

# Hospital Waste Management Practices: A Case Study in Iran

M. Farzadkia, S. Jorfi

**Abstract**—Hospital waste is a category of waste consisting of infectious and non-infectious waste, which pose environmental and health risks. Therefore, special planning and management is required, due to the potential hazards of them. The lack of valid and comprehensive information regarding the generation and management of hospital waste in Iran is one of the most important problems in this field. This research aimed to evaluate hospital waste management efficiency in Karaj city, Iran.

The four greatest hospitals in Karaj city had been selected in this cross-sectional study. Site observations and interviews with employees were implemented. The data was gathered based on the hospital waste management questionnaire which was designed by World Health Organization for developing countries. Collected Data had been analyzed using SPSS software.

The average of solid waste which was generated per bed was 2.78 kg, which included 90% of domestic waste and 10% of infectious waste. Based on the quantitative analysis of general and infectious waste in these hospitals, the highest contributors of general waste were consisting of food waste (37.39%), while textile (28.06%) were the highest contributors of the infectious waste.

According to the information contained in the questionnaires, the main defects of waste management in these hospitals were; inadequate staff in waste management sector, poorly disinfection of solid waste containers and temporary storage locations, and a lack of proper infectious waste treatment.

According to the results of this research, waste management in these hospitals were far from optimum conditions. In order to improve the existing conditions, mentioned problems must be solved quickly, and planning for continuous monitoring in the waste management field in these hospitals should be established.

**Keywords**—Waste management, hospital wastes, solid wastes, Iran.

## I. INTRODUCTION

**D**URING the recent decades, the public concern about the management of hospital waste has increased on a global basis. Hospital waste is a special category of waste because it poses potential health and environmental risks, in terms of sharps, human tissues or body parts, microbial materials and devices and other infectious materials [1]. A hospital waste, which is composed largely of general non-hazardous waste, also contains some amounts of hazardous waste, which should not be ignored. The hazardous part, not only contains infectious waste, but it also contains toxic chemicals and

heavy metals, and may contain substances that are genotoxic or radioactive. The potential for infection of employees who handle the waste and the general public, if the waste is not handled and disposed properly is the most important challenge of hospital waste management system [2]. Many studies have been carried out on hospital waste in developing countries such as Jordan [3], Iran [4], Egypt [5], Mauritius [6], Turkey [7], Brazil [8], Algeria [9], Mongolia [10], Libya [11], and India [12]. The findings of these studies and others indicate that, the management of hospital waste in many less-developed countries are often poor [13]. In these countries such as Iran, there is a lack of suitable waste treatment facilities, protective measures, and efficient training [12], [14]. Generally, hospital waste management suffers from lack of a special scientific and practical long-term strategy, because of unstable policy and poor cooperation between responsible authorities such as Ministry of health, Municipalities and Environmental protection organization.

Unfortunately, accurate information about the management of waste produced in Iranian hospitals is often not readily available [15]. Many hospitals in Iran have neither satisfactory solid waste disposal systems, nor a solid waste management and disposal policy [16]. The lack of information regarding the generation and disposal of medical waste in Iran, leads to poor planning for better management practices. In our previous work, we studied the medical waste management in teaching hospitals in Tehran [4]. In this study, the authors focused on hospital waste management in Karaj city. Karaj is the second largest city in North West of Tehran province after Tehran city, Iran, with a population of near 1,000,000 people and an area of 166 km<sup>2</sup>. Karaj is an industrial city which has undergone heavy urbanization and developing in recent decades, with the addition of numerous primary healthcare centers, clinics, physician offices, dental clinics and so on [17].

The main objective of this research was to investigate the hospital waste characteristics and management in Karaj city, Iran.

## II. METHODS

In this cross-sectional study, among the 8 active hospitals in the Karaj city, the four greatest hospitals were selected to be subject of this study. The criterion of selection was based on the number of active beds from most to least. Site observations and interviews with employees were conducted to all four hospitals to gather the required data.

Based on the recommendations of the World Health Organization for evaluation of hospital waste management in

M. Farzadkia is with the Environmental Health Engineering. Dept. School of Health, Iran University of Medical Sciences, Iran (corresponding author; phone: +98-912-258-8677; fax: +98-218-8622-707; e-mail: mahdifarzadkia@gmail.com).

S. Jorfi is with the Environmental Health Engineering. Dept. School of Health, Jundishapur University of Medical Sciences, Iran (e-mail: sahand369@yahoo.com).

developing countries [18] a data form and questionnaire were developed.

The sample of the questionnaire is presented in Table I. The study was conducted in the autumn and winter of 2014. This study was conducted to determine the quantity and quality (including weight, density, and per capita rate, the percent of water in non-infectious waste, physical analysis and percent of infectious and non-infectious wastes) of hospital wastes that was produced, the condition of segregation of waste, type of storage containers used and treatment procedures.

TABLE I  
THE SAMPLE QUESTIONNAIRE USED IN THIS STUDY

Row	Question
1	Name, location of hospital, name of city, type of special activity
2	The number of directories, beds and active beds of hospital on day
3	The number personals of the hospital and employees dealing with waste management
4	Do special regulations applied for segregation of infectious waste from general wastes?
5	Do in each directory separated containers are used for infectious waste and general wastes?
6	What kind and volume of storage container is used?
7	Do color codes are applied for storage containers and bags?
8	Are the storage containers are disinfected after decant?
9	Do special containers exist for sharp wastes?
10	Do noninfectious wastes are segregated into directories?
11	What is the duration of waste segregation in directories?
12	How are collected wastes transported to the temporary storage site?
13	What is the frequency of washing the containers?
14	What type of disinfectant was used for disinfection?
15	Do caution labels are attached to the containers?
16	What is the duration of temporary storage of wastes in winter and summer?
17	Do all sanitation conditions are applied to a storage site in hospital?
18	Do incinerator is used in hospital?
19	Do air pollution control equipment is used for incinerator?
20	Do autoclave is used in hospital?
21	How the volume of wastes is autoclaved by autoclave in each day?
22	Does radioactive waste are generated in hospital?
23	How radioactive wastes are managed?
24	What is the number of surgeries in each month?

TABLE II  
THE SUMMARY OF SPECIFICATION OF STUDIED HOSPITALS IN KARAJ CITY

Character	Hospital			
	Kasra	Emam khomeini	Ghaem	Alborz
Dependency	Private	Governmental	Private	Private
Activity	General	Specialized - General	General	Specialized
Waste generation (kg bed <sup>-1</sup> day <sup>-1</sup> )	2.9	3	2.74	2.5
Number of beds	total	70	200	350
	active	70	175	305
Departments number	6	18	17	16
type	General, Surgical	Burn, General, Surgical, Pediatric, gynecology and obstetrics	General, Surgical	General, Surgical, Pediatric

In order to determine the quantity and rate of waste generation, all generated wastes (hazardous-infectious, general and sharps waste) were weighed separately. For

physical analysis, wastes were sorted into food wastes, plastics, textiles, paper/cardboard, glass, sharps, liquid, metals and others. Before segregation, we sprayed the waste with disinfectant solution (0.5% sodium hypochlorite) [15]. These categories were weighed separately and the results were recorded. A special container with a 700 L volume was used to determine the waste volume and density.

### III. RESULTS

The daily waste generation rate in selected hospitals is shown in Table II. By considering the occupancy rate in the hospitals, between 2.5 and 3 kg of solid waste was generated per bed per day, providing an average of 2.78 kg bed<sup>-1</sup> day<sup>-1</sup> (S.d, ± 0.262) of which 0.302 kg bed<sup>-1</sup> day<sup>-1</sup> (S.d ± 0.0821) was consisting of infectious waste.

It should be noted that a bed day is defined as a bed that is occupied by a patient for a day. By dividing the waste in two main categories; namely general waste (non-infectious) and medical waste (infectious waste); it appears that about 86–91% (average, 89.21%, S.d ± 0.023) of generated waste is composed of general waste with water content of 60-70% and the remaining 9–14% (average, 10.78%, S.d ± 0.023) was infectious waste. The majority of infectious waste were textile, plastic and others including infectious devices, body tissues and sharp waste materials. The portions of general and medical waste are shown in Fig. 1.

The results of physical analysis of hospital wastes are presented in Tables III and IV. Quantitative analysis of generated hospital wastes for all selected hospitals indicated that textile (28.06%), plastic (23.9%), paper/cardboard (16.82%) and liquid (15.16%) have the highest contributions in infectious waste (Fig. 2). The highest contributors of general waste were consisting of food waste, textile, paper/cardboard, plastic in proportions of 37.39%, 22.05%, 12.45 and 8.62% respectively (Fig. 3).

TABLE III  
COMPOSITION OF INFECTIOUS WASTES IN SELECTED HOSPITALS

Type of waste	Hospital			
	Kasra	Emam khomeini	Ghaem	Alborz
Paper/cardboard	6.45	10.65	19.36	30.85
Plastic	23.85	31.85	21.98	17.93
Textiles	30.82	28.6	19.98	32.85
Sharps waste	1.07	2.36	1.98	1.93
Glass	3.81	2.98	4.98	8.96
Liquid	21.71	18.36	16.89	3.69
Others	12.29	5.2	14.83	3.79

Observations indicate that segregation of waste according to color coding is implemented in all four hospitals (black bag for general waste, yellow bag for infectious wastes and yellow safety box for Needles, infusion set, scalpels, blades and etc.), but disinfection and washing of containers is done poorly. In this term, Imam Khomeini hospital had the worst and Kasra hospital had the best conditions, but four studied hospitals have not an acceptable condition according to WHO standards. Also, temporary storage sites were disinfected occasionally, after each hauling of waste by municipality,

while they should be washed and disinfected after each hauling according to WHO guidelines. The frequency of waste collection and disinfection of containers in day are presented in Table V.

According to Table V, in Imam Khomeini, Albers and Ghaem hospitals, insufficient employees in waste management part is apparent which in turn has led to improper collection and disinfection frequency of wastes. Imam Khomeini and Alborz hospitals have more concerning conditions.

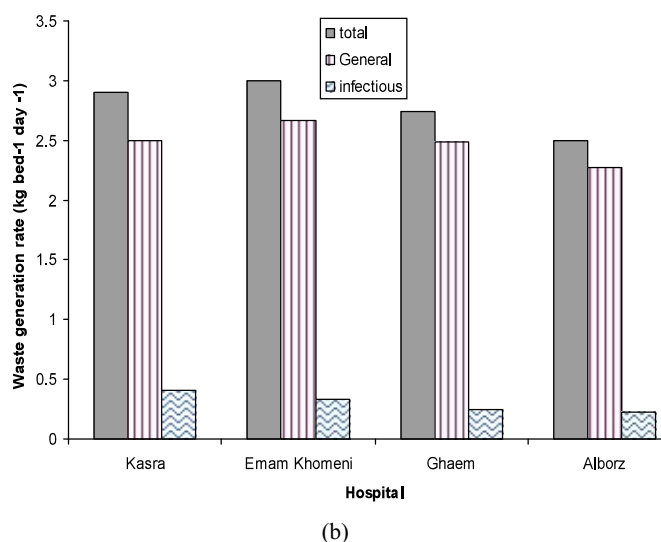
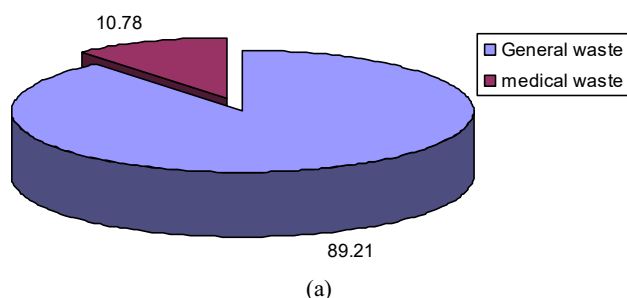


Fig. 1 (a) Comparison of general and medical waste in the selected hospitals; (b) amounts of different types of waste generated in the selected hospitals

Weight of waste (%)	Hospital			
	Kasra	Emam khomeini	Ghaem	Alborz
Paper/cardboard	11.36	20.69	4.56	13.2
Plastic	6.69	10.98	9.85	6.96
Textiles	18.36	14.36	30.85	24.65
food waste	41.69	35.95	31.96	39.96
Glass	3.98	6.98	7.2	1.68
Metals	2.98	3.98	4.6	2.36
Liquid	11.98	4.95	7.65	6.85
Others	2.96	2.11	3.33	4.34

No treatment facilities are used in Kasra and Ghaem hospitals, but in Imam Khomeini and Alborz hospitals, treatment facilities were operated, in which, the incinerator of

Alborz hospital causes air pollution problems. An incinerator was operated for treatment of Alborz hospital wastes with an operating capacity of 1500 kg day<sup>-1</sup>. Also in Imam Khomeini hospital, an autoclave apparatus with 40 L capacity per day was used for treatment of infectious wastes. The specifications of treatment facilities in studied hospitals are presented in Table VI.

Hospital	Employees		Times of collection per day	Frequency of washing and disinfection
	Total	Waste management sector		
Kasra	273	18	Dependent to waste generation rate	Dependent to waste generation rate
Imam Khomeini	619	6	4 to 5	1
Ghaem	345	2	4	3
Alborz	700	2	2	2

Hospital	Treatment apparatus	Operation time (h.day <sup>-1</sup> )	Amount of treated waste (day <sup>-1</sup> )	Volume reduction (%)	Required energy
Alborz	Incinerator	6	1500 kg	80	Electricity
Imam Khomeini	Autoclave with grinder	12	40 L	80	Electricity - water
Kasra	-	-	-	-	-
Ghaem	-	-	-	-	-

#### IV. DISCUSSION

By comparison of waste generation rate in selected hospitals of Karaj city, we can conclude that the generation rate of 2.5 – 3 kg bed<sup>-1</sup> day<sup>-1</sup> in Karaj hospitals is in agreement with the waste generation rate of the teaching hospitals of Tehran city by the mean value of 2.75 kg bed<sup>-1</sup> day<sup>-1</sup> [4], hospitals of Tehran by the mean generation rate of 2.71 kg bed<sup>-1</sup> day<sup>-1</sup> [14] and hospitals of Taiwan with generation rate of 2.41 to 3.26 kg bed<sup>-1</sup> day<sup>-1</sup> (P value < 0.05) [19]. However, some differences can be seen between the findings of the present study and others. For instance, in Shiraz hospitals, Iran with average generation rate of 4.45 kg bed<sup>-1</sup> day<sup>-1</sup> [20]. Taghipouer et al. study on hospitals of Tabriz city, Iran, with average generation rate of 3.48 kg bed<sup>-1</sup> day<sup>-1</sup> [21]. Bdour et al. study on hospitals of Jordan with average generation rate of 0.84 kg bed<sup>-1</sup> day<sup>-1</sup> [22] and Kerdsuwan et al. study on hospitals of Thailand with average generation rate of 1 kg bed<sup>-1</sup> day<sup>-1</sup> [23] (P value > 0.05). Based on physical analysis, waste composition varies greatly from hospital to hospital. This variation may be due to factors such as different hospital specializations, hospital size, economic, social, application of treatment facilities, and educational level of employees and cultural features of the patients, waste management activities and application of reusable items. Observations during the present study indicated that, fortunately, in opposite of many other hospitals in different cities of Iran, segregation of waste in color bags and containers is implemented in selected hospitals, but poor attention is paid to the disinfection of

containers. This matter shows the need for the implementation of teaching programs for staffs and employees and also public to enhance the general knowledge about potential health and environmental risks of mismanagement of hospital wastes and the methods of controlling and reducing the contamination of

environment via medical wastes. According to the definition of hazardous waste, any amount of contact between infectious and non-infectious waste leads to contamination of all the waste involved [24].

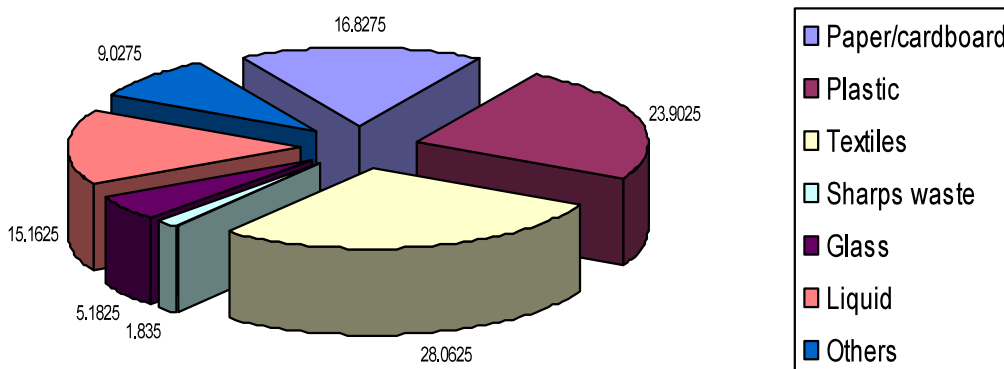


Fig. 2 The average composition of total infectious waste in selected hospitals in Karaj city

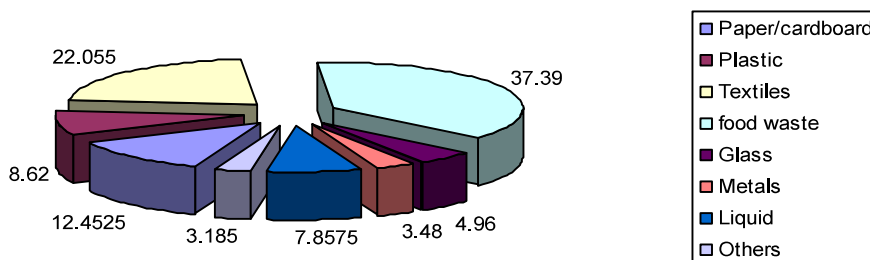


Fig. 3 The average composition of total general waste in selected hospitals in Karaj city

Food waste and textiles for general waste and textile and plastics comprise the first and second greatest contributors to hospital wastes in this study. Therefore, significant amounts of waste can be reduced by considering suitable programs, including replacing the textile and plastics materials by less wasteful materials and supplies, restrictions on purchasing supplies and devices with plastic packing and also teaching patients and employees about revising their cultural habitats to reduce the food waste and textile generation rate. Liquid wastes, which usually contain toxic and hazardous constituents and also disinfectant solutions, comprise the fourth greatest contributor of medical waste with an average value of 15.16% in this study. Observations showed that these liquid wastes are discharged to the sewers. Despite of a limitation on the discharge of medical liquids into sewers, most of the waste liquids are appropriate for disposal in the sewerage system [25], provided the separate wastewater treatment plant exist for each hospital before discharge of wastewater to the municipal sewerage system. Studied hospitals had wastewater treatment plants, which their performance and efficiency should be under periodic monitoring by authorities and responsible organizations.

In term of medical waste treatment, like many other hospitals in Iran, the situation is concerning. Two of studied hospitals do not use any treatment facility and an autoclave

with a 40 L day<sup>-1</sup> capacity is operated in Imam Khomeini hospital that doesn't cover total generated waste in a day. In Alborz hospital, an incinerator is used which observations and findings show that it creates air pollution problems. This matter should be considered carefully by responsible organizations, because the possibility of formation of dioxins and furans from medical waste incinerators and emission to the atmosphere, especially in developing countries with low level technologies is very high. Hospital waste stream typically contains significant amounts of plastic materials (confirmed in this study). It has been widely known that the medical waste incinerators are one of the major sources of dioxins and furans due to the presence of plastic products in the waste stream [26], [27].

Based on the present results and observations, studied hospitals were not efficient in waste management when compared with those in developed countries. Despite the practices for the well management of medical wastes, the current system of hospital waste management in Karaj city is not satisfactory and is in dire need of immediate attention and improvement. Generally, serious problems of waste management system in hospitals of Iran and in this case, Karaj city such as lack of a comprehensive policy and strategy, lack of a defined and special responsible organization, parallel activities and decisions, poor supervision, insufficient

infrastructure, inadequate budget in waste management sector, lack of educational programs for personnel, lack or poor implementation of internal and international rules, lack advanced treatment technologies, inadequate knowledge and skills of waste management employees, and poor health and environmental activities, which can lead to further deterioration of the unsatisfactory present conditions in hospitals of Karaj city, Iran if not directed practically and scientific.

#### ACKNOWLEDGEMENT

The authors would like to thank Iran University of Medical Sciences for its supports.

#### REFERENCES

- [1] Zhang Yong, Xiao Gang, Wang Guanxing, Zhou Tao, Jiang Dawei. Medical waste management in China: A case study of Nanjing. *Waste Management* 29 (2009) 1376–1382.
- [2] Bontle Mbongwe, Baagi T. Mmereki, Andrew Magashula. Healthcare waste management: Current practices in selected healthcare facilities, Botswana. *Waste Management* 28 (2008) 226–233.
- [3] Abdulla, Fayez, Qdais, Hani Abu, Rabi, Atallah, 2008. Site investigation on medical waste management practices in northern Jordan. *Waste management* 28, 450–458.
- [4] Mahdi Farzadkia, sahand Jorfi Arash Moradi, Mojtaba Shah Mohammadi. Hospital waste management status in Iran: a case study in the teaching hospitals of Iran University of Medical Sciences. *Waste Management & Research* 2009; 27: 384–389.
- [5] Soliman, SaharMohamed, Ahmed, Amel Ibrahim, 2007. Overview of biomedical waste management in selected Governorates in Egypt: a pilot study. *Waste Management* 27 (12), 1920–1923.
- [6] Mohee, R., 2005. Medical wastes characterization in healthcare institutions in Mauritius. *Waste Management* 25, 575–581.
- [7] Birpinar Mehmet Emin, Mehmet Sinan Bilgili, et al. 2009. Medical waste management in Turkey: A case study of Istanbul. *Waste Management* 29, 445–448.
- [8] Da Silva, C.E., Hoppe, A.E., Ravello, M.M., Mello, N., 2005. Medical wastes management in the south of Brazil. *Waste Management* 25, 600–605.
- [9] Z. Bendjoudi, F. Taleb, F. Abdelmalek, A. Addou. Healthcare waste management in Algeria and Mostaganem department. *Waste Management* 29 (2009) 1383–1387.
- [10] Shinee, Enkhtsetseg, Gombojav, Enkhjargal, Nishimura, Akio, Hamajima, Nobuyuki, Ito, Katsuki, 2008. Healthcare waste management in the capital city of Mongolia. *Waste management* 28, 435–444.
- [11] M. Sawalem, E. Selic, J.-D. Herbell. Hospital waste management in Libya: A case study. *Waste Management* 29 (2009) 1370–1375.
- [12] Patil, A.D., Shekdar, A.V., 2001. Health-care waste management in India. *Journal of Environmental Management* 63, 211–220.
- [13] Zhang Yong, Xiao Gang, Wang Guanxing, Zhou Tao, Jiang Dawei. Medical waste management in China: A case study of Nanjing. *Waste Management* 29 (2009) 1376–1382.
- [14] Askarian, Mehrdad, Vakili, Mahmood, Kabir, Gholamhosein, 2004. Results of a medical waste survey in private hospitals in Fars province, Iran. *Waste Management* 24, 347–352.
- [15] Suwannee, A. (2002) Study on waste from hospital and clinics Phitsanulok. *Online Journal Health Allied Sciences*, 1, 6–14.
- [16] Karamous, M., Zahraie, B., Kerachian, R., Jaafarzadeh, N. & Mahjouri, N. (2007) Developing a master plan for hospital solid waste management: A case study. *Waste Management*, 27, 626–638.
- [17] Iran Statistic Center. Census plan of industrial factory presidency bureau international affairs and public communication. Tehran: Presidency bureau; 2010 (in Persian).
- [18] WHO. (2001) Health care waste management. Rapid assessment tool for country level. Second draft.
- [19] Cheng, Y.W., Sung, F.C., Yang, Y., Chung, K. & Li, C. (2009) Medical waste production at hospitals and associated factors. *Waste Management*, 29, 440–444.
- [20] Askarian M, Vakili M, Kabri G. Results of a hospital waste survey in private hospitals in Fars province, Iran. *Waste Manage* 2004; 24:347–52.
- [21] Hassan Taghipour, Mohammad Mosaferi, Characterization of medical waste from hospitals in Tabriz, Iran. *Science of the total environment*. 407 (2 0 0 9) 1 5 2 7 – 1 5 3 5.
- [22] Bdour A, Altrabsheh B, Hadadin N, Al-Sharif M. Assessment of medical wastes management practice: a case study of the northern part of Jordan. *Waste Manage* 2006; 27(6):746–59.
- [23] Kerdsuwan S. Case study of using hospital waste incinerator in Thailand. 93rd Annual Meeting and Exhibition. Salt Lake City, UT: Air & Waste Manage. Assoc.; 2000. p. 18–22. Paper No. 00-107, June.
- [24] Ben, S., Laurent, E., Luc S., Spiros, N. & Agathos, I. (2008) Emerging high-throughput approaches to analyze bioremediation of sites contaminated with hazardous and/or recalcitrant wastes. *Biotechnology Advances*, 26, 561–575.
- [25] Pruss A, Giroult E, Rushbrook P. Safe management of waste from health-care activities. Geneva: World Health Organization; 1999.
- [26] Yong-Chul Jang, Cargro Lee, Oh-Sub Yoon, Hwidong Kim. Medical waste management in Korea. *Journal of Environmental Management* 80 (2006) 107–115.
- [27] Vesilind, P., Worrell, W., Reinhart, D., 2002. *Solid Waste Engineering*. Thompson Learning Inc., California, CA.