Available online at www.ap.iauardabil.ac.ir
Islamic Azad University, Ardabil Branch
Anthropogenic Pollution Journal, Vol 3 (2), 2019: 29-36
DOI: 10.22034/ap.2019.668484
ISSN: 2588-4646

Identification, Classification and Management of Industrial Hazardous Waste in Ardabil Province

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Submit Date: 01 August 2019/ **Accepted**: 08 September 2019/ **Published**: 31 September 2019

Abstract: Hazardous waste is generated by numerous industrial, commercial, agricultural and even domestic sources. The dangers of these wastes can vary depending on their types and environmental conditions and various short-term and long-term effects ranging from acute to chronic are expected. This study was carried out in regard to health and economic considerations and to create motivation for conducting studies to identify industrial hazardous waste which plays an important role in growing trend of country's industry. In this research, we selected 51 important industrial units of Ardebil province and data were collected through questionnaires, interviews with the units' authorities and referring to available documents. The information contained the types and amount of waste, temporary storage method, discharge frequency, final disposal method, and the status of recycling and reuse. The results obtained from data analysis without considering uncontrolled industrial wastewater show the annual production of approximately 2,010,265 tons of waste; of which about 1502 tons (according to available list in the Basel Convention) is classified as hazardous waste and about 12.42% of this type of waste as toxic. The share of liquid and solid physical states of the waste is respectively 59.87%, 13.77%. It should be noted that there is no temporary storage for about 20.29% of this waste. Reviewing the final disposal method indicates that about 28.66% of hazardous waste is discharged into the environment without any control.

Keywords: Environmental Management, Industrial Hazardous Wastes, Classification, Basel Convention

1- Introduction

Nowadays some of the main objectives of governments, companies and public and private organizations are technological advancements, expansion and development of various industries and producing various types of materials and products. However, waste associated with the consumption of these materials and products and pollution and waste from their production is a significant part of total pollution of the environment. In the last decade, due to rapid growth of technology and industries and discovery of devastating effects of hazardous waste generated by industrial activities that affect environmental health, climate, herbal and animal species (wildlife) and atmosphere, the media is filled with worrying news about the consequences of dysfunctional waste disposal methods. In recent years, the world has often heard the names of Seveso, Love canal**,** Lekkerkerk, Time Beach and many other names, all of which are associated with harmful toxic waste; wastes generated by trade businesses and industries, especially chemical industries and the list goes on, since thousands of black spots have scattered across the globe (Salvato et al. 2003). Disasters and calamities that have occurred in the environment have created a border between "hazardous waste" and what is generally considered as "waste". Annual production of about 560 million tons of hazardous waste in the world indicates the level of danger threatening the environment (Bagchi 2004). Having pathogenic potential including carcinogenicity in addition to harmful effects on the environment, this waste is a constant cause of concern for the environmental scientists and remarkable effort is being put into resolving these environmental problems and managing the waste in the best way possible. Although sources of hazardous waste production are very numerous and varied, the major source of their production is industrial activities (Ehrampoosh et al. 2005). Therefore, it is of utmost importance to pay attention to this matter in the process of flourishing of industries in different countries. Should we fail to do this important and essential task, we will face irreparable effects or an increase in more severe types of pollution. However, incurring huge costs to eliminate the pollution caused by hazardous waste from the environment will be a serious obstacle to country's economic development. Considering the importance of environmental protection and consistent industrial growth and development, it's a necessity to create a hazardous waste control and management system and in order to establish such system, in the first place we need to recognize sources that produce them and also control their quantity and quality (4). It should be noted that precision in the studies and obtained data at this stage will be the basis and reference of decisions made in the next steps. Yet, there is an insufficient amount of information on this issue because of researchers' not conducting large-scale waste identification studies. Currently, due to lack of a data collection and processing system, there is a lot of uncertainty in this regard which will affect the decision making process and operations in many areas. The main objective of this study is to collect required data and provide a general description of current state of industrial waste in Ardabil Province, located in northwestern Iran.

2- Materials and methods

In order to study the industrial and municipal waste zoning, we investigated the status of solid waste production in Ardabil province. According

to different types of industries in the province, waste was divided into four categories in terms of their physical state (solid-liquid-sludge-semi-solid) and five categories in terms of quantity of their production (food and beverage-textiles-chemical productions-mineral and non-metallic products manufacturing and other groups). Waste is generated by industrial units located within the industrial city, industrial units that operate outside the industrial city as well as urban residents. Various data concerning the amount of hazardous waste is provided in (Graph 3). Furthermore the total amount of recyclable materials was collected from industrial units across the province and quantitative and qualitative studies were carried out.

The stages of this research were as follows:

- Making a complete list of industrial units in the province
- screening to eliminate items that are not worth investigating or do not play a considerable role in production of specific industrial waste
- Selecting the samples according to priority criteria and their significance after screening

2-1- Findings

Zoning of estimated amount of waste generated by industrial cities and non-metallic, chemical, textile and food and beverage units outside the industrial cities is provided in Table 1 and Diagrams 1 to 6.

2-2- Introduction of study zone

Industrial Town of Ardabil Province with an area of 600 hectares and an approximate height of 1334 meters above sea level is located in Ardabil province (Figure 1).

Fig 1- Aerial view of Ardabil province (phase 1)

Ardebil Industrial and Mines Database and Ardebil Industrial city department have been used for obtaining information about Ardebil industrial units. According to the statistics, there are currently 1209 industrial units operating in 22 industrial groups in Ardabil province in industrial towns and individually around the suburbs and inside the city. Mineral and non-metallic products industrial group accounts for 29% of all industries in the province with the largest number of industrial workshops. In addition, major workshops and industries (71%) are located in Ardabil city. In order to select an appropriate sample and achieve the maximum coverage on the objectives of the study, several units (of a total of 190) were eliminated from the study process in accordance with EPA (US Environmental Protection Agency) method. Since hazardous waste is mostly generated by industries that have production or extractive properties, many units and activities can be excluded from process of the study without any particular bias. Therefore, units and activities which were not capable of producing hazardous waste due to their usage of non-hazardous materials and their production processes were excluded from the list. These were mostly observed in the non-metallic minerals production

group and a large number of sewing and assembly units. Thus these items were excluded from the study process. It is worth noting that all cases of high priority industries in terms of hazardous waste production (such as tanneries), were investigated instead of sampling. Moreover selected units which were unavailable for study due to administrative reasons or unexpected shutdowns were replaced with similar ones. As mentioned above, insignificant cases and those of minor significance were removed from the list during the screening and more important units that are frequently referred to in articles and reference books and emphasized by valid international organizations such as EPA and RCRA and Basel convention were emphasized and finally 51 samples have been selected for investigation. (Table 1).

Table 1- Available industrial groups, number of active units in every industrial group and number of selected units for reviewing in Ardabil province

1	Food and drinking products	250	7
2	Clothing and fur skin production	20	4
3	Tannery, leather, bags, suitcases, shoes, etc.	15	0
4	Wood and wooden products	64	4
5	Manufacturing of paper and paper products	25	3
6	Publishing, printing and reproduction	17	4
7	Coke and oil products	12	2
8	Manufacturing of chemical materials and products	94	3
9	Rubber and plastic products	102	6
10	Other mineral products	187	5
11	Manufacturing of basic metals	17	3
12	Fabricated metal products	163	4
13	Manufacturing of machinery and equipment	52	3
14	Office and accounting machinery	6	0
15	Electrical appliances	24	2
16	Radio, television and communication devices	12	0
17	Medical instruments, optics, watches	15	0
18	Motor vehicles	9	0
19	Other transportation equipment	7	1
20	Furniture and other artifacts	98	0
21	Manufacturing of Textiles	17	5
22	Recycling	3	0
23	Total	1209	51

A questionnaire has been used to collect information in this research. According to the World Bank reports, this method has been successfully used in many developing countries (Fataei 2005); because the best and to some extent the most accurate information is available to the owners of the industries and technical authorities involved with problems related to waste, and in particular hazardous waste.

It should be noted that questionnaires were completed in person and in the form of an interview. The questions were designed open-ended or closed, according to the nature of the case. The Questionnaire is set up in 12 pages and includes questions about type of waste, physical state, characteristic, amount, temporary storage method, discharge period, final disposal, recycling, etc.

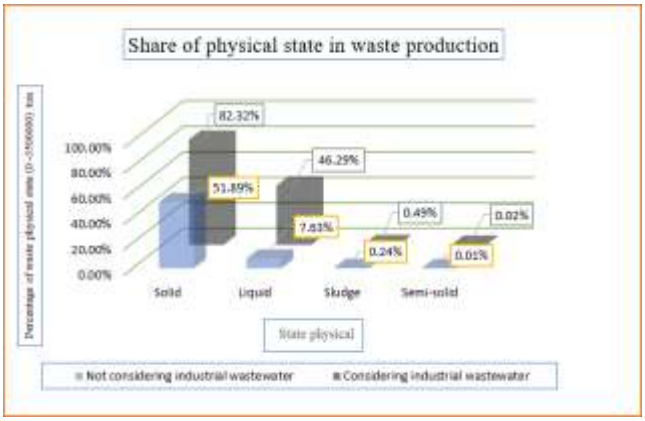
In this research, Microsoft Access XP software was used to store, retrieve and process information. It should be noted that due to uncertainty about the inclusion of uncontrolled industrial waste, among management of hazardous waste, data was processed in two ways: once considering uncontrolled industrial wastewater and the other without considering it and considering all the necessary breakdowns. The results are provided in the next section.

3- Results

Considering untreated wastewater in studied samples, approximately 3,108,002 tons of waste is produced annually; of which 78.09% is related to the group of manufacturing non-metallic mineral products and 24.41% is related to the group of manufacturing chemical materials and products. By removing the data related to uncontrolled industrial wastewater in processing, the total amount of recorded waste in studied units decreases to 2,010,265 tons annually, that in this case 52.97% of the most production of waste is related to industrial group of non-metallic and mineral products and the lowest production of waste related to other groups is about 0.72%.

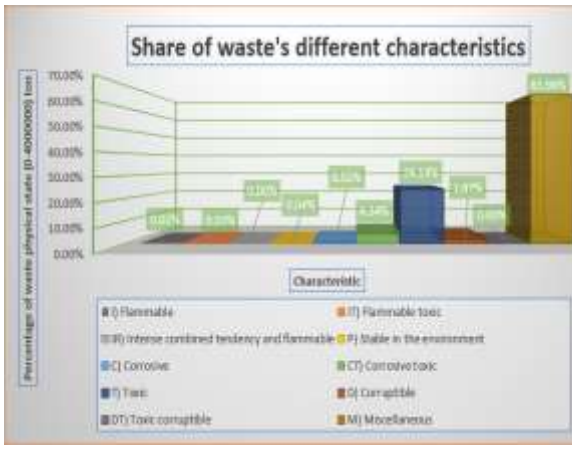
Graph 1- Share of industrial groups in waste production considering industrial wastewater and not considering it

Considering uncontrolled industrial wastewater, the share of solid, liquid, sludge and semi-solid is respectively 82.32%, 46.29%, 0.49% and 0.02% of total recorded waste in this case (Graph 2).



Graph 2 - Share of different physical states of waste production considering industrial wastewater and not considering it

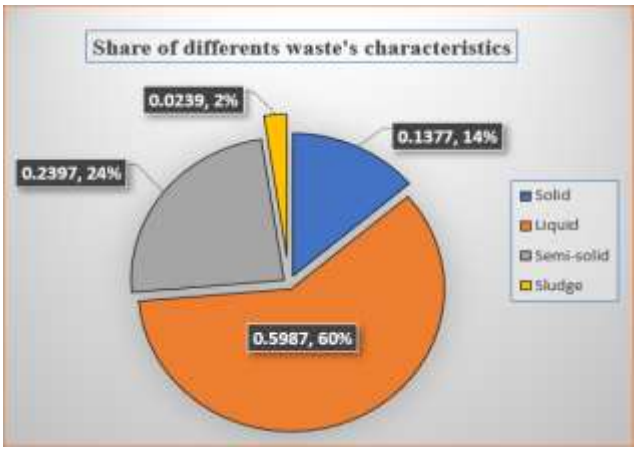
Concerning characteristics of total recorded waste (approximately 3,108,002 tons annually) in studied units, it can be said that about 24.14% of waste has toxicity characteristic (individually or in a mix), 4.34% has corrosive–toxic characteristic and about 65.98% of waste has miscellaneous characteristics. It should be noted that having this characteristic doesn't mean that waste does not pose any danger to environment; rather we can say that it may create risk in other situations (Graph 3).



Graph 3- Share of waste's different characteristics considering industrial wastewater and not considering it

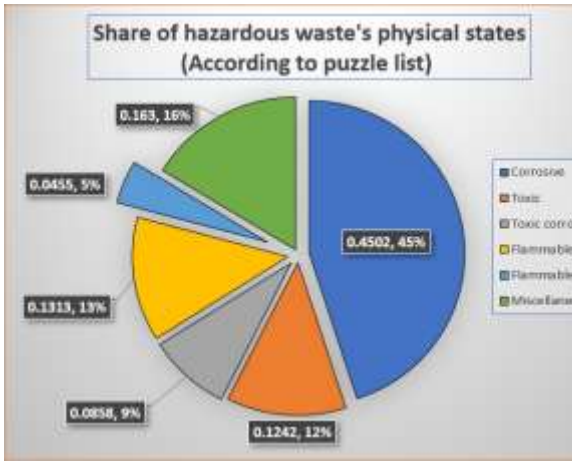
The status of final waste disposal recorded in units indicates that annually about 28.66% of the total waste is discharged into the environment without any control and about 62.65% use other disposal methods such as discharging in lagoons, discharging in absorbent well, discharging in wastewater network, sale, and so on. It should be noted that approximately 1502 tons of the total hazardous waste provided by the Basel Convention is considered 100% hazardous. Industrial groups of manufacturing fabricated metal products and manufacturing of chemical materials and products are of the most significant production sources of these kinds of waste in Ardabil province. The most significant physical states observed in liquids are about 59.87% and the lowest physical state for sludge is about 2.39% (Graph 4).

Graph 4- Share of various methods of hazardous waste disposal (According to the puzzle list)



Graph 5- Share of various hazardous waste characteristics (According to the puzzle list)

About 45.02% of this waste has corrosive characteristic, 12.42% of it has toxicity characteristic and 16.30% of it has miscellaneous characteristic (Graph6).



Graph 8- Share of hazardous waste's physical state (According to the Puzzle List)

4- Discussion

The approximate amount of 3,108,002 tons of waste from 51 industrial units was produced during one year of study (from spring 2018 to spring 2019); of this amount approximately 1,104,282 tons belong to industrial wastewaters. The major share of produced waste belongs to industrial groups of production of chemical materials and products and mineral and non-metallic products. Also, the results indicated that the share of solid, liquid, sludge and semi-solid waste respectively equal to 82.32%, 46.29%, 0.49%, and 0.02%.

Although Iran's current environmental management system contains bylaws, standards and regulations for controlling industrial wastewater, the implementation process is very slow in this regard; in addition, there is no proper system for controlling and monitoring the purification facilities that are rarely used in this regard. The reduction of total waste from approximately 3,108,002 tons annually to approximately 2,010,265 tons in the case of disregarding industrial wastewater is the evidence to prove this matter. In other words, the executive system for controlling industrial wastewater is not suitable in terms of performance; and considering the growing industry, it will not have the ability to achieve environmental management objectives, which is to maintain human health and the environment.

The results showed that in the case of disregarding industrial wastewater and processing the relevant information, predominant share of waste is still solid waste (about 82.32%) and about 12.42% of produced waste has toxicity characteristic which has mainly originated from industrial group of production of chemical materials and products that considering environmental hazards, there is special need to control them.

The results showed that in studied industrial units, waste disposal is often unavailing and non-technical, and the waste is practically discharged in environment without any control. Also, recycle and reuse of industrial waste in a practical and principled manner at the level of Ardabil province, is not done as it ought to; and while the issue of waste reuse is a key to reducing waste, it should be more emphasized in the waste management systems of the country (Freeman 1998).

The results showed that the approximate amount of 1502 tons of total recorded waste annually is in accordance with the hazardous waste list provided by the Basel Convention. These wastes are hazardous and come from various industries such as metal, chemical, oil and textiles industrials, etc. and are disposed in a non-scientific, non-technical, unhealthy and non-environmental way.

5- Conclusions

By surveying and analyzing the results, it is possible to apply necessary adjustments in

industrial waste control strategy by using a comprehensive plan with appropriate scale of deployment and distribution location of industries, these plans can be prepared in the form of geographic systems and information of industrial units can be connected to them (7); Including establishment of suitable places for treatment and final disposal of hazardous waste, so that the industrial waste that consist of any kind of contamination, will not spread in the environment. Considering that major part of toxic hazardous waste is produced in industries of manufacturing chemical materials and products, it is necessary to use and adapt to regulations and standards of other countries to control and manage industrial waste by designing and implementing waste minimization programs (Muller 1993). By provisioning rules and regulations and their full implement in respect of hazardous waste control, it is also possible to force industrial units to comply with scientific-technical, health and environmental disposal requirements; And the supervision of Environment Protection Agency in importing and consumption of chemical materials used by industries must be efficiently made by communication and inter-segment coordination with ministry of industry, commerce and other responsible agencies. This proposition is meant to reduce the consumption of chemical and hazardous materials and is one of the systematic ways of minimizing hazardous waste that will have impressive results in case of good implementation.

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