Environmental Impact Assessment of Medical Wastes Shredding Machine in Al-Hila Teaching Hospital-Babylon Province, IRAQ

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ABSTRACT

This study was carried out to assess the environmental impact of medical wastes shredding machine in Al-Hila Teaching Hospital- Babylon Province, IRAQ and samples of medical wastes received from various local health premises were identified and the percentage of each component in wet and dried forms were assessed. Several heavy metal ions were determined while air variables such as CO, NO_2 and SO_2 were measured in shredding machine location and surrounding environment. Regarding waste heavy metal content, current work has found that the highest mean concentration (1.473 ± 0.786 µg/kg) was recorded for cadmium ion which was within standard limit (1 – 3 µg/kg) while both copper and ferrous ions gave mean value of 0.0163 ± 0.005 µg/kg and 0.679 ± 0.431 µg/kg respectively. In case of air gases, it was found that there were no significant differences between all measured gases in all measured siteswithin shredding room and surrounding environment where NO_2 mean values were 0.0194 ± 0.006 ppm and 0.019 ± 0.002 ppm respectively while SO_2 gave mean values of 0.033 ± 0.002 ppm and 0.049 ± 0.003 ppm respectively and CO mean concentrations have been found to be 0.026 ± 0.023 ppm and 0.05 ± 0.007 ppm respectively.

Keywords: *Medical wastes, Shredding machine, Surrounding environment, Air gases, Noise level*

Introduction

It is very obvious that medical solid wastes generated by various health institutes represent environmental and health problems [1-3]. In general, these medical solid wastes can be classified into two main categories such as general and hazardous wastes [4,5]. General wastes consist of municipal and other un-harm wastes while hazardous wastes include biological, chemical and radioactive wastes [6].These medical wastes need to be soundly handled and controlled otherwise they would cause sever environmental and public health impacts. However, much attention has been focused on health care wastes worldwide [1,7,9] and various techniques have been invented to properly discharge these wastes such as land disposal [10], wet thermal treatment [11], chemical disinfection [12], waste autoclaving [13], microwaveirradiation [14], encapsulation [15], incineration [9,16] and recently applied technique of shredding [17,18]. Currently, the most common techniques used in various world countries are incineration and shredding of medical solid wastes. So, significant attention was focused upon health and environmental impacts imposed by incinerating such wastes due to various gasses and suspended particulate released from the burning process [1,2,9,11,16] and reported different health and environmental effects while shreddingtechnique has received few attention [9,18,19] which is associated with less harm impacts on both public health and surrounding environment. The current study was designed to assess environmental and health impacts caused by medical solid wastes shredding in Al-Hilla teaching hospital in Babylon Province, IRAQ via calculating daily generated solid waste, examining most wastes components andassessing certain heavy metals content. Also, the work has recorded the concentration of several air gases and noise level in shredding machine site and surrounding environment.

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Materials and Method

Al-Hilla teaching hospital is situated in Babylon province- Iraq and consists of 447 beds. Estimated medical solid wastes per bed was 0.44 kg/day (Hospital records). So, this study has calculated the expected daily total generated wastes using hospital recordsby the following equation:

Total daily generated medical solid wastes
= Rate of patient waste per day X Bed No.
= 0.44 kg/day X 447 bed = 196.68 kg/day

The annual grand wastes total = 71.984.88 kg.

Random sample of such waste with weight of 0.832 kg and free from municipal wastes was obtained from the hospital and isolated in different categories such as biological tissues, glass, metals, fabrics, plastics, and papers. Each waste component was weighted as fresh and dried and their percentages were recorded. Also, heavy metal contamination of medical solid wastes was determined for cadmium, copper and ferrous following the method of USEPA [20] at four weeks and finally, air contamination by CO, NO2 and SO2 was recorded using portable multi-gas detector in shredding, sterilizing, controlling, worker rooms and surrounding environment while noise level was measured only in shredding apparatus site and outside using portable sound meter.

Results and Discusion

Wastes Classification: Table 1 shows the fresh and dry weight and percentage of each medical solid wastes component. Apparently, all waste components were varied significantly in both fresh and dry weight values and it seems clearly that biological and fabric wastes had higher fresh weights than those of other components (Fig 1). In case of fresh wastes, biological wastes had the highest (34.8%) percentage followed by fabric waste ((21.07 %) while the lowest percentage (1.56 %) was recorded for metal waste followed by that paper (4.46 %) waste. But in terms of dry wastes, the highest percentage (41.56 %) was recorded for glass waste followed by that of plastic (21.96 %) waste while the lowest percentages were 2.55 % and 6.85 % for metal and paper wastes respectively (Fig 2). It was found that the average medical solid waste generated was 0.44 kg per bed per day. Similar mean medical waste was reported in Khartoum State Hospitals which was 0.38kg/bed/day [21] and in Istanbul- Turkey was 0.63 kg/bed/day [22] and similar work has found a mean of 0.758 Kg/Bed/Day in the Sirsa city- India [23] but other study in kargil hospital- India has reported a mean of 2.0 kg/bed/day [24] found to range from 2,250 to 2,500 kg/bed/day in Tanzanian [25] while in Brazil, it was found to range from 0.570 to 3.245 kg/bed/day [26]. However, this study has estimated that each patient would generate 160.6 kg medical wastes annually. In other words, the patient may produce about 66.758 kg, 35.273 kg, 21.406 kg and 11.011 kg as glass, plastic, fabric and paper wastes respectively. However, such generated waste quantities would be beneficially recycled and promote the concept of sustainable development of environmental resources. Such recycling process was suggested early for plastic wastes [22] while a study [28] has reported an improving waste revenue in India.

Table 1: Mean value of each medical solid waste component in a sample collected from Al-Hilla teaching hospital

Component	Mean value			
	Fresh		Dry	
	Weight (g)	(%)	Weight (g)	(%)
Biological wastes	290.2	34.8	64.1	13.735
Metals	13.3	1.56	11.9	2.55
Glass	197.4	23.9	194.0	41.568
Plastics	118.2	14.2	102.5	21.963
Fabrics	175.5	21.07	62.2	13.328
Papers	36.6	4.46	32.0	6.856
Total	832	100	466.7	100

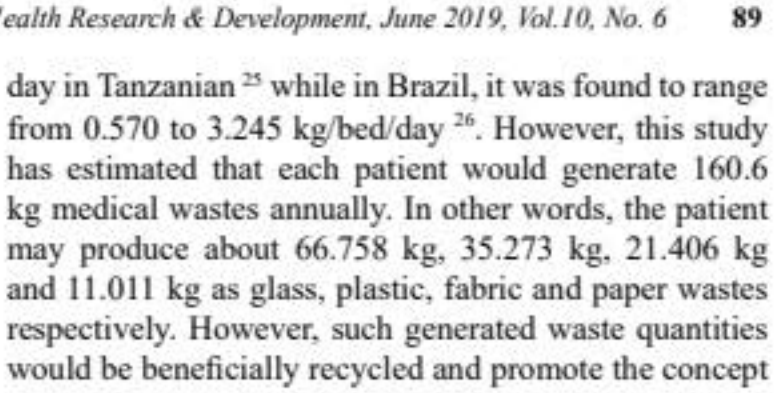

Fig. 1: Fresh and dry weigh of each medical solid waste component in sample collected from Al-Hilla teaching hospital

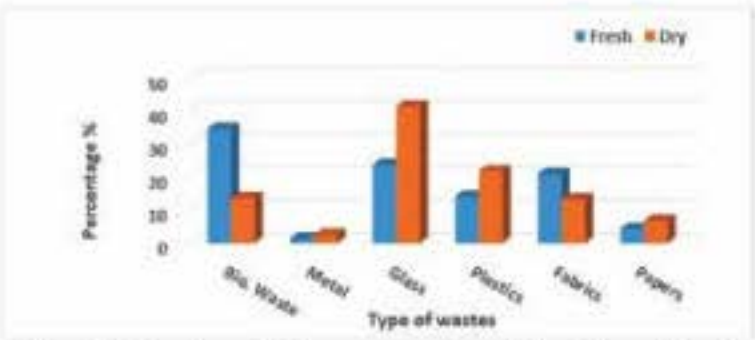

Fig. 2: Fresh and dry percentage of each medical solid waste component in sample collected from Al-Hilla teaching hospital

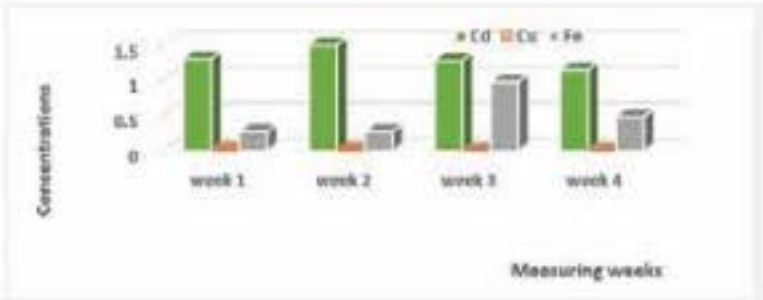

Fig. 3: Cd, Cu and Fe concentrations in medical solid waste from Al-Hilla teaching hospital

Waste Heavy Metal Contamination: Table 2 contains concentrations value of Cd, Cu and Fe in medical solid wastes in a sample collected from Al-Hilla teaching hospital measured in four weeks. It has been found that medical solid wastes contained certain heavy metal ions such as Cd, Cu, and Fe. Cadmium ions content was varied from 1.14 to 2.1786 µg/kg and copper ion concentrations were found to range from 0.0089 to 0.0252 µg/kg while ferrous ions had varied from 0.271 to 0.9719 µg/kg. Apparently, quantity and quality of heavy metal ions contained in medical solid wastes are affected by medicine species and healthcare equipments used. However, a recent study [29] has examined heavy metals content in medical solid wastes after being incinerated and reported that the ash of such wastes had high Fe, Zn, Cd and Pb ions.

Table 2: Cd, Cu and Fe concentrations in medical solid waste from Al-Hilla teaching hospital. measured in 4 weeks

Time	Concentration value in µg/kg		
	Cadmium	Copper	Ferrous
1st week	1.2962	0.0252	0.2721
2nd week	2.1786	0.0215	0.271
3rd week	1.2769	0.0097	0.9719
4th week	1.14	0.0089	0.4859

Air Contamination: Table 3 shows concentration of CO, NO2 and SO2 measured in shredding, sterilizing, controlling and worker rooms and surrounding environment. The highest CO concentration (0.4 ppm) was in sterilizing room while surrounding environment had the lowest (0.05 ppm) concentration and for NO_2 concentrations, it was found that the highest (0.025 ppm) concentration was again recorded in sterilizing room but worker room had the lowest (0.014 ppm) concentration. In case of SO_2, surrounding environment had the highest (0.06 ppm) concentration while the worker room contained the lowest (0.03 ppm) concentration (Fig. 4).

In general, all concentrations of these air gases were within standard limits. No data related to air pollutants in shredding medical solid wastes are available but many works have examined such air contaminants in case of incineration of such medical wastes [30].On the other hand, noise level was found in shredding room being higher than that recorded in surrounding environment (Fig 5) and such difference may be expected due to the sounds generated by shredding machine operation. The current work has concluded that shredding technique of medical solid wastes seems to be much better in terms of having almost insignificant impacts on both public health and surrounding environment and may present good opportunity to recycle certain solid wastes components such as plastic and metals but it needs controlling and treating biological pollutants in proper methods and to handle hazardous wastes scientifically and soundly.

Table 3: Concentration of CO, NO2 and SO2 measured in shredding, sterilizing, controlling and worker rooms and surrounding environment

Measuring Sites	Concentrations ppm		
	tCO	NO2	SO2
Shredding room	0.3	0.022	0.04
Sterilizing room	0.4	0.025	0.05
Controlling room	0.01	0.015	0.05
Worker room	0.02	0.014	0.03
Surrounding environment	0.05	0.019	0.06

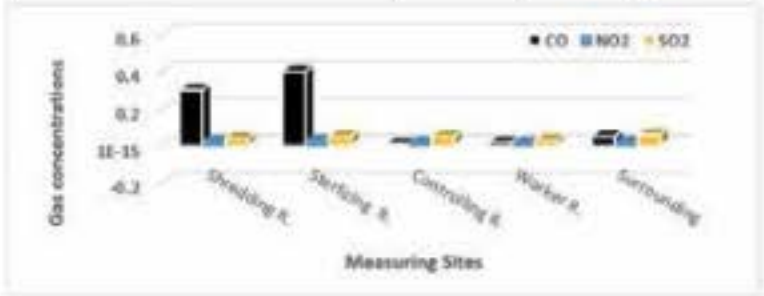

Fig. 4: CO, NO_2 and SO_2 concentrations measured in shredding, sterilizing, controlling, worker rooms and surrounding site.

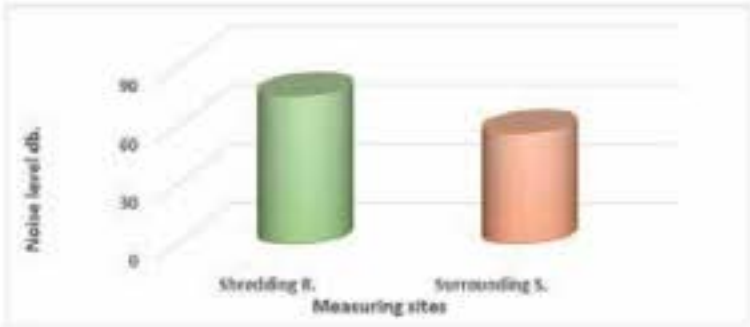

Fig. 5: Noise level measured in shredding room and adjacent site.

Conclusion

Regarding waste heavy metal content, current work has found that the highest mean concentration (1.473 ± 0.786 µg/kg) was recorded for cadmium ion which was within standard limit (1 – 3 µg/kg) while both copper and ferrous ions gave mean value of 0.0163 ± 0.005 µg/kg and 0.679 ± 0.431 µg/kg respectively. In case of air gases, it was found that there were no significant differences between all measured gases in all measured siteswithin shredding room and surrounding environment where NO_2 mean values were 0.0194 ± 0.006 ppm and 0.019 ± 0.002 ppm respectively while SO_2 gave mean values of 0.033 ± 0.002 ppm and 0.049 ± 0.003 ppm respectively and CO mean concentrations have been found to be 0.026 ± 0.023 ppm and 0.05 ± 0.007 ppm respectively.

Financial Disclosure: There is no financial disclosure.

Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved under the Sanitary and Environmental Engineering, Department of Building and Construction Engineering- University of Technology, Iraq and all experiments were carried out in accordance with approved guidelines.

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