HAZARDOUS WASTE MANAGEMENT IN THE WORLD AND TURKEY: A COMPERATIVE ANALYSIS

Dünyada ve Türkiye’de Tehlikeli Atık Yönetimi: Karşılaştırmalı Bir Analiz

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ABSTRACT

Hazardous waste is a waste with properties that make it dangerous or potentially harmful to human health or the environment. They can be the by-products of manufacturing processes or simply discarded commercial products, like cleaning fluids or pesticides. The disposal and recycling facilities’ capacity in Turkey is not enough for the wastes generated in the country’s industry. For this reason, waste management in industry should be built in the basis of reducing the wastes in the production units, classifying the wastes according to their characteristics and collecting them separately, using recycling or reusing methods if possible.

Key Words: Hazardous Waste, Hazardous Waste Management, Turkey, The World

ÖZET


Anahtar Kelimeler: Tehlikeli Atık, Tehlikeli Atık Yönetimi, Türkiye, Dünya

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Introduction

After the 19th century, the improvements experienced in the area of industrialization and urbanization brought along many environmental problems. Then after 1972 Stockholm, developments at international level regarding these problems to be dispelled have began to be experienced. The environmental problems arising as a negative side effect of economical development in the countries that becomes industrialized or is on the process of industrialization in the world has spoiled the ecological balance and come to a point that threatens human life.

However, the environmental consciousness and public pressure developed in the society in the last years has removed the dilemma of environment or economic development, and enabled the adoption of economic development approach harmonic with the nature.

In accordance with this foresight “The Regulation of Checking Hazardous Waste” was prepared by Environment Law based on Basel Agreement aiming at composing hazardous waste management system. In 23.03.2005, it was published in official newspaper and came into force. The Regulation of Checking Hazardous Waste shows parallelism in appearance with the existing international law and regulations, especially Basel Agreement.

The Regulations of Checking hazardous Waste was published on the basis of the environment law article of 8, 11, 12, temporary 2nd article and the 3rd article of Basel Agreement with regard to Cross-Border Transportation and Aside Controlling of Hazardous Waste which was published in the date 15/5/1995 and 21935 numbered Official Newspaper.

In the regulations, hazardous wastes have been classified as general categories, possible sources, components and types. Also hazard features and legal disposal methods were included for wastes.

Materials considered as waste according to regulation appendix, included in wastes defined by regulations, has one or more of the hazardous waste characteristics, wastes to be disposed by disposal methods stated in the regulations or materials polluted by these wastes are considered as “Hazardous Waste” and their disposal in residential warehousing is forbidden.

1. Hazardous Waste

The developments in industry and technology cause rapid depletion of natural resources. As a result; the natural resources in the environment are consumed without limit and wastes increase rapidly. The wastes that are produced can be classified as residential wastes (non-hazardous), special wastes (hazardous/non-hazardous middle category wastes), medical wastes, radioactive wastes and hazardous wastes.

Hazardous waste is mostly generated by industrial activities and driven by specific patterns of production. It represents a major concern as it entails serious environmental risks if poorly
Hazardous waste is a waste with characteristics that make it dangerous or potentially harmful to human health or the environment. The universe of hazardous wastes is large and diverse. Hazardous wastes can be liquids, solids, contained gases, or sludges. They can be the by-products of manufacturing processes or simply discarded commercial products, like cleaning fluids or pesticides.

In regulatory terms, a RCRA hazardous waste is a waste that appears on one of the four hazardous wastes lists (F-list, K-list, P-list, or U-list), or exhibits at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity. Hazardous waste is regulated under the Resource Conservation and Recovery Act (RCRA) Subtitle C.

By definition, EPA determined that some specific wastes are hazardous. These wastes are incorporated into lists published by the Agency. These lists are organized into three categories (USEPA, 2007):

- **The F-list** (non-specific source wastes); this list identifies wastes from common manufacturing and industrial processes, such as solvents that have been used in cleaning or degreasing operations. Because the processes producing these wastes can occur in different sectors of industry, the F-listed wastes are known as wastes from non-specific sources.

- **The K-list** (source-specific wastes); this list includes certain wastes from specific industries, such as petroleum refining or pesticide manufacturing. Certain sludges and wastewaters from treatment and production processes in these industries are examples of source-specific wastes.

- **The P-list and the U-list** (discarded commercial chemical products); these lists include specific commercial chemical products in an unused form. Some pesticides and some pharmaceutical products become hazardous waste when discarded.

**Hazardous Waste Characteristics:**

The United States Environmental Protection Agency (EPA) regulates waste materials that meet one or more of the following physical characteristics as hazardous waste (USEPA, 2007).

- **Ignitability:** ignitable wastes are capable of causing or intensifying a fire during routine handling. A waste is characteristic for ignitability if it has any one of the following properties:
  - a liquid with a flash point less than 140o F (60o C);
  - a solid, capable under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and when ignited, burns vigorously and persistently;
  - an ignitable compressed gas; or, an oxidizer.

Examples include, but are not limited to, most organic solvents such as: Acetone, Ethyl
ether, Pentane, Benzene, Heptane, Petroleum ether, Ethanol, Hexane, Toluene, Ethyl acetate, Methanol, Xylene.

**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. Toxicity is defined through a laboratory procedure called the Toxicity Characteristic Leaching Procedure (TCLP). TCLP helps identify wastes likely to leach concentrations of contaminants that may be harmful to human health or the environment.

Figure 1. Total Waste Generation in Selected OECD Countries in Mid-1990s.

2. Hazardous Waste from Manufacturing in the World and Turkey

The Basel Convention has estimated the amount of hazardous and other waste generated for 2000 and 2001 at 318 and 338 million tons respectively. These figures are based on incomplete
reports from the parties to the Convention. Compare this with the almost 4 billion tons estimated by the OECD as generated by their 25 member countries in 2001 (Environmental Outlook, OECD) and the problems of calculating a definitive number for global waste generation are obvious. Therefore the figures shown below should be used with caution. Countries that report to the Basel Convention produced around 108 million tons of hazardous waste in 2001. Uzbekistan is the hazardous waste leader, with 26% of the total (http://vitalgraphics.net/waste/html_file/34-35_hazardous_caution.html). USA’s 25 million tonnes of hazardous waste generation in 1970’s has reached to 300 million tones in the year 2000 (http://www.ebso.org.tr/tr/yonkom/cevre/tehlikeliatiklar.ppt).

Figure 2. Global Hazardous Waste Generation by Type as Reported by The Parties to The Basel Convention for the Years 1993-2000 Million Tones.

According to the reported values of Basel Convention, Estonia is the leading country in Manufacturing Industry Waste Generation with 13.5 kg/day for each person. Monaco, Ukraine, Kyrgyzstan, Uzbekistan, and Denmark follow Estonia respectively. At the bottom lies Cyprus, and Turkey’s Manufacturing Industry Waste Generation is around 0.65 kg/day per person (UNEP - http://vitalgraphics.net/waste/html_file/08-09_waste_generation.html).

2.1. Situation in European Union (EU)

As a requirement given in IPPC Directive, in European Union well documented studies regarding determination of waste generation amounts have been conducted. In IPPC Directive,
establishment of an inventory of principal emissions and sources is emphasized.

In July 2000, the European Commission adopted a Decision on the implementation of a European Pollutant Emission Register (EPER) according to Article 15 of Council Directive 96/61/EC concerning IPPC. National governments of all EC Member States are required to maintain inventories of emission data from specified industrial sources and to report emissions from individual facilities to the European Commission. The reported data will be made accessible in a public register (EPER), which is intended to provide environmental information on major industrial activities (http://europa.eu.int/comm/environment/ippc/eper/index.htm).

The waste generated depends on the technology used, the nature of the raw material processed and how much of it is discarded at the end of the chain. Very often manufacturing wastes end up in the hazardous category (see figure 3 and 4).

Table 1 presents a summary of the hazardous waste arisings in a number of countries as reported to the OECD and Eurostat. Per capital figures vary significantly from one country to another and appear to have increased substantially in many countries during the 1990s. According to the data of the year 2000, annual hazardous waste generation of EU and OECD has reached to 40 million tones in total. When the hazardous waste amount generated in 15 chosen EU countries,
the most waste generating countries are seen as Germany and France. Hazardous wastes generated in these two countries are 8 million tones in average and the average hazardous waste generation per person is calculated as 115 kg/year. This figure is over EU average which is 80-90 kg/year/person.

### Table 1. Total Generation of Hazardous Waste in EEA Member Countries Stated in Tons.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Total Generation in Tons</th>
<th>Generation in kg per capital</th>
<th>Regular Waste Housing %</th>
<th>Burning %</th>
<th>Recycling %</th>
<th>Number of Burning Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1999</td>
<td>970 000</td>
<td>120</td>
<td>–</td>
<td>11</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Belgium</td>
<td>1997</td>
<td>2 030 000</td>
<td>199</td>
<td>39</td>
<td>7</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>Denmark</td>
<td>1996</td>
<td>270 000</td>
<td>51</td>
<td>33</td>
<td>37</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Finland</td>
<td>1997</td>
<td>570 000</td>
<td>111</td>
<td>49</td>
<td>18</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>France</td>
<td>1997</td>
<td>7 000 000</td>
<td>119</td>
<td>11</td>
<td>11</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td>Germany</td>
<td>2000</td>
<td>9 170 000</td>
<td>111</td>
<td>29</td>
<td>9</td>
<td>–</td>
<td>31</td>
</tr>
<tr>
<td>Greece</td>
<td>1995</td>
<td>350 000</td>
<td>33</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Ireland</td>
<td>1995</td>
<td>230 000</td>
<td>64</td>
<td>13</td>
<td>13</td>
<td>–</td>
<td>11</td>
</tr>
<tr>
<td>Italy</td>
<td>1997</td>
<td>3 400 000</td>
<td>59</td>
<td>24</td>
<td>3</td>
<td>–</td>
<td>6</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1995</td>
<td>140 000</td>
<td>346</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2002</td>
<td>2 700 000</td>
<td>168</td>
<td>22</td>
<td>10</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Portugal</td>
<td>2001</td>
<td>250 000</td>
<td>25</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Spain</td>
<td>1997</td>
<td>2 000 000</td>
<td>50</td>
<td>70</td>
<td>2</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Sweden</td>
<td>1999</td>
<td>270 000</td>
<td>30</td>
<td>–</td>
<td>37</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1996</td>
<td>2 370 000</td>
<td>41</td>
<td>24</td>
<td>10</td>
<td>–</td>
<td>3</td>
</tr>
</tbody>
</table>


### 2.2. Situation in Turkey

There are very limited data on hazardous waste generation in Turkey. Major sources of information on hazardous wastes are Manufacturing Industry Survey developed by the Turkish Statistical Institute (TSI) on a regular basis data from Ministry of Environment and Forestry (MoEF), and the project entitled “Hazardous Wastes Management” realized by TCT-Zinerji Consortium for the Ministry of Environment and Forestry (MoEF, 2001; Yetis and etc, 2001).

Manufacturing Industry Survey of TSI includes air pollution statistics, municipal wastewater statistics, municipal solid waste statistics, municipal drinking water statistics, mining industry waste statistics, and wastes statistics of industrial districts’. According to Turkish Statistical Institute (TSI), the total quantity of hazardous waste generated in Turkey (from 370 establishments) in 2004 is about 1,2 million tons/year. The data from the survey conducted by TSI covered only part of provinces and waste generating industries, and it is highly probable that the actual hazardous waste generation is substantially higher than reported (http://www.die.gov.tr/TURKISH/SONIST/CEVRE/k_271205.xls).

Findings of this statistic are not adequate to present a waste inventory for industrial wastes.
because industrial wastes comprise only a portion of the results given under Manufacturing Industry Survey at the website of TSI. Nevertheless, these statistics are continuously being updated and there is a possibility that statistics covering new topics more related to industrial wastes will be added.

In Hazardous Waste Management Project, hazardous waste generation and disposal practices, institutional structure and legal framework are covered and possible sources of problems are investigated. Suggestions were made on legal framework related to management of hazardous wastes and harmonization with EU directives (MoEF, 2001).

In Hazardous Waste Management Project, hazardous waste generation in Turkey was evaluated based on the total number of employees working in hazardous waste generating industries adopting a method from Germany. The hazardous waste generation estimation was made for the regions of Marmara, Aegean and Mediterranean considering the industrial development in these regions. The hazardous waste generation rates predicted for the years 2000 and 2020 by this project are shown in Table 2 (MoEF, 2001).

<table>
<thead>
<tr>
<th>Year</th>
<th>Landfillable</th>
<th>Burnable</th>
<th>Municipal</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,067,400</td>
<td>118,600</td>
<td>24,890</td>
<td>1,210,890</td>
</tr>
<tr>
<td>2020</td>
<td>1,748,700</td>
<td>194,300</td>
<td>40,780</td>
<td>1,983,870</td>
</tr>
</tbody>
</table>


In Hazardous Waste Management Project, the hazardous waste generation in Turkey was evaluated based on the total number of employees working in hazardous waste generating industries adopting a method from Germany. The hazardous waste generation estimation was made for the regions of Marmara, Aegean and Mediterranean considering the industrial development in these regions. The hazardous waste generation rates predicted for the years 2000 and 2020 by this project are shown in Table 2 (MoEF, 2001).

3. Hazardous Waste Management in Turkey

The yearly waste generation of the Manufacturing Industry in Turkey was 11.980 million tones in 1994, and it has risen to 17.497 million tones in 2004. The yearly average waste generation of the Manufacturing Industry is 13.3 million tones between 1994 and 1997. The average for 2000 and 2004 is 17.3 million tones/year. Finally, 1994-2004 average is 14.6 million tones. In this increase trend, the biggest share is Metal Industry’s with (44%). Food, beverages and tobacco industry (25%), chemical-petroleum, coal, rubber and plastic products industry (12%), mining industry (9%), and other industries (10%) follow metal industry respectively. Waste generation during 2000-2004 is 0.24 kg/year/person in manufacturing sector (Table 3).

Nearly 7 million tones/year (45%) of Turkish Manufacturing Industry’s waste generation (total of 15 million tones/year) is recycled, re-used, sold, and donated. 8 million tones of it (55%) is disposed. When disposal methods are considered, around 1.4 million tones (18%) is being sent to municipality garbage dump, 46 thousand tones (0.6%) is being burned, and the rest 6.7 million tones (81.4%) is being disposed by other methods (regular warehousing, haphazard throwing,
burying, throwing to the sea or river, using as filling material, warehousing in facilities, etc.) (See Table 4).

### Table 3. Yearly Solid Waste Generation of Manufacturing Industry.

<table>
<thead>
<tr>
<th>Year</th>
<th>Kod (ISIC, Rev3)</th>
<th>Industry Group</th>
<th>Quantity (1000 tones/year)</th>
<th>Average Waste Generation %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31</td>
<td>Food, beverages and tobacco industry</td>
<td>3,531 3,857 4,150 3,562 3,381 3,324</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Textile, ready-made clothes and leather industry</td>
<td>505 352 260 169 176 103</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>33+34</td>
<td>Forestry products and furniture + paper products, printing industry</td>
<td>330 339 285 278 280 275</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>Chemical-petroleum, coal, rubber and plastic products industry</td>
<td>1,712 1,473 1,910 1,906 1,884 1,356</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>Mining industry</td>
<td>1,693 1,180 1,228 1,132 1,141 1,257</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>Metal industry</td>
<td>7,765 8,642 6,092 6,217 5,109 5,152</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>38+39</td>
<td>Machinery and equipment, transportation vehicles, scientific and occupational measurement devices + other industry</td>
<td>1,962 1,217 733 657 523 513</td>
<td>6%</td>
</tr>
</tbody>
</table>

Besides manufacturing industry wastes, mud is generated in water treatment plants. This mud contains heavy metals and classified as hazardous wastes. The five year average of water treatment mud generation in Turkey for 1994, 1995, 1997, 2000, and 2004 is 2,400,000 tonnes/year. 6% of this mud is used in agriculture, 12% is sent to municipality garbage dump, 4% is burned, and 78% is disposed by using other methods.

As seen in Table 5, when 5 year data (2000-2004) are examined, 3,650,000 tonnes of hazardous waste, along with mud from water treatment plants, is being generated in our country.
and only 400.000 tones (11%) of this is being recycled. The remaining 3.250.000 tones (89%) are being disposed by other methods (regular warehousing, haphazard throwing, burying, throwing to the sea or river, using as filling material, warehousing in facilities, etc.). Nearly 12% of the disposed wastes are being sent to municipality garbage dumps each year, and 77% is sent away haphazardly.

Table 5. Hazardous Waste Quantity Generated in Turkey, Disposal and Usage Methods (2000-2004 Average)

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Generated</th>
<th>Recycled</th>
<th>Disposed</th>
<th>Sent to Municipality Dump</th>
<th>Burned</th>
<th>Used in Agriculture</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Waste</td>
<td>1 250</td>
<td>400</td>
<td>850</td>
<td>40</td>
<td>100</td>
<td>710</td>
<td></td>
</tr>
<tr>
<td>Water treatment plant mud</td>
<td>2 400</td>
<td>0</td>
<td>2 400</td>
<td>345</td>
<td>55</td>
<td>185</td>
<td>1 815</td>
</tr>
<tr>
<td>Total</td>
<td>3 650</td>
<td>400</td>
<td>3 250</td>
<td>385</td>
<td>155</td>
<td>185</td>
<td>2 515</td>
</tr>
</tbody>
</table>


4. Conclusion

In Turkey, the types of industrial wastes emerged along with rapid industrialization, is not very different than the wastes generated in developed countries. However, it can be said that in Turkey, waste types and quantity are more than the developed countries, because effective processes and waste reduction technologies existing in the developed countries are not practiced enough and legal sanctions are not effective. In order to get detailed information on this subject, first of all a waste inventory showing types and quantities of the wastes generated by industries and municipalities must be created. All the studies that will be made on waste management will be based on a reliable waste inventory.

According to the data of Turkish Statistical Institute (TSI), the highest hazardous waste generation is seen in Marmara. Aegean, Central Anatolia, Black Sea, Mediterranean, Southeastern Anatolia and Eastern Anatolia regions follow that respectively. GDP trends rooting from hazardous waste generation and production industry show accordance. The regions’ waste generation and their contributions to GDP are in the same order.

Wastes, emerging in industrial facilities and considered as undesirable byproducts, are raw material losses and cause additional costs. Also, throwing them haphazardly to the nature brings along ecological environmental damage. As a result, the industry using natural resources as a production input is negatively effected from this. For this reason, waste management in industry should be built in the basis of reducing the wastes in the production units, classifying the wastes according to their characteristics and collecting them separately, using recycling or reusing methods if possible.

Transporting the wastes to recycling and/or disposal facilities by licensed vehicles and
drivers is mandatory. In Turkey, there is waste transportation licensing circular for the transportation of hazardous wastes, and it is mandatory to transport the wastes by licensed vehicles. However, the number of these special transportation companies to transport hazardous wastes (solid and liquid) is not enough to meet the demand. Thus, there is a great need for such companies.

The disposal and recycling facilities’ capacity in Turkey is not enough for the wastes generated in the country’s industry with over 2.5 million tones per year. In one of the most important industrial zones of Turkey, there is Izmit IZAYDAS facility with 25,000 tones/year warehousing capacity and 35,000 tones of burning capacity, built for disposal of industrious wastes and operating under temporary license. There is also Izmir Petkim Aliaga with 17,500 tones/year burning capacity and apart from that there is no other licensed and organized waste disposal facility for industrial wastes. On the other hand, there is no facility that accepts industrial wastes except Izmir Harmandali hazardous waste area. For this reason, organized warehousing areas must be immediately built for industrial wastes and their management, which needs specialists, must be privatized. Although some small scaled facilities were given “temporary license” for recycling of wastes like motor oils and solvents, these facilities are not efficient because they lack inspection in disposal and the quantity and quality of waste materials are not enough. Besides the ones being sent to municipality garbage dumps, the management of industrial wastes are still an important problem in our country. Thus, regional waste management units are needed under an organizational structure. These units will be responsible from execution and following up of all solid waste management activities regionally.

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