RESEARCH ARTICLE

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Heavy Metals Monitoring in Leachate from Landfill Site of Qazvin, Iran

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Background & Aims of the Study: Leachate production is a major problem for solid waste landfills and causes important threat to health public and environment. One of the typical properties of heavy metals is that they cannot easily decompose in the environment. The aim of this study was to measure of heavy metals concentrations in old-age leachate from Qazvin landfill site, Iran.

Materials & Methods: Sampling was conducted during summer 2014 from the leachate which was produced in Qazvin landfill site in Lia park. The concentration of heavy metals including Zn, Ni, Hg, Cu, Co, Cd, Cr, Fe, Mn, and Pb along with pH were measured based on the standard method.

Results: The results of this study indicated the leachate generated from Qazvin landfill site, contains large amounts of different heavy metals. The mean concentration of Zn, Ni, Hg, Cu, Co, Cd, Cr, Fe, Mn, and Pb were 2.8, 0.2, 0.01, 0.1, 0.08, 0.04, 0.04, 4.6, 1.4 and 1.3 ml/L, respectively. Also pH value was 8.4. The concentration of Fe, Pb, Zn and Mn in the landfill leachate was higher than the permissible standard value which was suggested by Department of Environmental (DOE).

Conclusion: The results suggest that we can achieve the permissible standards to discharge effluents into the surface water, absorbing well and agricultural irrigation by applying biological and physicochemical methods.

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Background

Today, we are witnessing the growth of population and increasing the development of industries along with increasing the production of hazardous waste which should be reduced, using suitable methods. Leachate is a strong wastewater with high organic load and heavy metals (1) which are mainly produced during waste collection, transfer and disposal (2). Nowadays, the problems arising from the heavy metals in landfill leachate have always been important issues (3). Heavy metals can be concentrated in food chains and cause adverse effects on humans healthy and environment (4). Therefore, in order to prevent destructive effects, the leachate must be treated to reach its discharge standards before disposal (3). Also, an accurate management of the leachate containing heavy metals as one of the contaminants of water resources is very critical. An important step in proper leachate treatment is determination of heavy metal concentration. Since leachate quality varies in different landfill sites, they must be studied separately to achieve an appropriate treatment method (5,6).

Qazvin landfill site has daily housed more than 300 tons of municipal and industrial solid waste for 29 years.

Aims of the study:

The aim of the current study is to study heavy metals concentration in the leachate of Qazvin

Qazvin landfill site where a large amount of wastes are produced every day.

Materials & Methods

This study was performed during summer 2014 from the leachate which was produced in Qazvin landfill site in Lia Park. Ten leachate samples were prepared from two separate pits in the landfill site. The samples were collected in the plastic 10 L containers (7) and transferred to the laboratory under oxygen-free conditions at -4℃. Then, the concentrations of Zn, Ni, Hg, Cu, Co, Cd, Cr, Fe, Mn, and Pb in the leachate as well as its pH were measured immediately. In order to measure the concentration of heavy metals in the samples, acidic digestion method for heavy metals was used according to "standard methods" (8). For adjustment of pH, HCl and NaOH (1 N and 5 N respectively) were used. The pH was measured, using pH meter and finally the samples were read by Liquid Chromatography, Optima-8300 DV. All obtained data during study were tested and recorded based on arithmetic mean with at least two iterations. Qualitative properties of the leachate are presented in table 1.

Results

The average concentration of heavy metals and pH value in the leachate as well as permissible standards by DOE for discharge into surface water, absorbing wells and agricultural irrigation are given in Table 1. According to the obtained results in Table 1, Hg and Fe with corresponding 0.01 and 4.8 mg/l concentration devote the lowest and highest concentration, respectively. Comparison of the average concentration of metals which are exiting in the leachate with the permissible standards by DOE, demonstrated that the concentration of Fe, Pb, Zn and Mn is higher than the permissible limits.

Figure (1) indicates the average concentration of heavy metals in the leachate and their permissible limits for discharge into the host environments.

Table 1) The average concentration of heavy metals and pH value in the leachate as well as DOE standards for discharge into the host environments

Parameters	Unit	Sample.NO	Range	Mean (S.D)	The permissible DOE standards (mg/l)		
					Agricultural irrigation	Surface water	Absorbing wells
Zn	mg/l	10	2.7-3	2.8 ±0.4	2	2	2
Ni	mg/l	10	0.15-0.24	0.2±0.05	2	2	2
Hg	mg/l	10	0.008-0.017	0.01±0.006	negligible	negligible	negligible
Cu	mg/l	10	0.08-0.15	0.1±0.03	0.2	1	1
Co	mg/l	10	0.08-0.094	0.08±0.002	0.05	1	1
Cd	mg/l	10	0.033-0.047	0.04±0.001	0.05	0.1	0.1
Cr	mg/l	10	0.037-0.044	0.04±0.001	1	0.5	1
Fe	mg/l	10	4.32-5.1	4.6±0.8	3	3	3
Mn	mg/l	10	1.1-1.6	1.4±0.09	1	1	1
Pb	mg/l	10	1.21-1.44	1.3±0.1	1	1	1
pH	-	10	8.1-8.7	8.4±0.4	6.5-8.5	6.5-8.5	5-9

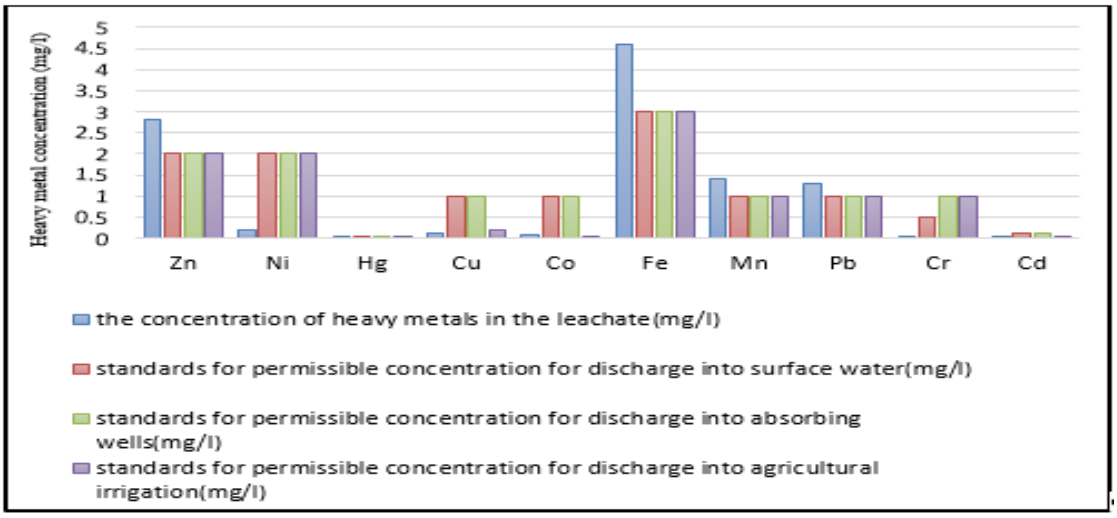

Figure 1) The average concentration of heavy metals in the leachate and their permissible limits for discharge into the host environments.

Discussion

The decomposition, stabilization, and removal of contaminants from a landfill depend on numerous factors such as composition of the wastes, degree of compaction, temperature, various inhibiting materials present, presence of moisture, input and output of water, rate of water movement and hydrological characters. The quality of leachate is mainly the result of physical, chemical, biological processes and the presence of inhibitory and toxic materials (7).

The concentration of Ni, Hg, Cu, Cd, and Cr was found to be within the permissible Iranian standards for irrigation, discharge to surface water and absorbing wells. Also, Co became within even lower than the permissible limits for discharging to surface water and absorbing wells but was not permissible to use for irrigation. Absorbing by soil or organic materials in soil might reduce the amount of these heavy metals (8).

The concentration of Zn, Fe, Mn, and Pb were higher than the acceptable DOE standard limits for irrigation, discharging to surface water and absorbing wells. The high concentration of Pb in leachate samples can be due to the disposal of Pb batteries, Pb based paints, chemicals for photograph processing and also pipes at the landfill site (8,9) which is frequently reported from other landfill sites. Previous studies have also indicated the presence of Cd, Pb, Cr, Cu and Ni in leachate (9,10). The origin of Zn, Fe, Mn and Pb in Qazvin landfill site can be due to disposal of wide variety of wastes.

Different studies indicated that the landfill age has a significant effect on its composition. Kulikowska and Klimiuk (11) reported a low concentration of heavy metals in an old site. As landfill age increases, further increase in pH values cause a certain decrease in metal solubility. On the contrary in young landfills, slightly higher metals concentrations exist as a result of low pH and high degree of metal solubilization during the acidification stage. The pH values of leachate had nearly constant trend during monitoring period with variation between 8.1 and 8.7. Tatsi and Zouboulis (12) indicated an average pH 7.9 with variation from 7.3 to 8.8 in an old landfill. The values are in agreement with our results approximately.

Mansouri et.al (13) reported the mean concentration of heavy metals 0.007, 0.21, 0.03-0.04, and 0.2-0.45 µg/L for Cd, Cr, Cu, Ni and Pb respectively in the leachate landfill site

of Mashhad, Iran. The results of our study showed the higher values for each parameter.

A review of 106 Danish landfills showed that the mean concentration of heavy metals for all landfills were 0.13, 0.006, 0.67, 0.07, 0.08 and 0.07 mg/l for Ni, Cd, Zn, Cu, Cr and Pb, respectively (11).

In our study the concentration of Pb, Zn, Cu, Cr, Ni were higher than the results which were obtained by Yoshida et al. (7). Another obtained results by Al-Sabahi et al. (10) indicated the mean concentration of Cd, Cr, Cu, Ni and Pb in the leachate were 0.25-0.30, 0.145-0.150, 21.50, 1.70-1.80 and 2.60-2.85 µg/L, respectively. These results were lower than our study. As it is expected, the concentration of heavy metals in the old landfill leachate goes below the standard limits but the current study showed that the concentrations of Fe, Pb, Zn and Mn are higher than the standard limits. It can be due to the disposal of municipal and industrial wastes to the study site.

Conclusion

With respect to increasing disposal of wastes into landfill sites and in order to reduce environmental contamination, we need to determine the quality of leachate to develop an appropriate treatment method. In this research, the concentration of heavy metals in Qazvin landfill leachate was analyzed. As the concentration of heavy metals in the leachate was high due to daily discharge of industrial waste into the landfill, the leachate should be treated by suitable methods before reuse or disposal into the host environment to avoid harmful effects on public health and environment. Since high concentration of heavy metals is an inhibitor agent for biological treatment, we cannot merely apply traditional biological methods for leachate treatment in Qazvin landfill. As a result, in order to achieve the discharge standards into the host environment, a combination of biological and physicochemical methods, electrocoagulation and advanced oxidation are proposed for treatment of leachate.

Footnotes

Acknowledgments:

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Conflict of Interest:

The authors declare no conflict of interest.

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