	*0.4 – 1.6*
Land weeds	*0.8 – 1.4*	*0.2 – 0.9*	*1.2 – 2.7*

Adopted Techniques for disposal

After the survey following techniques are adopted for proper disposal of institutional solid wastes in PXE. Burning, the easy but most polluting technique has been completely stopped. The existing procedure of selling the Non-biodegradable but sellable solid wastes to outsiders through auction by MSTC is continued. Two stage vermicomposting procedure (Sannigrahi and Sannigrahi, 2006), being very easy to follow even by the contractual workers collecting the biodegradable solid wastes in the PXE premises, has been adopted for producing vermicompost from biodegradable institutional solid wastes except wet canteen wastes. Processed vermicompost is used in arboriculture gardening work. One 4 cubic meter capacity Biogas plant produced and installed by M/s B – Sustain Energy Projects Private Limited, Chennai is in use at PXE for converting food wastes to biogas within 48 hrs. The gas is used for preparing tea, hot water, rice and special curry in canteen. Utilization of food wastes in a biogas plant at wet canteen helps to avoid stinky environment and also produces a considerable quantity of biogas, thus saving costly LPG gas. Instead of burning, all plastic wastes are stored for its future use during construction of durable and shiny roads inside the premises. The technique of using melted plastic wastes with bitumen during road construction is found highly effective in this coastal area (Sekhar, 2009). However, the dumping of non-biodegradable and non-sellable solid wastes is continued in soil pit.

Conclusion

Round-the-year proper management of solid wastes in the institute by above adopted procedures not only stopped unscientific and pollution prone burning or dumping system but also reduced the load of urban solid wastes. Since solid wastes management helps in economic gain through production of biogas and vermicompost, institute authority feels no problem to engage poor and less qualified youths as contractual labours for helping in this activity. Processing of biodegradable solid wastes into vermicompost and biogas helps to improve the soil quality as well as plant growth and also to save cooking fuel besides keeping the campus clean. Employees are also motivated to keep the premises clean and hygienic by arranging periodic awareness program on 'Reduce – Reuse – Recycle' principle of solid waste management.

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