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Original Article

Characterization and management of industrial hazardous waste in Qom province

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Abstract

Background & Aims: The aim of this study was to examine industrial waste minimization through identifying physicochemical properties and recyclable components and classifying hazardous wastes. On the other hand, the importance of this study is that it envisages opportunities as the eco-industrial park through using industrial waste management at international and national levels to reduce waste and pollution.

Materials and Methods: All the industrial units of industrial towns of Qom province (Shokohieh, Salafchegan, and Mahmoud Abad) and Taghroud industrial area, which have been active in the production of chemical, pharmaceutical, metal, and non-metal materials, were considered as the studied society in this cross-sectional study. The quantity and quality of industrial hazardous waste were evaluated by a questionnaire approved by the Iranian Environmental Protection Organization and field inspections.

Results: The results of the quantitative and qualitative characteristics of the industrial hazardous wastes of industrial towns, including Shokohiyeh, Salafchegan, Mahmoud Abad, and Taghrud (1239 industrial units) demonstrated that 118.449 tons/day of industrial wastes and 15.743 tons/day of hazardous wastes, including 65% solid waste, 31% liquid waste, 3% semi-solid waste and less than 1% and equivalent to 0.02%), were produced in industrial towns. It was found that the industrial units of non-metallic minerals (35.25 tons/day) and then food industries (31.9 tons/day) had the highest amount of industrial waste and dioctyl phthalate units (DOP, 5.8 tons/day), and chemical industry (4.84 tons/day) and lead recycling units (4.14 tons/day) produced the highest amounts of special waste, respectively. Based on the relevant diagrams, the highest values of hazardous wastes were related to Basel Convention code (Y9) for unit process waste DOP (511.5 tons per day) and Basel Convention code (Y31) for lead recycling unit wastes (3.587 tons/day).

Conclusion: Planning and necessary training for managers and technical officials of industrial units in the field of hazardous waste management and the development of a comprehensive plan in this regard is inevitable.

Keywords: Industry, hazardous waste, Qom, Iran

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1. Introduction

Waste management is one of the most important environmental issues of the present century. This management consists of a set of coherent and systematic regulations from production to waste disposal complying with the most efficient principles of public health, economics, resource protection, and other environmental requirements [1]. Industrial wastes have special importance and a position in terms of environmental factors and components due to the presence of more hazardous materials. In addition, the emergence of new technologies, the acquisition of new production processes, the replacement of synthetic materials with natural fibers, and the synthesis of thousands of chemicals and compounds have increased the volume of industrial waste and in some cases, increased the production of hazardous waste. These wastes have become a costly issue for industrialists and a double burden on the environment [2]. Reducing pollution, recycling, and reuse of waste, production of environmentally friendly products, increasing the efficiency of raw material consumption, and reducing waste can be justified and examined from a macroeconomic point of view and usually increase economic profits at the level of households, industrial units, and diverse social strata. Industrial waste as one of the main types of waste needs careful and comprehensive management [3,4].

In this regard, it is necessary to take any action regarding waste management, including quantity and quality of waste, as well as the measurement and amount of hazardous waste, and more precisely, to determine the specificity of waste. This will not be achieved unless through studying the identification and classification of waste based on a correct and valid reference at the local and regional scale [5]. Industrial regions in Iran annually produce and dispose of approximately 1 billion tons of

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industrial waste, which are considered hazardous waste due to their characteristics. Part of the industrial waste, which also includes hazardous waste, endangers human health and other living organisms due to the inability to biodegrade in the environment, cumulative effects, and the like [6].

The current research has systematically examined numerous kinds of hazardous waste produced in Qom province. This study aimed to examine industrial waste minimization through the identification of physicochemical properties and recyclable components and the classification of hazardous wastes. On the other hand, this study is important because it envisages opportunities as the eco-industrial park through the use of industrial waste management at international and national levels to reduce waste and pollution, efficiently sharing resources such as information, materials, water, energy, infrastructure, and natural resources [7-9].

2. Materials and Methods

This cross-sectional study was accomplished with the studied population, including all the industrial units of the industrial areas of Qom province (Shokohieh, Salafchegan, Mahmoud Abad, and Taghroud) as the producer of chemicals, pharmaceuticals, metals, and non-metals, and the like (Figure 1). The waste evaluation was performed to identify industrial waste and specify all types of industrial waste by the type and process of each industrial unit (waste disposal of raw materials, packaging waste, including metal, plastic, paper and cardboard containers, textiles, disposal and replacement parts, and the like). Moreover, the other identified wastes were hazardous types, including burnt oils, lead batteries, wastes containing mercury in electronic components, and used mercury lamps, paint and pigment wastes, solvents, and the like. Data were extracted from valid sources and prepared in the form of a valid questionnaire approved by the experts of the Iranian Department of Environment. The questionnaire contains demanded information, including 400 questions about raw materials, products, quantity and quality of industrial and hazardous wastes, as well as how to manage waste, including the possibility of recycling, recycling rate and type of use of recycled materials, type of collection, and storage specifications, and the like [10,11]. To evaluate and analyze the quantity and quality of industrial and hazardous wastes, 96 industrial units were selected for waste analysis and sampling. The number of samples in the study was chosen according to continuous activity, production capacity, the possibility of self-declaration of the industrial and special wastes of the industrial unit manager, and the safety and health expert.

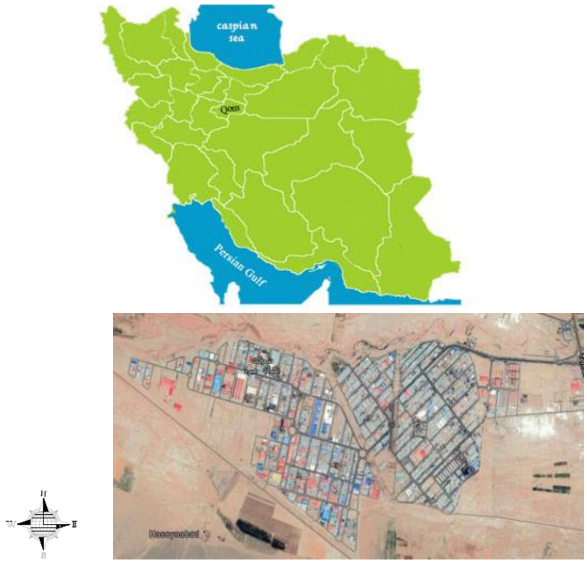

Figure 1. Location of industrial areas of Salafchegan

The industrial and hazardous wastes were analyzed daily for two consecutive weeks. Waste samples were received and weighed by analysis containers ($V = 1\ m^3$), in a specific space as an analysis site, industrial, and special, for each of the selected industrial units. The quantities of industrial waste and special production waste were collected and weighed in accordance with the identification and list of hazardous waste with the international methods of the Basel Convention. Finally, the daily analysis report and the waste specifications questionnaire were completed for the industrial unit [12,13].

3. Results

Table 1 provides the results of the analysis and identification of the composition of industrial and hazardous wastes related to the 98 selected samples of the studied industrial units of the industrial areas in Qom province according to the type of waste.

Figure 2 illustrate the quantitative and qualitative characteristics of industrial and hazardous wastes for all units located in the industrial areas of Qom province according to specifications such as average daily production, Basel Convention code, physical properties, composition, and correlation rate in the production of industrial and hazardous wastes.

4. Discussion

In total, 118.449 tons/day of industrial waste and 15.743 tons/day of hazardous wastes (including 65% of solid wastes, 31% liquid waste, 3% semi-solid waste, and less than 1% and equivalent to 0.02%) were produced based on the results of estimating the quantitative and qualitative characteristics of industrial and hazardous wastes in the industrial areas of the Qom province (1239

Table 1. The production rate of industrial and hazardous waste of industrial areas

Industrial units (n)	Hazardous waste (kg/d)	Industrial waste (kg/d)	The ratio of hazardous waste to industrial waste
98	5723	28651	0.2

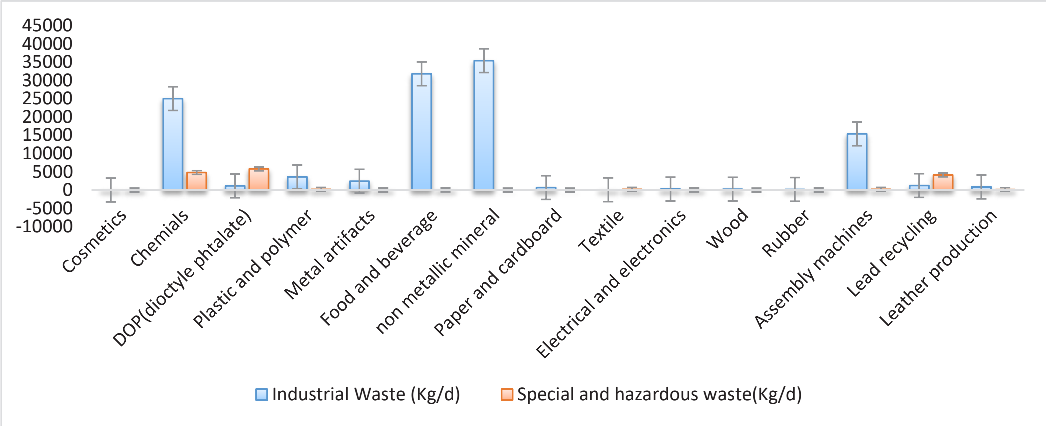

Figure 2. Quantitative and qualitative characteristics of industrial and hazardous wastes

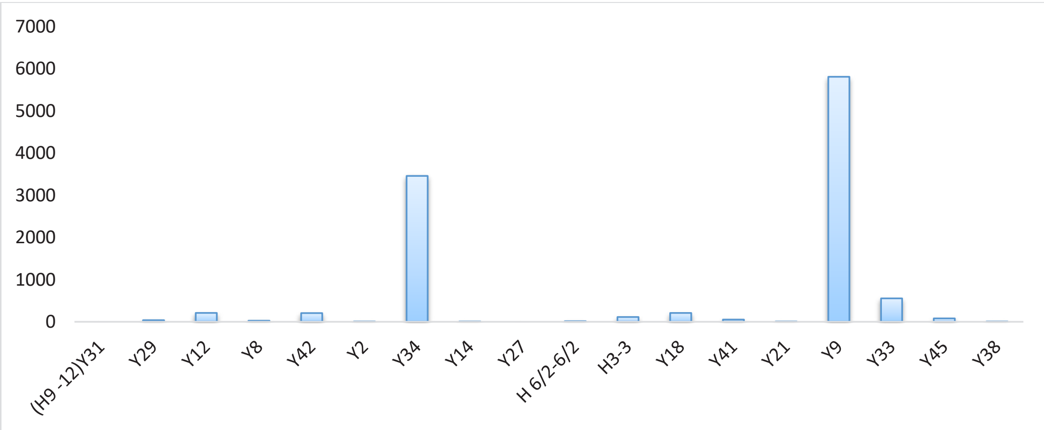

Figure 3. Quantitative and qualitative characteristics of hazardous wastes according to Basel Convention code

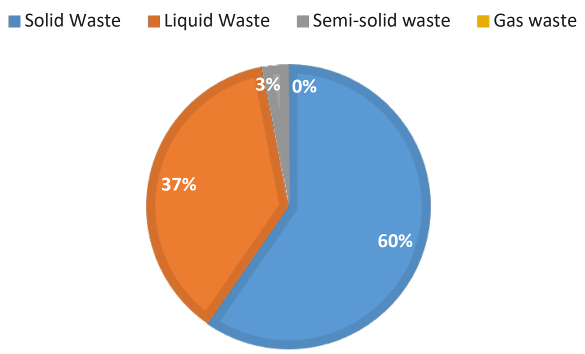

Figure 4. Physical properties of hazardous wastes

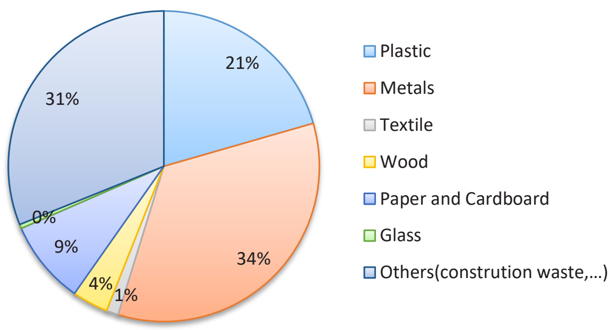

Figure 5. Composition of industrial wastes

industrial units). The ratio of hazardous to industrial waste production was set at 20%. The findings showed that the highest volume of industrial waste belonged to non-metallic mineral industries, food industries, chemical industries, basic metals, machinery production, and polymer, respectively, so that by examining tables and graphs, non-metallic mineral industrial units (35.25 tons/day) and food industry (31.9 tons/day) had the highest quantity of industrial waste, as well as DOP units (5.8 tons/day) and chemical industry (84.4 tons/day), and lead recycling units (4.14 tons/day) had the highest amounts of hazardous waste, respectively. Based on the data in Figure 3, the highest values of hazardous wastes were related to Basel Y9 codename for the DOP waste process (511.0 tons/day) and Basel Y31 codename for lead recycling wastes (3.587 tons/day). The composition and characteristics of industrial wastes (Figure 5) demonstrated that 34% of industrial wastes including metals (iron and aluminum), 31% non-metallic minerals including construction waste, 29% plastics and polymers,

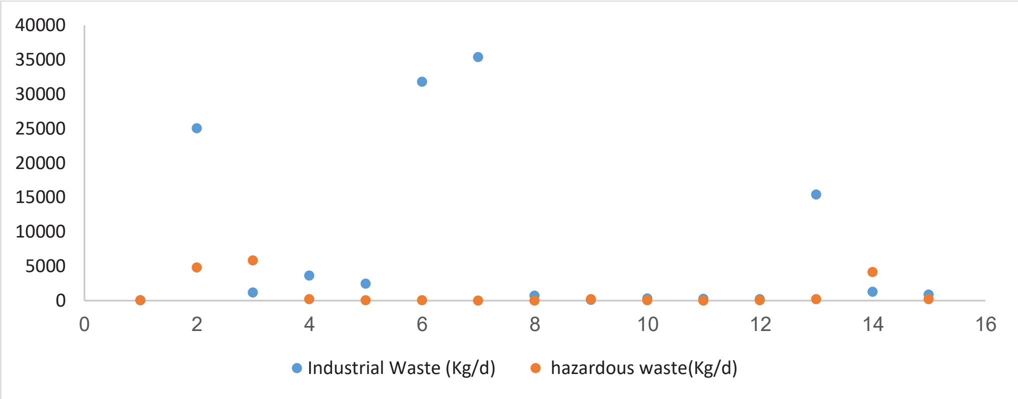

Figure 6. Correlation between production rate of industrial and hazardous wastes

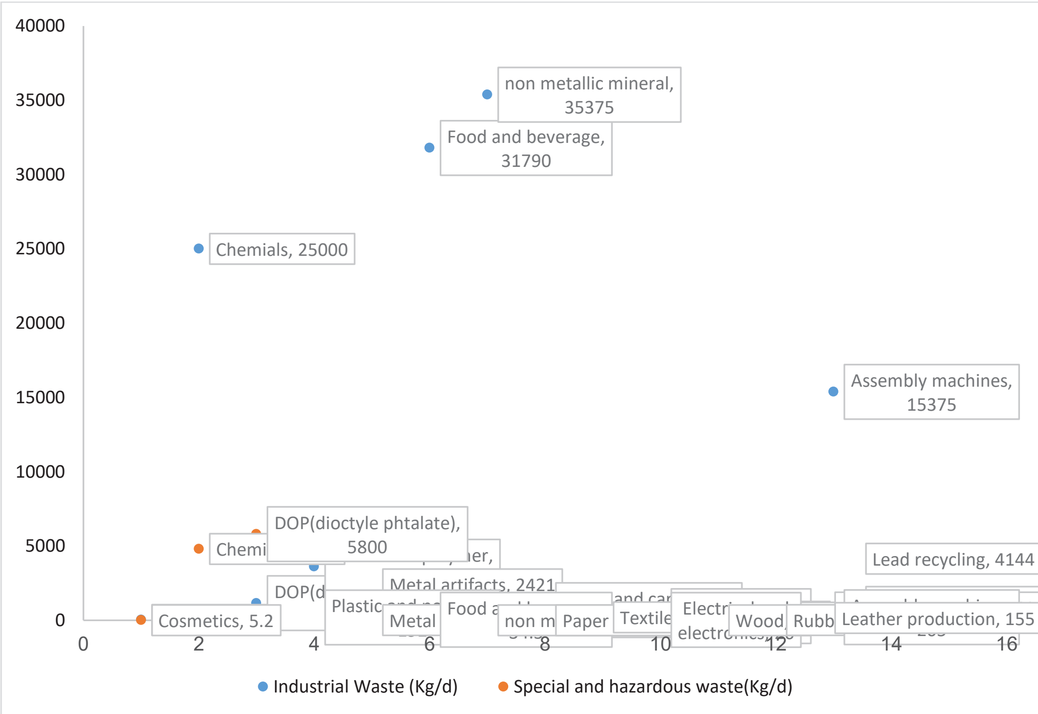

Figure 7. Correlation between production rate of industrial and hazardous wastes regarding industrial unit type

9% paper and cardboard, 4% wood, is 1% of fibers and textiles and less than 1% of glass These results are comparable with those of other studies related to the evaluation of industrial waste contrary to the sample size and similar units so that the results of Farzadkia et al and Monavari & Dimyadi were the same due to the amounts of the wastes in DOP units [14, 15]. In the composition of industrial wastes (Figure 4), 34% of the component of industrial waste is allocated to metals. Although the composition of industrial wastes follows local and regional patterns, the results of this study are in line with the findings of Schoeman et al in Southern Africa. Based on the results of a study about waste characteristics and management activities in the iron and steel industry in Southern Africa, the global average of 0.3 tons of waste generated per ton of produced crude steel represented an increase [16]. According to the results of the composition of industrial wastes (Figure 5), most of the industrial waste is recyclable. Due to the non-governmental management of industrial areas in Qom province, the issue of recycling and rehabilitation options has received a low priority. Government responsibility and services for industrial waste management are inevitable. Nissapokin et al found that Thai industrial waste management under the supervision of the Department of Industrial Works emphasizes only eight international principles of industrial waste management in comparison with the 10 principles of best international practice. Private factories prioritize disposal first and foremost, and recovery least, indicating that such factories do not concentrate on solving the problem of industrial waste management at its primary source [17]. The results of another study by

Jandieri about a new approach to the resource policy of the manganese industry in Georgia highlight the intensification of recycling due to the expansion of the range and volume of recyclable industrial waste [18], which is in line with the findings of the present study, which can lead to the creation of new policies and approaches in metal recycling in the industrial area of Qom province. It is necessary to explain that differences in the results of the study with other studies conducted in industrial areas should be analyzed and evaluated based on fluctuations in waste production, various process factors, and management decisions in the field of waste [19-21]. Figures 6 and 7 display that the correlation between industrial waste production and hazardous waste is negligible ($r^2 = 0.05$), but in the leather, chemical, DOP, and lead recovery industries, the relationship between hazardous waste and industrial waste is quite evident [22]. This connection is because of the large proportion of hazardous wastes in industrial areas, including process wastes; moreover, they are usually in the category of special wastes which can be used in accordance with common patterns in hazardous waste management and consist of conversion processes to reduce volume and minimize the weight, disposal, and recovery of modified products, as well as the quantity and quality of these wastes [23-25]. In this study, physicochemical properties, recyclable components, and classification of hazardous wastes were investigated, which were for handling hazardous waste, which conforms to the study of Mayank et al [26]. Zhang et al indicated that the trends of the global industrial waste production quantity and physiochemical properties are vital for the efficient management of wastes to mitigate environmental impacts [27]. One of the important aspects of identifying the characteristics and specifications of industrial waste is the value stream mapping as a supporting management tool to identify the flow of industrial waste; it is considered a practical method for identifying opportunities and challenges in waste management, reducing waste, and achieving an environmentally responsible zero-waste environment. According to the quantitative and qualitative characteristics of industrial waste in Qom province, the results of the study also revealed that energy and material recovery are the essential methods of industrial waste management, as well as opportunities for boosting power outputs [28]. In China, the state of hazardous waste generation increased from 9.74 Mt (1 Mt = 10^9 kg) in 1998 to 75 Mt in 2018. During 2001-2017, the comprehensive utilization, disposal, and storage were in the range of 5-20 Mt, 2-15 Mt, and 3-10 Mt, respectively. Human and environmental impacts can be found through the changing state of waste generation and handling. As a response, China has led the world to hazardous waste management and recovery lineups through resource efficiency and recycling. Finally, we also attempted to draw a coherent roadmap for future direction and associated policies [29]. The inevitable part of the National Environmental Policy Act of 1969 is about the industrial and social activities to perform measurements for effectively managing hazardous waste. Apart from many pollution control laws, hazardous solid waste disposal is ineffective in large urban areas. In the recent industrial era, it should be noted that many industrial wastes contain hazardous chemical, radioactive, and biological compounds, and thus the environmental consequences and hazards of hazardous waste should be managed with the best strategy [30].

The findings of a study by Jha et al on measurement and practices for hazardous waste management demonstrated that the best strategy to maximize safety and minimize the environmental impacts of hazardous waste is the implementation of action plans for the characterization of chemical, radioactive, and biological hazards of hazardous waste [31].

5. Conclusion

Due to the importance of the executive waste management hierarchy and classification of priorities derived from the requirements and national laws, it can be understood that planning and necessary training for the managers and technical officials of industrial units in the field of hazardous waste management and development of a comprehensive plan for hazardous waste management is inevitable.

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Conflict of Interests

The authors declare that they have no conflict of interests.

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