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Industrial Solid Wastes and Their Management in Guilan Province

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Industries, like other waste sources, are associated with numerous waste-related environmental problems. Guilan province is considered as an important industrial area in northern Iran. There are *ca.* 1976 industrial units in Guilan province, most of which are located in the outskirts of cities. In the current study an approximation of the quality and quantity of the generated waste in food industry of Guilan province, which is recognized as the largest waste generator industry in the study area in Iran is provided. In present study, questionnaires were used to collect data regarding methods of waste management used in 142 of the food businesses in the area of study. The results of the present research show that putrescibles are the most important waste in this industry. The high percentage of putrescibles in the waste stream (73.7 %) and relatively appropriate physico-chemical characteristics of the waste, suggest the possibility of composting. Additionally, more than 70 % of total non-organic wastes is contributed to packaging processes. There are relatively few industries that implement such correct waste management. Relatively low price of raw materials and lack of efficient penalties in case of inappropriate waste disposal by industries are considered as the major reasons of such deficiency in regional waste management. It is highly recommended that the implementation of such tax policy accompanied by joint management of generated industrial wastes be enforced in the area.

Key Words: Industrial waste management, Food industry, Guilan, Iran.

INTRODUCTION

In the last decade, the global economy has undergone radical changes that have had significant implications for the development of industrial operations[1]. Industrial development has generated complex wastes, a complexity not only due to the quantity of wastes, but also to their composition[2]. The term industrial waste refers to all wastes produced by industrial operations or derived from manufacturing processes[3]. Industrial wastes encompass food wastes, rubbish, ashes, construction and demolition wastes, special wastes and hazardous wastes[4]. There are many examples of industrial waste management in several countries that have recently become interested in industrial waste[5-7].

Industries, like other waste sources, are associated with numerous waste related environmental problems. However, industrial solid waste is generally associated with more hazardous constituents and as such has a higher public health and environmental risk potential. Problems associated with industrial solid waste are also common with other types of waste pertain to malpractices during storage, collection, transportation and treatment as well as disposal. By their very nature, industries tend to concentrate pollution. They comparatively emit more concentrated pollutants on per-discharge basis and higher pollution discharges on per-source terms[8].

Iran has experienced a rapid increase in its economy during recent decades and has moved quickly to encourage domestic industrialization by attracting more local investment. However, in the absence of a comprehensive sustainable development scheme, this increase has brought severe environmental issues, such as water resources depletion and pollution, soil erosion, desertification, acid rain, forest depletion and solid waste pollution. This trend is most pronounced in northern coastal provinces (Guilan and Mazandaran) where most ecotourism infrastructures and natural resourses are located. Among these environmental issues, solid waste is becoming a critical issue, not only in terms of the impacts being created but also in terms of resources being consumed. Similar studies have been estimated that the amounts of industrial waste increased in Iran and some other developing countries[8-11]. If not properly managed, the accumulation of industrial wastes can give rise to serious environmental damage, as well as increased safety problems and health-care costs. One of the significant challenges facing industrial managers is how to minimize the negative impacts of solid wastes while still attempting to promote rapid industrial development. One solution has been to adopt principles of integrated solid waste management by encouraging government and industries to integrate sustainable practices, comply with environmental regulations and select and apply suitable technologies and management programs to achieve realistic waste management goals and objectives[5]. A considerable amount of literature is available on industrial solid waste management in developing countries[12-14]. However, these studies essentially focused on quantification and characterization of the waste. Most of the available literature on solid waste management covers in general. Studies that have taken an in-depth look at a specific industry is not found in the literature.

The food industry generates large amounts of solid and liquid wastes. Most of these wastes are biodegradable and putrescible and may contain valuable resources. The environmental and economic impact of food processing may be high unless effective environmental control systems are in place. Modern environmental control strategies feature efficient waste treatment systems to reduce the environmental impact, as well as measures to minimize waste generation and to maximize resource recovery and upgrading, efficient recycling and waste segregation[15].

This paper identifies the current status of industrial waste generation and examines the planning and application of integrated solid waste management in Guilan province by employing a case study of food industry, which is recognized as the largest waste generator industry in the study area.

Study area: There are *ca.* 1976 industrial units in Guilan province, most of which are located in the outskirts of cities. Guilan province is considered as an important industrial area in northern Iran. Fig. 1 shows the graphical location of Guilan province; northwest of Iran that is just between the Alborz mountains and Caspian sea.

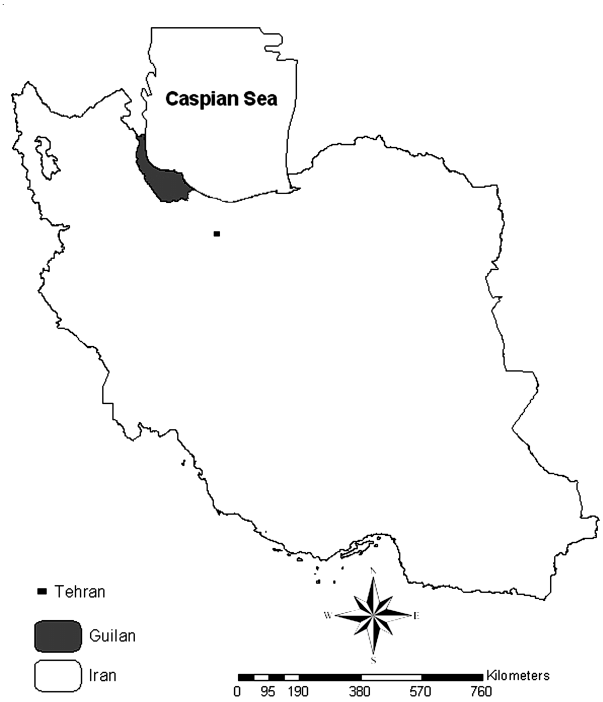

Fig. 1. Location of Guilan province in Iran

EXPERIMENTAL

A variety of waste management problems in the area under study were identified. The implementation of a waste management system is feasible if, there is a preliminary study of the waste generated. Consequently, the first step is to study the quantity, type and composition of this industrial waste in order to plan and develop a more adequate waste management system[3].

Three general methods have been used to identify the current status of functional elements concerning industrial waste[16]: (a) an empirical approach using available industry information, (b) a questionnaire survey, (c) use of control/monitoring data from a waste management system.

International research[1,10,16,17] give examples of the use of questionnaires with a view to study the quantity and type of industrial wastes generated, along with the management and control methods used. On the basis of the studies carried out in

other countries as well as in Iran[10], the current research prepared an initial questionnaire regarding the functional elements and organizational structure of industrial waste management practices. It included information on the following items: (i) industrial group, (ii) number of employees, (iii) number of staff involved in waste management inside the factory, (iv) type of waste generated and its components, (v) volume of waste per week, (vi) methods of waste collection, (vii) reuse, recycling and on-site waste processing, and (viii) final disposal methods.

The questionnaire was given to the 200 companies located mostly in the outskirts of large cities of the province, namely; Rasht, Bandar Anzali, Lahijan, Roudbar and Talesh. Of the total questionnaires given, 58 were not taken in to consideration because of major deficiencies. The final total of questionnaires came to 142, a sample that was adequate for the purpose of the research.

Categorization of industrial activities: The qualitative and quantitative characteristics of generated industrial wastes usually depend on the type of each industrial activity. In this study, industrial activities were classified as follows: food industry, metal industry, car industry, wood industry, paper and pulp industry, textile industry, plastics and chemicals industry and non-metallic minerals industry.

Considering waste generation rate and variety of wastes materials, authors consider food industry as the major waste generator within the province (Table-1 and Fig. 2).

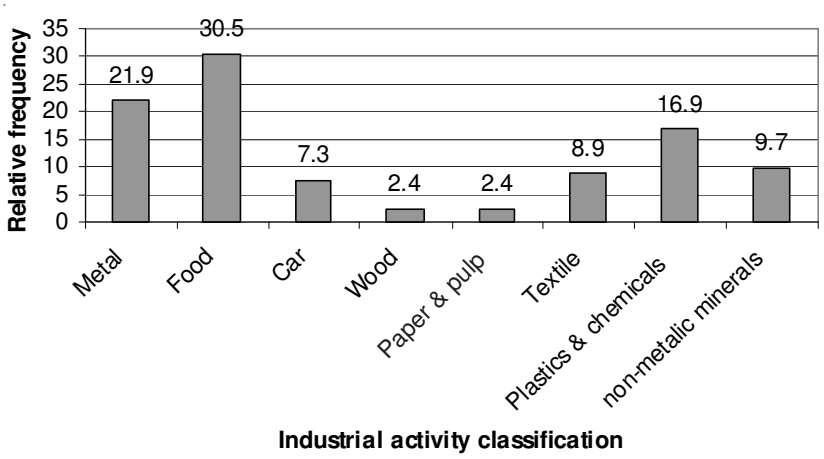

Fig. 2. Relative frequency of industrial activities in the study area

Accordingly, the wastes generated by the food industry were classified according to their composition *i.e.*, (i) wood, paper and cardboard, including office materials, packaging, *etc.*, (ii) plastics and polymers, including packaging and various other wastes, (iii) metals (*e.g.*, iron, aluminum, bronze, lead, copper, steel and brass) from packaging, (iv) textiles, (v) inert wastes, (vi) putrescibles, their composition is basically organic matter with some small packaging. Garden and pruning wastes are also included, and (vii) chemicals.

TABLE-1
PRODUCT AND WASTE GENERATION IN DIFFERENT INDUSTRIES OF GUILAN PROVINCE

Industry	Food	Metal	Car	Wood	Paper & Pulp	Textile	Plastics & Chemicals	Non-metallic minerals
Generated product (ton/year)	1890000	236550	51920	86520	121150	30000	1150000	1960000
Generated waste (ton/year)	83338	4258	1243	1644	6542	330	24246	27455

RESULTS AND DISCUSSION

The classification of the industrial activities in the studied sample is shown in Fig. 2. Most of the industries belong to the food, metal and plastics and chemicals. There are also a few non-metallic minerals, textiles, car, pulp and paper and wood industries.

The mean generation rate of industrial waste can be expressed as weight or volume rate. Both waste weight and volume must be known in order to develop a proper waste management system, if we consider that certain industrial wastes have a high volume (*e.g.*, industrial packaging). Since wastes, such as paper and cardboard, plastic and wood, have a high volume, special collection technology is necessary. This could take the form of mechanical volume reduction or another processing technique. The mean waste generation rate in food industry was 83,338 tons per year which is more than 50 % of total generated industrial waste in the province (Table-1). Fig. 3 shows the waste generation rate (ton/year/worker) and variety of wastes materials in food industry in comparison with those of other industries.

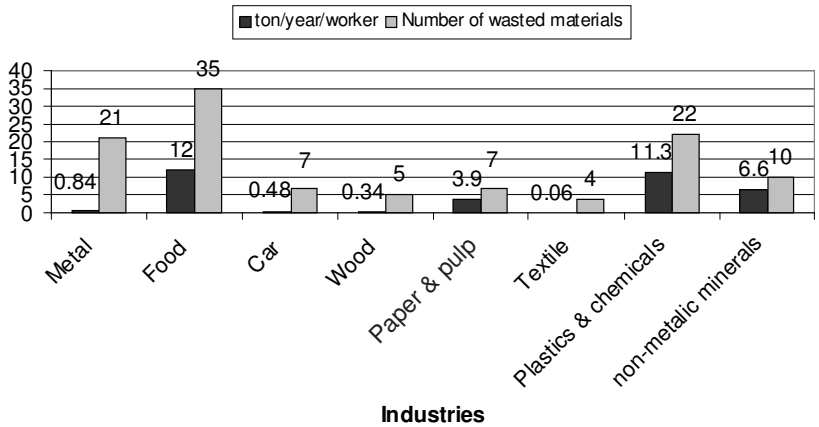

Fig. 3. Waste production by weight and number of wasted materials in different industries

Particular climatic and geographical characteristics of Guilan province (enough humidity, precipitation, proper soil, *etc.*) in Iran justify the development of food industry. This practice resulted in an increase of pollution through the generation of different kinds of wastes.

Fig. 4 shows that 73.7 % (by weight) of the wastes are putrescibles. This is the most important group by weight. Plastics and polymers make up the second group by weight (8 %), percentage that corresponds to the packaging processes and chemicals. Paper and wood (6.9 %), metals (6.5 %) and inert materials (3.4 %) are the next most significant groups by weight. Finally, textiles are present in 0.3 % of the total generated waste. Fig. 5 shows the percentages by weight of packaging in wastes. More than 70 % of total non-organic wastes is contributed to packaging processes.

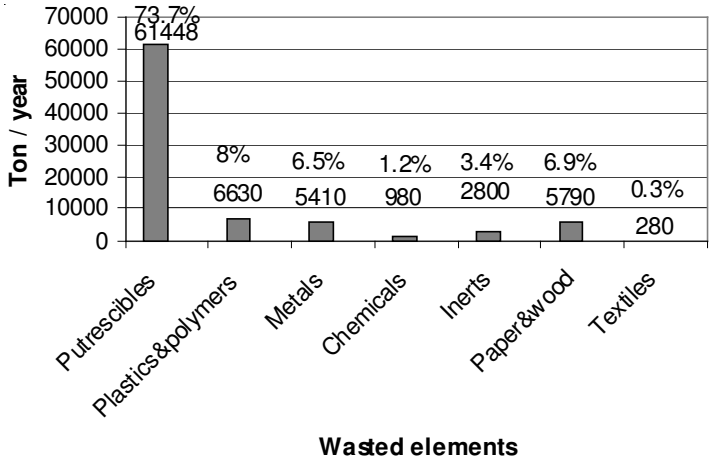

Fig. 4. Waste production by weight and per cent in studied food industries

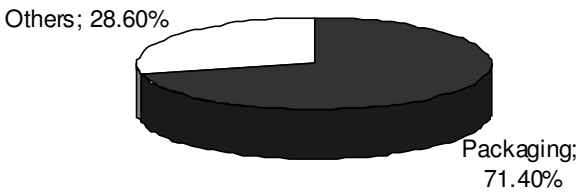

Fig. 5. Percentage of packaging and other non-organic wastes by weight

Physical characteristics of wastes are shown in Fig. 6. A more detailed analysis of this picture shows that non-bulky wastes are more significant in weight and in volume than other types. To be exact non-bulky materials comprises 86 % of the weight of all wastes. Bulky wastes represent 6 % of the total weight and finally, powders and sludge materials represent only 7 and 1 % of the weight of all generated wastes, respectively.

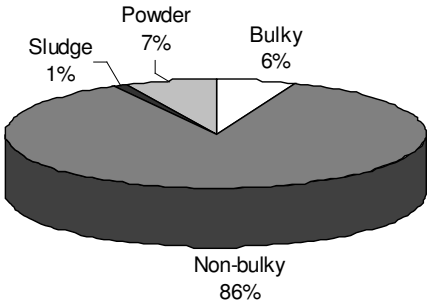

Fig. 6. Physical characteristics of generated wastes reported in food industries

Conclusion

Questionnaires have been used as a tool to learn about the management of wastes in industrial areas, as well other types of wastes[1,10,16,17]. In the current study an approximation of the quality and quantity of the generated waste in food industry of Guilan province in Iran is provided. The results of the present research show that putrescibles are the most important waste in this industry. The high percentage of putrescibles in the waste stream (73.7 %) and relatively appropriate physico-chemical characteristics of the waste, suggest the possibility of composting. However, implementation of an efficient source separation plan must be considered in order to assure the quality of raw materials entering the composting process. Furthermore, a market for composted products would also have to be established within the province or neighboring ones. Similar results have been achieved by the author in dealing with putrescible materials of the waste stream in Iran[17].

In the last few years, many industries have been engaged in extensive environmental audits and not surprisingly, this has led to the evaluation of their own waste management activities. An increasing number of companies are being certified according to the International Organization for Standardization (ISO) 14001, mainly related to internal organizational routines concerning environmental issues[18].

Correct management is that which takes into account activities without negative environmental impact as: minimization, reuse, recycling, valorization and elimination in sanitary landfill[3]. There are relatively few industries that implement such correct waste management. Relatively low price of raw materials and lack of efficient penalties in case od inappropriate waste disposal by industries are considered as the major reasons of such deficiency in regional waste management.

Active tax policy is a solution that some countries are using at the moment with the cooperation of local authorities or under the pressure of public opinion. This is presently the case in Poland[19] and Sweden[18]. It is highly recommended that the implementation of such tax policy accompanied by joint management[3] of generated industrial wastes be enforced in the area. Such implementation would highlight the key role of minimization, reuse, recycling and valorization elements in the process of waste management system.

The results obtained in this study are also valid for other food industrial areas in north of Iran (Mazandaran and Golestan provinces) with similar climatic and geographical characteristics as well as industrial priorities.

REFERENCES

1. M. El-Fadel, M. Zeinati, K. El-Jisr and D. Jamali, *J. Environ. Manag.*, **61**, 281 (2001).
2. M.S. Wei and K.H. Huang, *Waste Manag.*, **21**, 93 (2001).
3. M.L. Casares, N. Ulierte, A. Mataran, A. Ramos and M. Zamorano, *Waste Manag.*, **25**, 1075 (2005).
4. G. Tchobanoglous, H. Theisen and S.A. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, New York, McGraw-Hill, Inc. (1993).
5. Y. Geng, Q. Zhu and M. Haight, *Waste Manag.*, **27**, 141 (2007).
6. S.E. Mbuligwe, *Resour. Conserv. Recycl.*, **35**, 131 (2002).
7. P.C. Raymond and E. Cohen-Rosenthal, *J. Cleaner Prod.*, **6**, 181 (1998).
8. S.E. Mbuligwe and M.E. Kaseva, *Resour. Conserv. Recycl.*, **47**, 260 (2006).
9. B. Mrayyan and M.R. Hamdi, *Waste Manag.*, **26**, 195 (2006).
10. M. Asadi, D.F. Razy and M. Vojdony, *Waste Manag. Res.*, **14**, 211 (1996).
11. R. Bai and M. Sutanto, *Waste Manag.*, **22**, 557 (2002).
12. M.E. Kaseva and S.K. Gupta, *Resour. Conserv. Recycl.*, **17**, 299 (1996).
13. M.E. Kaseva and S.E. Mbuligwe, *Resour. Conserv. Recycl.*, **28**, 147 (2000).
14. R.A.M. Mato and M.E. Kaseva, *Resour. Conserv. Recycl.*, **25**, 271 (1999).
15. C.A. Zaror, *Food Control*, **3**, 190 (1992).
16. D.J. Monahan, *Waste Manag. Res.*, **8**, 145 (1990).
17. M.A. Abduli, *Environ. Int.*, **22**, 335 (1996).
18. W. Hogland and J. Stenis, *Waste Manag.*, **20**, 537 (2000).
19. M. Grodzinska-Jurczak, *Resour. Conserv. Recycl.*, **32**, 85 (2001).

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