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The Waste Crisis: Sources and Remedies

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Abstract:
Waste is a major environmental problem in all over the world. With the advancement in science and technology, exploitation of natural resources is also envisaged. With urbanization, more and more waste is produced and improper management, especially in India cause severe degradation to its inhabitants. In the present study, an attempt has made to study crisis due to waste production and their storage, collection, transportation, disposal. The study has been carried out on hazardous, non-hazardous, chemical, radioactive waste and its disposal. A study has revealed that how to tackle the waste crisis and what can be the solution for that either by incineration, solar techniques, or alternative technology. Now-a-days, an emphasis is given on waste management. For the maintenance of a clean environment, suitable methods of collection of waste and disposal, both solid and liquid are a need of the hour. Convert waste into useful products as useful resources or as building material is a dire need. The study is concluded that reducing the need for toxic by any of the methods is very important step for an individual to make. So, like the survival of democracy, the protection of individual health and safety is ultimately dependent on a citizenry that follows its own educated instinct.

Key words: *waste; waste management; incineration; solar techniques; recycling*

1. Introduction

The twentieth century was characterized by fast development of human civilization. During the last decades, industrialization has given many useful products to mankind, e.g. medicine, insecticides, drugs, dyes, plastics, cosmetics etc. which improve the quality of life on the earth. The dependence of human on all these products is increasing day by day and with a growth in population, more number of industries are established to produce these products in large quantity. With the advancement of technology, it produces various by-products which are harmful for the environment and cause severe pollution problems. There are adverse outcome due to the discovery of insecticide, drugs, pesticides leading to air, water, soil pollution, e.g. DDT accumulated in birds cause thinning of shells resulting in species decline.CFC from air conditioner, freezers deplete the ozone layer which protects us from harmful UV radiation of sun. In all over the world, People produce a variety of wastes –the inevitable and product of human activity. Most of the waste generates by developed countries like USA, And European countries. In developed countries, the waste products like plastic bags, broken toys, food waste old appliance, aluminium and tin cans when used are thrown away in municipal garbage. But in developed countries, especially in Africa, broken objects or used bottles are not casually discarded but are mended and restored to useful products. The refuse materials such as newspaper, foodstuffs, skin, clothes, leather, fish, etc., anything produced by human activity, is going to be waste somehow and somewhere. This is all due to increase in population and an increase in the standard of living. For example, in metropolitan cities such as Mumbai, India, more than 7000 tons of Municipal solid Waste (MSW) is produced every day.

2. Solid waste

Solid waste is defined as any discarded or insoluble material such as Municipal garbage, chemical, industrial, agricultural or even sludge. It can be rubbish, ashes (residue of combustion) etc. Most of these cannot be recycled for further use. Solid waste can be broadly classified as solid, liquid or gaseous form. Furthermore, waste may be hazardous or non – hazardous waste. Hazardous waste means toxic or even fatal to human which is produced by heavy industries. The hazardous wastes are improperly treated, stored, transported, Disposed of or otherwise managed. Non –hazardous waste are those which are produced in small industries or household activity (toxicity in small volume) poses no hazard to human life. As the urbanization increase, there is a corresponding increase in the population, and also there is an increase in per capita garbage more and more. This causes lack of places to dump our junk and

hazardous nature of waste, all adds to waste-crisis. The quantity of municipal solid waste depends on a number of factors such as food habits, living standard, and commercial activities. No doubt, with increasing urbanization and changing life style, Indian cities generate eight times more MSW than they did in 1947.Presently, about 90 million tones of solid waste are generated annually as byproducts of agricultural, industrial ,mining etc. A data in Table 1 clearly shows that average per capita generation of waste increase as we move from small cities to big metropolitan cities.

Population ranges (in millions)	Average per capita Garbage generation (gram/capita/day)
0.1 to 0.5	210
0.5 to 1.0	250
1.0 to 2.0	270
2.0 to 5.0	350
5.0 plus	500

Table 1: A View of Per Capita Garbage generation in Indian cities
Source: NEERI (1999)

A research analysis reveals that MSW generation rates in small towns are lower than those of metropolitan cities and per capita generation of waste range from 0.2 to 0.5 kg/day. It is also estimated that 217 million people living in urban areas have waste around 23.86 million tons per year in 1991 and more than 39 million tons in 2001. The quantity of waste generated in 2001 and 2011 is shown in Table 2. It can be seen that per capita generation is higher in metro cities due to rapid economic growth and high level of urbanization. No doubt, the syringes, dressing, medical waste, dead marine birds, toxic dioxin from paper mill- all these are signs of disturbing symbol of waste crisis. Therefore, all putrecible and nonputrecible waste, household waste, street waste, hazardous waste is also tragic signals of waste crisis.

Cities	2001		2011	
	Population	Waste per capita generation(kg/day)	Population	Waste per capita generation(kg/day)
Kolkata	13,205,697	0.580	17,405,109	0.662
Mumbai	16,434,386	0.450	21,660.521	0.514
Delhi	12,877,470	0.570	16,972,505	0.650
Chennai	6,560,242	0.621	8,646,349	0.708
Ludhiana	1,398,467	0.530	1,843,180	0.605

Table 2: A view of waste per capita generation in metropolitan cities (2001 and 2011)
Sources: NEERI

There are technologies to be used to prevent continued use of air and water as dumping grounds of waste. These wastes are either buried or burned. But still, these are not sufficient to overcome the ever increasing load of waste, so that our health, our earth, and our environment could be protected.

3. Waste disposal

Most of the waste is disposed of on land either in landfills, waste pile, underground injection wells or surface impoundments. The waste can be hazardous, non-hazardous, radioactive, medicine or household waste.

3.1. Hazardous Waste

Hazardous waste having an obnoxious foul looking smell is very difficult to handle. Hazardous waste can be diesel fuel, used oil, hydraulic fluid, waste paints, thinners, adhesive, computer monitors, and television with cathode ray tube, mercury containing demolition waste (fluorescent tubes, broken mercury switches), corrosive acids, reactive explosives such as cyanide, bleach, waste oxidizers etc. The central problem is the prevention of environmental contamination. Maximum hazardous waste is disposed of on land. About 5% of land disposed hazardous waste goes to landfills, 60% injected into underground wells, 35% into surface impoundments and less than 1% in waste piles. Hazardous waste landfills must have double lines and leach ate collection system. But, it is found that landfills are unlined and pose a serious threat to ground water.

3.2. Non-Hazardous Waste

Municipal solid waste (MSW) ends up in landfills. The problem confronting municipalities is the disappearance of disposal sites. The city's dump site is now overflowing with garbage. As the big cities are expanding and more populated, the cost of land also correspondingly increases. No doubt, the availability of new disposal sites decreases. This, in turn, leads to increase in the cost of

disposal. Obviously, municipalities try to find out new disposal sites to outer area or less developed cities. This creates a havoc situation to villages or less developed cities. So, MSW management is major environmental issue for the Indian government. In India, the waste generation annually is increase from 1 to 1.33%.Figure 1 clears that increasing rate of MSW from 1947 to 2047 under business as usual (BAU) scenario assuming the daily per capita waste generation in 1995 is 0.450 kg and increase is about is 1.33%.The calculated values of daily per capita waste generation in 1997 is 0.468 kg.

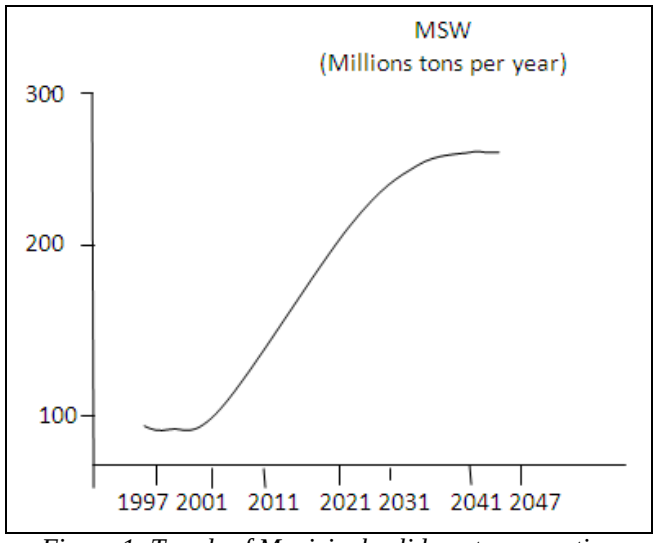

Figure 1: Trends of Municipal solid waste generation (Source: BAU Scenario)

It means waste quantity generation in 2047 will be approximately 260 million tons i.e. more than five times of the present level. This disastrous increase in level of waste would ne alarming signal for land required for disposal. So, amount of land required for disposal of MSW in 2047 would be 1400 square kilometer. Average depth of landfill site is 4 meter and average waste density is 0.9 tones/m^3

3.3. Chemical Waste

These include solid, liquid and gaseous chemical used for diagnostic and laboratory work. These are used in cleaning, housekeeping and disinfection purposes. One of the chemical used is formaldehyde which is used to preserve the biological specimen, tissues and also used in pathology, dialysis, autopsy and nursing units. In X-ray department, Hydroquinone solution, Potassium Hydroxide and acetic acid are used as solution in both developing and fixing. The various solvents such as methylene chloride, chloroform, xylene, methanol, acetone, isopropanol, toluene, acetonitrile, etc. are used in pathology and histology laboratories in hospital and engineering department. All these are chemical waste. Various inorganic chemicals waste mainly acids and alkalis like HCl, HNO_3, H_2SO_4, KOH .These wastes also includes oxidant like $KMnO_4$, $k_2Cr_2O_7$ or reductant like $NaHSO_3$, $NaSO_3$. Waste contaminated with huge amount of heavy metals also usually highly toxic. Mercuric waste from broken thermometers or blood pressure gauge, Cadmium from discarded batteries, arsenic in drugs are all chemical waste..

Actually, their hazardous nature can be described on the basis of properties like

- Toxicity
- Corrosive nature
- Flammability
- Genotoxicity

Chemical waste is first reviewed and classified by substances and level of danger and threat. Chemical can be solvents, oils, radioactive, spent organic acids, spent mineral acids. These chemical should be stored in leak proof, strong plastic preferably container. Then it is picked up for appropriate disposal. The EPA (Environmental protection agency) can be contained for guidelines on waste minimization and storage.

3.4. Radioactive Waste

The material produced in nuclear reactors is called nuclear waste. The main sources are commercial nuclear power plants and manufacture of nuclear weapons. In our cities, 75% to 90% of radioactive waste is produced by health care center. In a radiotherapy or laboratory techniques, i.e. unused liquid, contaminated glass wares, packages and absorbent paper contain isotopes such as radioactive Strontium-90, Iodine-131 and caesium-137.Spent commercial fuels also contain high level of waste but it still contains plutonium and uranium. These radioactive isotopes remain a hazard for a very long life time because their half life of several hundred to thousands of years. Some of the toxic metals have infinite half life, meaning that they last forever. These wastes containing toxic metals such as Cd or Hg are dumped into oceans or contaminate soils; their threat to ecosystem and to human health lingers indefinitely. So, the open

oceans and coastal marine areas dumping ground for kind of waste-raw, radioactive, municipal, sewage, sludge, drilling waste from offshore gas or oil operator.

4. Remedies

Before waste gets disposed of, there are numerous methods to change its form, i.e. reduce its effects, convert into useful purpose or recycle its components.

4.1. Incineration

It is a chemical treatment of processing waste. In this process, waste undergoes burn in the presence of oxygen. As the disposal sites are decreasing day by day, there is big question how to tackle the crisis, how we decrease the volume of waste. This is done by directly putting down municipal waste into the combustor. These plants not only reduce the volume of waste, but also produce electric power as a by-product. This is the best and economical method to convert waste into energy

Plastic waste industry also supports the idea of converting into energy. This also solves the problem of waste management. Big cities like Chennai or Mumbai set up the plant for energy recovery. In Chennai, 14.85 MW waste into energy is going to set up where 6000 tons /day of MSW would be converted into electricity .In developed countries like Sweden, 95% of heat generated from incineration is used for district central heating covering roughly 10% of the total power requirement. Indian waste composition is very different from the western countries. In India, waste into electricity follows following limitation:

- Calorific value of Indian waste is around 800 to 1000KJ/Kg which is very low. This need additional fuel for combustion, which thereby extra cost to operational cost. This is because Rag pickers retrieve most of the combustible materials from the dustbins and dump yards.
- Incineration changes the form of the waste, reduces its volume and weight, but does not destroy many of its hazardous components.
- Incineration techniques causes' air pollution and causes release of toxic gases like So_x, NH_3, dioxins or furan, generation of fly ash.

In fact, two new forms of waste are produced: gaseous emission and solid residue. Gases exit from the smokestacks of the incinerators and solid residue include ash from combustion chamber (bottom ash) and fly ash that rises up the smokestacks.

The most important toxic products are dioxin, furan, formaldehyde and toxic metals like Pb, Cd, Be, Hg, As. These metals are very harmful and can affect the nervous system, liver, kidney and other organs. These metals after incineration, its physical and chemical form is totally changed e.g. He is changed into a gas which is directly entering into air. Sometimes, these metals converted into small particles which escape through filtering device and enter into our lungs affecting respiratory system. Some of metal like lead after chemical treatment with HCl converted into lead chloride, which is more soluble in water and easily carried in our environment. Their levels are going higher and higher in the atmosphere and become a hazard for human and animals.

4.2. Solar Technology

Solar technology is being used to destroy toxic chemicals in industrial waste and polluted ground water. There are three ways to tackle the waste crisis:

- Contaminated water containing the catalyst pass through solar collectors that focus the sun's UV energy on the waste water mixture, about 90% of contaminates are destroyed.
- Sun's heat focus on collectors containing organic chemicals and catalyst. At temperature 1000^0C, organics are converted into CO andH_2, which further form CH_3OH as a fuel.
- Third way to increase the intensity of sun's heat by passing through quartz vessel containing dioxin. The high intense sun's heat breaks down 99.99% of the dioxin molecule into harmless compounds and also decomposes waste.

4.3. Recycling

The best way to avoid toxic waste is to make fewer toxins. There is wastage of time how to avoid toxic waste; rather we have to find out measures how toxicity can be avoided. Industries can reduce their use by improving manufacturing technologies. A Consumer can do it by consuming less. So, consumption can be reduced by a variety of ways like recycling, conservation or find substitute products for those which are toxic to the environment. One useful purpose of recycling by which discarded auto tyres can be converted into a wide range of new products like gaskets, mats, storage bins. The technique used is much more economical and produce very less harmful substances. The mixed plastics waste can also be converted into useful plastics. Some industries have developed ways to use toxic wastes of other industries e.g. certain chemical used in oil industry cannot be reused, but can be sold to cement manufacture for their subsequent use. In the absence of such practices, the toxic waste will go to landfill sites or other disposal sites.

4.4. Alternative Technology

There are three approaches to tackle waste crisis

- Finding an alternative for toxins: There are numerous chemical synthesis which involves the use of toxic solvents like methanol, acetone, formaldehyde etc. which is no doubt are hazardous. To avoid these toxic chemicals, there is need to find out green solvents which are not harmful. For sustainable development, green and biotic growing awareness approach, use of green solvent such as supercritical CO_2 is a better substitute for conventional and noxious solvents in organic synthesis.

These green solvents used in polymer production, extraction, cleaning process .These green solvents are of lower cost and improve efficiencies.

- Improved techniques to produce minimum toxins: Alternative fuel is becoming important due to diminishing fossil fuel resources, their high cost and environmental hazards. There is dire need, to promote alternative fuels such as gasoline, CNG, biofuels, electric vehicle, hydrogen, etc., which will reduce the pressure on trade and fuel production. CNG (compressed natural gas) has higher hydrogen to carbon ratio and no major changes are required for using LPG or CNG in vehicles. Biodiesel from vegetable oil, ethanol from sugarcane should be produced on a large scale.
- Increased efficiency of products so as to reduce toxins, waste: No doubt, energy conservation and recycling can help reduce the use of toxins, but a much better way to find out those consumer goods which are less toxic For example, some garden pesticides such as pyrethrum and some food preservatives such as acetic acid are less toxic. Another substitute for Styrofoam, which is not biodegradable replaced by popped corn used in the commercial packing application.

5. Conclusion

The major concern for hazardous waste, i.e. may be MSW, chemical, radioactive in India is illegal dooming sites, mismanagement of disposal sites, and mismanagement of disposal waste in the country. In India, industrial incinerators are not efficient and merit a combustion chamber and source of toxic products such as dioxin, furans. There is a dire need to establish a hazardous waste management facility (CHWMF) common for small and medium scale industrial units. There is need to develop alternative technology for eliminating hazardous and non-hazardous waste. Secured landfills and incineration techniques have enormous scope for management; treatment process in the environmental management programme of the country.It is only through right planning, designing and implementation of improved fundamental scientific methodology and multi-prolonged effort that one can protect human life from health and environment in an economically viable manner.

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