Industrial Solid Waste Management Practices in Medium Sized and Small Scale Industries

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Abstract:
The industrial solid wastes have done harm to the environment and human health. Efforts has to be made for controlling pollution arising out of the disposal of wastes by conversion of these unwanted wastes into utilisable raw materials for various beneficial uses. The problems relating to disposal of industrial solid wastes are associated with lack of infrastructural facilities and negligence of industries to take proper safeguards. The solid waste management practices among medium scale and small scale industries like mining industry, metallurgical industry, power industry, chemical industry, oil chemical industry, light industry and other manufacturing industries located in India are compared in this project. The data on various solid waste management elements from the concerned industries were collected and analyzed to identify the type of industries problems and how to prevention and control of pollution of industrial solid wastes.

Keywords: Industrial Solid Waste, Environmental Impact, solid waste management practices, Medium and small scale industries.

1. INTRODUCTION

Industrial solid waste refers to solid waste generated in production activities such as industry, traffic, and resource development. They include solid wastes, semi-solid wastes, and liquid and gaseous wastes in vessels that are not permitted to discharge into the environment. Industrial solid wastes are classified into organic wastes and inorganic wastes based on their components; into solid wastes, semi-solid wastes and liquid (gaseous) wastes based on their species; into hazardous wastes and common wastes based on pollution characteristics. Because many industrial solid wastes hold hazardous characteristics, they usually receive special attention. Industrial solid waste pollution has become an increasingly serious problem in the world. The developing countries have to specially confront it. Every year, large quantities of industrial solid wastes are generated from the growing industries. However, there are no adequate treatment and disposal facilities and qualified personnel in these developing countries. All these have seriously hindered the development of industries in these countries and done harm to the human being health and the environment. During 1980s, much attention has been paid to the pollution control of industrial solid wastes. Significant progress has been made in establishing corresponding management and legislation systems, in developing treatment and disposal technologies, and in turning the research results into industrial practice. As a result, the serious situation of hazardous waste pollution has been alleviated in the developed countries although this situation has not completely changed. However, many problems in the management of industrial solid wastes need to be resolved in the developing countries.

2. PROBLEM IDENTIFICATION

Assessment of industrial solid waste management problem greatly varies depending on the nature of the industry, their location and mode of disposal of waste. Further, for arriving at an appropriate solution for better management of Industrial solid waste, assessment of nature of waste generated is also essential. Industries are required to collect and dispose of their waste at specific disposal sites and such collection, treatment and disposal is required to be monitored by the concerned State Pollution Control Board (SPCB) or Pollution Control Committee (PCC) in Union Territory. The following problems are generally encountered in cities and towns while dealing with industrial solid waste

1. There are no specific disposal sites where industries can dispose their waste;
2. Mostly, industries generating solid waste in city and town limits are of small scale nature and even do not seek consents of SPCBs/PCCs;
3. Industries are located in non-conforming areas and as a result they cause water and air pollution problems besides disposing solid waste.
4. Industrial estates located in city limits do not have adequate facilities so that industries can organize their collection, treatment and disposal of liquid and solid waste;
5. There is no regular interaction between urban local bodies and SPCBs/PCCs to deal such issues relating to treatment and disposal of waste and issuance of licenses in non-conforming areas.

3. SOLID WASTE MANAGEMENT

3.1 SOLID WASTE MANAGEMENT

Solid waste management is one of the most challenging issues in India than elsewhere at the global. The quantity of solid waste has also increased tremendously with improved life style, social status of the populations and industrials in urban centers. Today, the scenario is quite different and the urban environment all over the world poses serious threat from excessive generation of solid waste. Industrial and Municipal
corporations of the developing countries are not able to handle the increasing quantity of waste, which leads to uncollected waste on roads and other public places. According to World Bank study, urban per-capita waste management rate for most of the low-income countries will increase by approximately 0.2 kg per day by 2025 because of relatively high annual growth rate of GNP and urban population. In developed countries, per capita waste generation increased nearly three-fold over the last two decades, reaching a level five to six times higher than that in developing countries. With increase in industries, population and living standards, waste generation in developing countries is also increasing rapidly and it may double in volume in the current decade. If current trends continue, the world may see a five-fold increase in waste generation by the year 2025. In recent years, Indian cities are invariably filled with huge amounts of garbage and solid waste in open places and corners. There is continuous increase in industrial growth; waste has been increasing in variety and volume. The stray dogs, rats and cats meddle with this open disposal of radioactive wastes, fly ash, hazardous and toxic materials, produce packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

Figure 3.1 Solid Waste Management which spreads diseases. The solid waste disposal is severe in slum areas. Solid Waste Management (SWM) is a science associated with the management of generation, storage, collection, transportation, segregation, processing and disposal of solid waste using the best principle and practices of public health, economics, engineering, conservation, aesthetics and other environmental conditions. As the Solid Waste Management (SWM) is of local native it is the responsibility of the state which in turn has entrusted to local authorities who carry out the solid waste management in areas under their control using mostly their own funds, staff and equipment. Solid waste management was never taken up seriously either by public or by concerned agency or authorities and now the large amount of waste is threatening our health, environment and well-being. In solid waste, organic domestic waste poses a serious threat, since they ferment, creating conditions favorable to the survival and growth of microbial pathogens. The direct exposure to wastes can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning. Uncollected solid waste can also obstruct storm water runoff, resulting in the formation of stagnant water bodies that become the breeding ground of disease. Direct dumping of untreated waste in rivers, seas, and lakes results in the accumulation of toxic substances in the food chain through the plants and animals that feed on it. Although India has formulated legislation relating to industrial waste, municipal solid waste, hazardous waste, and biomedical waste, the compliance and awareness of rules among communities and industrial, municipalities are lagging behind. With this background the current study aims to assess the practices of SWM and problems due to solid waste in India.

Figure 3.2 Initial Steps in Solid Waste Management

4. TYPES OF SOLID WASTE MANAGEMENT

Depending on the nature of origin, solid wastes are classified into
1. Urban or Municipal Wastes
2. Industrial Wastes
3. Hazardous Wastes

4.2.1 Urban or Municipal Wastes
MSW includes commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. It consists of household waste, wastes from hotels and restaurants, construction and demolition debris, sanitation residue, and waste from streets.
Urban wastes include the following wastes:

- Domestic wastes containing a variety of materials thrown out from homes.
  Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc.
- Commercial wastes: It includes wastes coming out from shops, markets, hotels, offices, institutions, etc.
  Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc.
- Construction wastes: It includes wastes of construction materials.
  Ex: Wood, Concrete, Debris, etc.
- Biomedical wastes: It includes mostly waste organic materials
  Ex: Anatomical wastes, Infectious wastes, etc.

Classification of urban wastes

Urban wastes are classified into:

- Bio-degradable wastes - Those wastes that can be degraded by microorganisms are called bio-degradable wastes
  Ex: Food, vegetables, tea leaves, dry leaves, etc.
- Non-biodegradable wastes: Urban solid waste materials that cannot be degraded by microorganisms are called non-biodegradable wastes.
  Ex: Polythene bags, scrap materials, glass bottles, etc.

Figure 4.1 Urban or Municipal Wastes

Figure 4.2 Industrial Wastes

4.2.2 Industrial Wastes

The unwanted or useless solid material generated from combined residential, industrial and commercial activities is termed as solid waste. Effective management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. Therefore, it becomes necessary that the local bodies along with State Pollution Control Board work out requisite strategy for organizing proper collection and disposal of industrial solid waste. Industries generating solid waste have to manage such waste by themselves and are required to seek authorizations from respective State Pollution Control Boards under relevant rules. Some of the industries generating solid waste include steel industry, leather industry, sugar industry, textile industry and dyeing industry. Integrated steel plants usually consist of five main units, viz., coal washer, coke oven, blast furnace, steel melting, and rolling mills (hot and cold). In addition to the above the plants may have auxiliary units like oxygen plant and power plant for their own uses. The major solid wastes generated in steel plants are, blast furnace slag, steel making slag, fly ash from the captive power plants, blast furnace clarifier sludge’s, blast furnace flue dusts, steel making dust, mill scales, waste refractories, coke breeze etc. Generation of such products fully depends on the quality and quantity of raw materials used in the process. Leather industry has been categorized as one of the highly polluting industries and there are concerns that leather making activity can have adverse impact on the environment.

Sources of Industrial Wastes

The main sources of industrial wastes are chemical industries, metal and mineral processing industries.

- Nuclear plants: It generated radioactive wastes
- Thermal power plants: It produces fly ash in large quantities
- Chemical Industries: It produces large quantities of hazardous and toxic materials.
- Other industries: Other industries produce packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

4.2.3 Hazards Wastes

The Environmental Protection Agency (EPA) defines solid waste as any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. There are two primary types of solid waste - municipal solid waste (trash or garbage) and industrial waste (a wide variety of non-hazardous materials resulting from the production of goods and products. Conversely, hazardous waste is waste that is dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gasses, sludges, discarded commercial products (e.g., cleaning fluids or pesticides), or the by-products of manufacturing processes. Proper waste management is an essential part of society’s public and environmental health. The Resource Conservation and Recovery Act (RCRA), passed in 1976, created the framework for America’s hazardous and non-hazardous waste management programs. Materials regulated by RCRA are known as “solid wastes.” Only materials that meet the definition of solid waste under RCRA can be classified as hazardous wastes, which are subject to additional regulation. EPA developed detailed regulations that define what materials qualify as solid wastes and hazardous wastes. Understanding the definition of a solid waste is an important first step in the process EPA set up for generators to hazardous waste to follow when determining if the waste they generated is a
regulated hazardous waste. Some of the materials that would otherwise fit the definitions of a solid or hazardous waste under waste identification are specifically excluded from the definitions. EPA concluded that these materials should not be regulated as solid or hazardous wastes for a number of reasons. Much exclusion are mandated in RCRA. EPA selected other exclusions to provide an incentive to recycle certain materials, because there was not enough information on the material to justify its regulation as a solid or hazardous waste, or because the material was already subject to regulation under another statute.

Figure 4.3 Hazards Wastes

- **Ignitability.** Ignitable wastes can create fires under certain conditions, are spontaneously combustible, or have a flash point less than 60 °C (140 °F). Examples include waste oils and used solvents.

- **Corrosivity** Corrosive wastes are acids or bases (pH less than or equal to 2, or greater than or equal to 12.5) that are capable of corroding metal containers, such as storage tanks, drums, and barrels. Battery acid is an example.

- **Reactivity.** Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when heated, compressed, or mixed with water. Examples include lithium-sulfur batteries and explosives.

- **Toxicity.** Toxic wastes are harmful or fatal when ingested or absorbed (e.g., containing mercury, lead, etc.). When toxic wastes are land disposed, contaminated liquid may leach from the waste and pollute ground water posing a hazard to the environment.

### 5. INDUSTRIAL SOLID WASTE

The major generators of industrial solid wastes are the thermal power plants producing coal ash, the integrated Iron and Steel mills producing blast furnace slag and steel melting slag, non-ferrous industries like aluminum, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime and fertilizer and allied industries producing gypsum.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name</th>
<th>Quantity (million tones per annum)</th>
<th>Source/Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Steel and Blast furnace</td>
<td>42.02</td>
<td>Conversion of pig iron to steel and manufacture of Iron</td>
</tr>
<tr>
<td>2</td>
<td>Brine mud</td>
<td>0.05</td>
<td>Caustic soda industry</td>
</tr>
<tr>
<td>3</td>
<td>Copper slag</td>
<td>0.0164</td>
<td>By product from smelting of copper</td>
</tr>
<tr>
<td>4</td>
<td>Fly ash</td>
<td>80.0</td>
<td>Coal based thermal power plants</td>
</tr>
<tr>
<td>5</td>
<td>Kiln dust</td>
<td>5.6</td>
<td>Cement plants</td>
</tr>
<tr>
<td>6</td>
<td>Lime sludge</td>
<td>5.0</td>
<td>Sugar, paper, fertilizer tanneries, soda ash, calcium carbide industries</td>
</tr>
<tr>
<td>7</td>
<td>Mica scraper waste</td>
<td>0.01</td>
<td>Mica mining areas</td>
</tr>
<tr>
<td>8</td>
<td>Phosphogypsum</td>
<td>8.6</td>
<td>Phosphoric acid plant, Ammonium phosphate</td>
</tr>
<tr>
<td>9</td>
<td>Red mud/ Bauxite</td>
<td>6.23</td>
<td>Mining and extraction of alumina from Bauxite</td>
</tr>
<tr>
<td>10</td>
<td>Coal washing dust</td>
<td>5.4</td>
<td>Coal mines</td>
</tr>
<tr>
<td>11</td>
<td>Iron tailing</td>
<td>23.45</td>
<td>Iron Ore</td>
</tr>
<tr>
<td>12</td>
<td>Lime stone wastes</td>
<td>68.08</td>
<td>Lime stone quarry</td>
</tr>
</tbody>
</table>

### 5.1 DESCRIPTION OF IMPORTANT INDUSTRIAL SOLID WASTE

#### 5.1.1 Coal Ash

In general, a 1,000 MW station using coal of 3,500 kilo calories per kg and ash content in the range of 40-50 per cent would need about 500 hectares for disposal of fly ash for about 30 years’ operation. It is, therefore, necessary that fly ash should be utilised wherever possible to minimize environmental degradation.

Out of Control: Mounting Damages From Coal Ash Waste Sites

The thermal power plant should take into account the capital and operation/maintenance cost of fly ash disposal system as well as the associated environmental protection cost, vis-a-vis
Dry system of collection and its utilisation by the thermal power plant or other industry, in evaluating the feasibility of such system. The research and development carried out in India for utilisation of fly ash for making building materials has proved that fly ash can be successfully utilised for production of bricks, cement and other building materials. Indigenous technology for construction of building materials utilising fly ash is available and are being practised in a few industries. However, large scale utilisation is yet to take off. Even if the full potential of fly ash utilisation through manufacture of fly ash bricks and blocks is explored, the quantity of fly ash produced by the thermal power plants are so huge that major portion of it will still remain unutilised. Hence, there is a need to evolve strategies and plans for safe and environmentally sound method of disposal.

5.2 INTEGRATED IRON & STEEL PLANT SLAG

Figure 5.2 Integrated Iron & Steel Plant Slag

The Blast Furnace (BF) and Steel Melting Shop (SMS) slags in integrated iron and steel plants are at present dumped in the surrounding areas of the steel plants making hillocks encroaching on the agricultural land. Although, the BF slag has potential for conversion into granulated slag, which is a useful raw material in cement manufacturing, it is yet to be practised in a big way. Even the use of slag as road subgrade or land-filling is also very limited.

5.3. PHOSPHOGYPSUM

Phosphogypsum is the waste generated from the phosphoric acid, ammonium phosphate and hydrofluoric acid plants. This is very useful as a building material. At present very little attention has been paid to its utilisation in making cement, gypsum board, partition panel, ceiling tiles, artificial marble, fiber boards etc.

5.4 RED MUD

Red mud as solid waste is generated in non-ferrous metal extraction industries like aluminum and copper. The red mud at present is disposed in tailing ponds for settling, which more often than not finds its course into the rivers, especially during monsoon. However, red mud has recently been successfully tried and a plant has been set up in the country for making corrugated sheets. Demand for such sheet should be popularised and encouraged for use. This may replace asbestos which is imported and also banned in developed countries for its hazardous effect. Attempts are also made to manufacture polymer and natural fibres composite panel doors from red mud.

Figure 5.4 Red Mud Waste

5.5 LIME MUD

Lime sludge, also known as lime mud, is generated in pulp & paper a mill which is not recovered for reclamation of calcium oxide for use except in the large mills. The lime mud disposal by dumping into low-lying areas or into water courses directly or as run-off during monsoon is not only creating serious pollution problem but also wasting the valuable non-renewable resources. The reasons for not reclaiming the calcium oxide in the sludge after recalcination is that it contains high 75 amount of silica. Although a few technologies have been developed to desilicate black liquor before burning, none of the mills in the country are adopting desilication technology.

Figure 5.6 Lime Mud Waste

5.7 WASTE SLUDGE AND RESIDUES

Treatment of industrial wastes/effluents results in generation of waste sludge/residues which, if not properly disposed, may cause ground and surface water pollution.

5.8 POTENTIAL REUSE OF SOLID WASTES

Research and Development (R&D) studies conducted by the R&D Institutions like Central Building Research Institute,
6. TYPES OF INDUSTRIAL SOLID WASTES

6.1 SOLID WASTES FROM THE MINING INDUSTRY
This kind of waste includes waste stones generated during mining and tailings. Waste stones mean wall rocks peeled off from major ore during the mining of metal and non-metal mines. Tailings mean the residue slag after distilling refining mines during mill run.

Figure 6.1 Solid Wastes from the Mining Industry

6.2 INDUSTRIAL SOLID WASTES FROM THE METALLURGICAL INDUSTRY
This kind of waste includes varies of slag from the metallurgical procedure and processing of metals and non-metals. Some industrial solid wastes from the metallurgical industry are listed in Table 6.1.

Figure 6.2 Industrial Solid Wastes from the Metallurgical Industry

<table>
<thead>
<tr>
<th>Slag</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast furnace slag</td>
<td>Generated in blast furnace iron smelting</td>
</tr>
<tr>
<td>Steel slag</td>
<td>Generated in steel smelting by level furnace, converter, and electric stove</td>
</tr>
<tr>
<td>Non-ferrous metal slag</td>
<td>Generated in smelting processing of the non-ferrous metals, such as copper, nickel, lead, and zinc</td>
</tr>
<tr>
<td>Red mud</td>
<td>Generated in abstracting aluminum oxide</td>
</tr>
</tbody>
</table>

Table 6.1 Industrial solid wastes from metallurgical industry

6.3 SOLID WASTES FROM THE POWER INDUSTRY
This kind of waste includes coal fly ash, coal slag, and flue ash from power plants in which coals are used as fuel. It also includes gangue generated from coal excavating and coal-washing.

Figure 6.3 Solid Wastes from the Power Industry

6.4 SOLID WASTES FROM THE CHEMICAL INDUSTRY
This kind of wastes includes inferior products (semi-finished products), outgrowth, disabled catalysts, waste additives, raw materials that have not reacted, and impurity in raw materials discharged from chemical reaction during production processes, such as chemical combination, decomposition and synthesis. They also include wastes discharged from refining, separating, and washing procedures and from devices. Furthermore, they include the pyritic slag, acidic slag, alkali slag, salt mud, mud from kettle, residues of refining or distillation, pharmaceutical wastes, waste medicines from the producing and processing sectors in the chemical industry, and waste pesticides from medicine and insecticide production.

Figure 6.4 Solid Wastes from the Chemical Industry

In addition, they include dust from air pollution control facilities, sludge from wastewater treatment facilities, solid wastes from equipment examination and repairing, equipment scraps, vessels, and industrial refuses.

6.5 SOLID WASTES FROM THE OIL CHEMICAL INDUSTRY
This kind of wastes includes oil mud, tar shale slag, waste catalysts, and waste organic solvent in oil processing.

6.6 SOLID WASTES FROM LIGHT INDUSTRY
This kind of wastes includes sludge, animal residues, waste acid, waste alkali, and other wastes from the processing procedure in light industries, such as food industry, paper making and printing industry, spinning and dye-printing industry, and leather industry.

6.7 OTHER INDUSTRIAL SOLID WASTES
These kinds of waste mainly include metal dross from mechanical processing, plating sludge, construction wastes, and slag from processing in other industries. In the USA, solid wastes means any garbage, refuse, sludge from a wastewater treatment plant, a water supply treatment plant, or an air pollution control facility; and other discarded materials
including solid, liquid, semi-solid, or contained gaseous materials arising from industrial, commercial, mining, and agricultural operations, and from community activities; but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under the Federal Water Pollution Control Act, as amended, or source, special nuclear, or by-product materials as defined by the Atomic Energy Act, as amended. Industrial and special wastes are primarily non-hazardous wastes generated by certain industries and households. Industrial solid wastes come from a broad spectrum of USA industries and are neither municipal nor hazardous wastes under federal and most state laws. Some industrial solid wastes may be listed in the catalog of hazardous wastes or identified as holding hazardous properties based on the hazardous waste identification standards and identification method.

7. EFFECTS OF SOLID WASTE

7.1 IMPACTS OF SOLID WASTE MANAGEMENT

The infiltration of rainfall into landfill, together with the biochemical and chemical breakdown of the wastes, produces a leachate which is high in suspended solids and of varying organic and inorganic content. All household and most industrial wastes will produce leachate. If the leachate enters surface or groundwater before sufficient dilution has occurred, serious pollution incidents can occur. In surface waters, leachate high in organic material and reduced metals will cause severe oxygen depletion and result in fish-kills. Leachate high in non-biodegradable synthetic organic compounds is a particular threat, through bioaccumulation; concentrations of these substances may increase to toxic levels and endanger animal and human life. The decomposition of solid wastes in landfill results in the production of carbon dioxide and methane (landfill gas), both important greenhouse gases. Seven % of methane generated by man’s activities is estimated to be coming from landfill. Operation of incinerators can cause nuisance and atmospheric pollution from the emission of particulates, acidic gases, unburnt waste material, heavy metals, and trace quantities of organic compounds. Air pollution control measures have previously been aimed at reducing particulate emissions, but stricter emission controls requiring reductions in the emissions of acidic gases and heavy metals have been introduced in most developed countries. A much publicised problem of waste incineration has been the formation of dioxins as a by-product of the incineration process. They are emitted in the flue gases. Their environmental impact is still a matter of controversy. In many developed countries, public awareness of this problem has led to strong opposition to the siting of new incinerators near major population centres and increased the amount of waste incinerated at sea.

7.2 EFFECTS OF POOR SOLID WASTE MANAGEMENT

- Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.
- Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soil.
- Toxic substances may percolate into the ground and contaminate the groundwater.
- Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.
- During the process of collecting solid waste, the hazardous wastes usually mix with ordinary garbage and other flammable wastes making the disposal process even harder and risky.

8. DATA ANALYSIS

Data analysis is the process of arranging the raw data. The relevant data obtained from the administered research tool have been analyzed. The collected data on safety management elements from engineering industries was used for descriptive analysis. It provides information about the nature of a particular group of individuals. In the present study the Standard deviation were calculated to determine the central tendencies and dispersion of variables by comparing the research tool elements. Table I and II shows the condition of solid waste management elements in small and medium scale industries. Figure 1, 2 and 3 shows the comparison of solid waste management elements in small and medium scale industries under good, satisfactory and poor scale respectively. From Fig 1, Fig 2 and Fig 3 it was inferred that medium scale industries ensure good solid waste management practices compared to small scale industries. Fig.1 shows that 68% of medium scale industries ensured safe storage element which was higher among all 10 solid waste management elements. Fig.2 shows that 56% of medium scale industries ensured waste volume reduction element which was higher among all 10 solid waste management elements. Fig.3 shows that 56% of medium scale industries ensured waste volume reduction element which was higher among all 10 solid waste management elements.

![Figure 8.1 Comparison of solid waste management element valued for “good” scale](http://ijesc.org/)
9. PREVENTIVE AND CONTROLLING TECHNIQUES

9.1 CONTROLLING TECHNIQUES

Two important steps involved in solid waste management are:
- Three R’s – Reduce, Reuse and Recycle of Raw Materials
- Proper Discarding of wastes

9.1.1 Three R’s – Reduce, Reuse and Recycle of Raw Materials

If you have heard of something called the “Solid waste hierarchy” you may be wondering what that means. It is the order of priority of actions to be taken to reduce the amount of waste generated, and to improve overall waste management processes and programs. The waste hierarchy consists of 3 R’s as follows:

- **Reduce**
- **Reuse**
- **Recycle**

Called the “three R’s” of waste management, this waste hierarchy is the guidance suggested for creating a sustainable life. You might be wondering as to how you can incorporate these principles in your daily life. They are not hard to implement. All you need is to bring a small change in your daily lifestyle to reduce waste so that less amount of it goes to the landfill that can reduce your carbon footprint.

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**Figure 8.2** Comparison of solid waste management element valued for “satisfactory” scale

**Figure 8.3** Comparison of solid waste management element valued for “poor” scale

**Figure 9.1** Zero Waste Management

10. CONCLUSION

Solid Waste Management plays a vital role in environmental pollution prevention. Industries in this aspect, takes huge responsibility in managing the solid waste generated at site, satisfying reuse, recycle and reduce policy. The study considered the solid waste management practices in small and medium scale industries located in TamilNadu. The analysis was carried out by questionnaire which covered 10 important solid waste management elements. Based on the results, it was concluded that the medium scale industries follow good solid waste management practices compared to small scale industries.

11. REFERENCE


