J. Basic. Appl. Sci. Res., 2(11)10869-10875, 2012
© 2012, TextRoad Publication

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

A Survey of Dry Sludge from the Activated Sludge Wastewater Treatment Plants in Iranian Cold Regions (A Case Study in Chaharmahal Va Bakhtiari Province).

Asadi Ardali Hamed[1], Nazari Aslan[2], Nazari Hamed[3]

[1]MSc Graduate, Department of Environmental Engineering, School of Environment and Energy, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran.
[2]MSc Graduate of Health Services Management, School of Management, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran.
[3]BSc Graduate of Health Services Management, Department of Health, Ahvaz University of medical sciences, Ahvaz, Iran.

ABSTRACT

One of the choices to dispose sludge is to use it in agricultural lands as fertilizer. However, due to the possibility of various kinds of micro organisms disease it may cause a wide range of bacterial and parasitic diseases in human and livestock. In this study, three Wastewater Treatment Plants of Chahar Mahal and Bakhtiary province in Iran were selected as the sample plant, including Shahrekord, Farsan and Borujen due to their similarity in the weather condition and the treatment process. In order to investigate the sludge in it was lowest and the highest rate of evaporation, in the freezing cold winter and burning hot summer respectively. Assessing the results achieved from this study showed that after drying in natural conditions based on EPA standards, biological sludge production of all three Wastewater Treatment Plants in winter was in class B. Considering the limitations in standards, this sludge can be used in agriculture. Sludge bacterial quality products of Wastewater Treatment Plants in summer are lower than standards of American Environment protection agency for sludge class B, and It couldn't be used in agriculture. Since the best statistical relationships between parasite eggs and Fecal Coliform and parasite eggs and Total coliform that other treatment plants with similar weather and process to this studies treatment plant can predict their dried sludge microbial and parasite eggs condition by using this statistical relationships and SPSS analytic. The purpose of this research is to study the possibility for use of sludge manufacturing from urban Wastewater Treatment Plants processes as fertilizer in agricultural, communication statistics that considering the valid standards environmental and health and possible connection between the statistical parameters germs had not signed it.

KEYWORDS: Sludge, Wastewater Treatment Plants, Total coliform, Fecal coliform, Statistical relationship, EPA standards, 40 CFR part 503

1. INTRODUCTION

The increase of wastewater treatment plants results from the large quantities of residual sewage sludge. Safe disposal of the sewage sludge is one of the major environmental concerns throughout the world.[1] There are differences between the sewages of one city to another, because various physical processes and chemical biology is used for removing organic materials and mineral from the sewage. Manufacturing specifications of sludge taps discussed in sewage`s primitive biological and chemical. So based on the right to choose for classified as designed and suitable sludge management system.[2] All kinds of dirt or other liquids materials like trash grain and foam in a Wastewater Treatment Plant with close sewage are different in filtration system and method of the usage. The sewage sludge is usually divided into primary, secondary (biology) and supplementary (chemistry).[3] Today, with the development of sewage treatment, sewage management including the construction of the new Wastewater Treatment Plants and improvement of the installations has become one of the top environmental issues[4]. Regarding to the growing urban Wastewater Treatment Plants sewage and production of a considerable amount of dirt in Iran, it is necessary to make arrangement for the usage of this product. The popular methods for the usage of the sludge and also for disposal in developed or developing countries is in agricultural lands. This issue to the point where it is important that during the past few decades the usage of sewage in agriculture become a common process. However, since it has a large part of microorganism infection and disease generator, its use in agriculture will lead to the concerns of health and public health threatens.[5] The regulation of usage sludge in agriculture is in part 503, the fortieth federal law (part 503 40 CFR), which is related to the protection of the environment compiled by U.S EPA.[6] The aim of this regulation was to cure the human and environments health against usage sludge. It is

Corresponding Author: Asadi Ardali Hamed, MSc Graduate, Department of Environmental Engineering, School of Environment and Energy, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran. E-mail: asadiardalih@yahoo.com

divided into: 1.total predict, 2 .Land application 3.surface disposal 4.dicrease of pathogens and absorb of vehicles 5.burn of late. Iran is one of the countries that attempt to remove urban sewage and reduce traditional methods to engineering methods. These plans about extol level of the public hygiene that caused most of the cities have sewage treatment (with activated sludge system) or to be making. At least a huge amount of biological sludge produced in these Wastewater Treatment Plants, so we should plan on them to both decrease bad effects and to fertilize agricultural lands.[7,8] The standard pathogen decrease in A and B level. If the amount of that, according to gram, MPN/gr < 1000 in each of the total solid sludge, it is in A level and if the amount of that, MPN/gr < 2×10^6, is in B level [7]. According to considering restrictions in the consumption in agriculture sludge (the kind of production and harvesting) is essential.[9] Statistical analysis can be usage for show connection between the sludge parameters that Statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation (a metadata dictionary is stored in the data file) are features of the base software. Correlation is a technique for investigating the relationship between two quantitative, continuous variables for example, parasite eggs and Fecal coliform. Pearson's correlation coefficient is a measure of the strength of the association between the two variables. Pearson's correlation coefficient for continuous (interval level) data ranges from -1 to +1 Positive correlation indicates that both variables increase or decrease together, whereas negative correlation indicates that as one variable increases, so the other decreases, and vice versa. The first step in studying the relationship between two continuous variables is to draw a scatter plot of the variables to check for linearity. The correlation coefficient should not be calculated if the relationship is not linear. For correlation only purposes, it does not really matter on which axis the variables are plotted. However, conventionally, the independent (or explanatory) variable is plotted on the x-axis (horizontally) and the dependent (or response) variable is plotted on the y-axis (vertically). Regression analysis is the next step up after correlation; it is used when we want to predict the value of a variable based on the value of another variable. In this case, the variable we are using to predict the other variable's value is called the independent variable or sometimes the predictor variable.[10]

Regarding to all of the consultant Pearson correlation factor from this study are more than 0.9 than this implicit parameters have a proper statistical relationships. All sludge researches in Iran based on EPA standard cannot use the sewage sludge without any limitation. These studies are against the foreign studies like Haruki and Tomolazu in Japan in 1997 and Estrada and Gomez (2005) studied sludge in Spain too. In this research we try to choose the biological sludge as a sample, then to dry them in natural qualification and finally to evaluate the decline pathogens to use them in agriculture. We compare the quality of the sludge with usage standards for discovering the level of the sludge. The purpose of this research is to study the possibility for use of sludge manufacturing from urban Wastewater Treatment Plants processes as fertilizer in agricultural, communication statistics that considering the valid standards environmental and health and possible connection between the statistical parameters germs had not signed it that other treatment plants with similar weather and process to this studies treatment plant can predict their dried sludge microbial and parasite eggs condition by using this statistical relationships and SPSS analytic

MATERIALS AND METHODS

This research was done in 2010. In this research we choose three Sewage Treatment Plants in Shahrekord, Farsan and Boroujen in Chaharmahal and Bakhtiari (CH & B) province. All these treatment plants have similar local conditions and process. With regard to the mountainous region and possessing cold weather in the winter and the sun burning hot in the summer, these two seasons were selected. The situation in sludge conditions along with the highest and lowest evaporation rate examined here the Fecal coliform and total coliform are selected as indicators of microbial sludge index and assessment with American environmental protection agency standard via health.The Wastewater Treatment Plants with activated sludge process in this province dried up the sludge. It is important because it is used as fertilizer in agricultural lands. Sampling was done in two seasons in winter and summer. The same samples gathered from dry up sludge beds on the sterilized vessels. To prevent the change of status samples, They are kept in proper conditions (0-4 ^{0}C). For all of the samples, Total coliform, Fecal coliform (MPN) and parasite egg were measured. Sampling of the sludge has been done after asking permission from the Ch & B Water and Sewage Engineering Company. The analyses have performed in Chemistry, Parasitology and Microbiology Laboratories of Department of Environmental Health Engineering, School of Public Health, Shahrekord University of Medical Sciences (SUMS). 18 samples have been taken from dewatered sludge of those Plants during summer and winter of 2010 before final disposal (after 3 to 5 months of retention in drying beds). At least 7 samples require for sludge analysis according to USEPA - 40 CFR 503 standards. This work has been done manually by composite sampling from the middle depths of different parts of the sludge bed. Vessels used for this sampling were of plastic kind with screw caps. Selection the volume of samples and the other conditions required for sampling were all in accordance with the recommendations outlined in Standard Methods for the Examination of Water and Wastewater

All of the sludge samples have been prepared for analysis by accomplishing dehydration process, screening and grinding.[11,12]

According to standards for raising precise measurements, tests were done three times and they were reported with average. Due to universality between countries 503 standard 40 CFR has been used in this investigation. All of data evaluated by statistical software SPSS and EXCEL.

RESULTS

Practical observations on the disposed sludge samples in these Wastewater Treatment Plants show that sludge are dark brown and smelly. The findings are including Total coliform, Fecal coliform and parasite egg in CH & B Sewage Treatment Plants (as a cold zone). We performed them on 6 samples. Findings are shown in the Table 1 in next page:

The results in diagram 1,2 and 3 shown that in winter for Shahrekord Wastewater Treatment Plants, Total coliform average were 1.39×10^7 and 1.63×10^6 for Fecal coliform. At the other hand, for Farsan 2.1×10^7were Total coliform average and 1.93×10^6 Fecal coliform. And finally for Borujen's Wastewater Treatment Plants, average Total coliform were 2.11×10^7 and 1.98×10^6 Fecal coliform. And in summer amount of average Total coliform and Fecal coliform were 2.53×10^7 and 4.51×10^6 respectively for Shahrekord's Wastewater Treatment Plant were 3.77×10^7 , 5.75×10^6 for Farsan's water treatment plant and 5.19×10^7 and 9.23×10^6 for Broujen water treatment plant are received.

We can see Total coliform comparison in winter and summer in diagram 1 for Ch & B Wastewater Treatment Plants and diagram 2 shows comparison between Fecal coliform average in these two seasons with class **A** at the other hand we can see comparison between Fecal coliform average in these two seasons with class **B** in diagram 2.

TABLE 1: The mean values for results of qualitative analyses of disposed sludge

Operation Characteristic	Sampling Factor				Sampling Characteristic		
Detention Time in sludge dried bed Day	TSS mg/l	Helminth EGG †N / 4gr TS	FC MPN/gr	TC *MPN/gr	Time of Sampling	Season	Sampling Place
51	195	3	1.3×10^6	1.16×10^7	2010/02/25	Winter	**Shahrekord**
55	264	6	2.08×10^6	1.39×10^7	2010/03/01		
61	248	5	1.50×10^6	1.61×10^7	2010/03/07		
45	215	21	4.5×10^6	2.57×10^7	2010/07/28	Summer	
52	211	16	4.2×10^6	2.27×10^7	2010/08/04		
60	225	17	4.82×10^6	2.76×10^7	2010/08/12		
40	245	8	1.99×10^6	1.75×10^7	2010/02/25	Winter	**Farsan**
44	175	7	1.80×10^6	$1/95 \times 10^7$	2010/03/01		
50	239	8	2×10^6	2.56×10^7	2010/03/07		
35	278	18	5.16×10^6	3.44×10^7	2010/07/28	Summer	
42	211	25	6.04×10^6	3.94×10^7	2010/08/04		
50	247	29	6.04×10^6	3.94×10^7	2010/08/12		
37	232	9	1.87×10^6	1.7×10^7	2010/02/25	Winter	**Borujen**
41	358	9	1.87×10^6	2.03×10^7	2010/03/01		
47	368	11	2.2×10^6	2.6×10^7	2010/03/07		
40	401	31	10.84×10^6	5.62×10^7	2010/07/28	Summer	
47	458	25	9.5×10^6	5.2×10^7	2010/08/04		
55	368	27	7.36×10^6	4.75×10^7	2010/08/12		

*- Most Probable Number per 1 gram of dry solids

†-Number per 4 gram of Total Solids

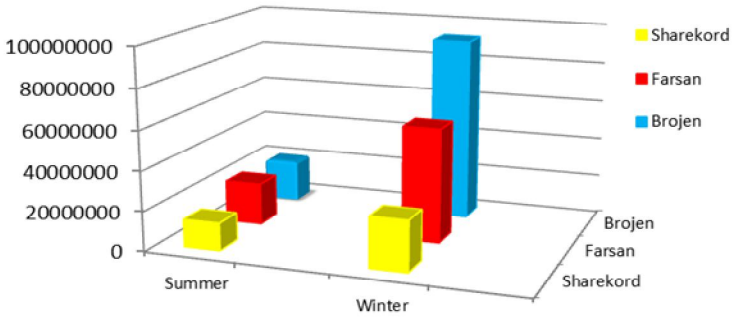

diagram 1 : Compare between Total coliform average in winter and summer for Ch & B Wastewater Treatment Plant sludge

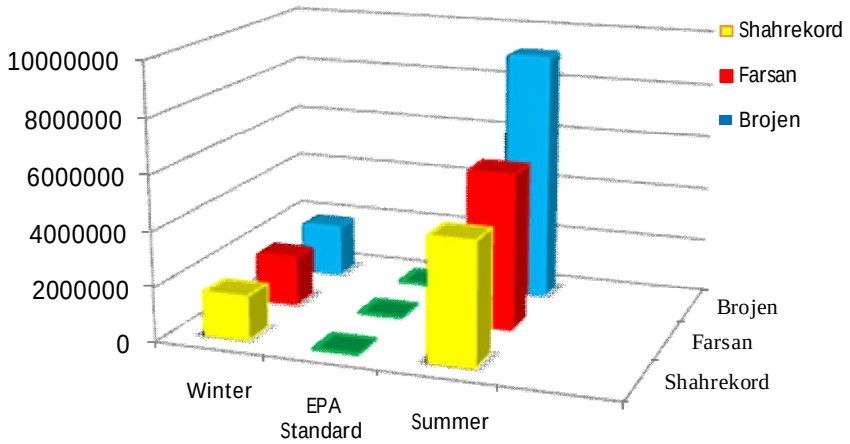

diagram 2 : Compare between Fecal coliform average in winter and summer for Ch & B Wastewater Treatment Plant sludge with **class A**, 503 40 CFR of US EPA

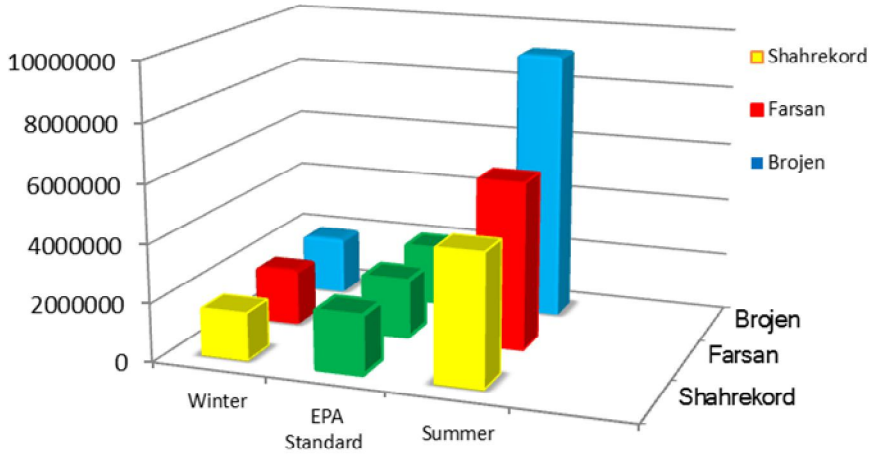

diagram 3 : Compare between Fecal coliform average in winter and summer for Ch & B Watewater Treatment Plant sludge with **class B**, 503 40 CFR of US EPA

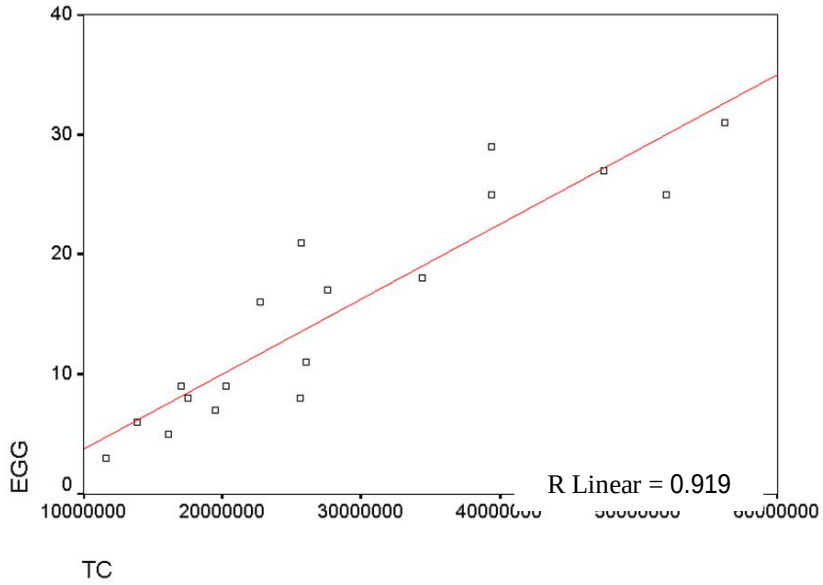

Figure 1. Regression graph for parasite eggs and Total Coliform for Ch & B Wastewater Treatment Plant sludge

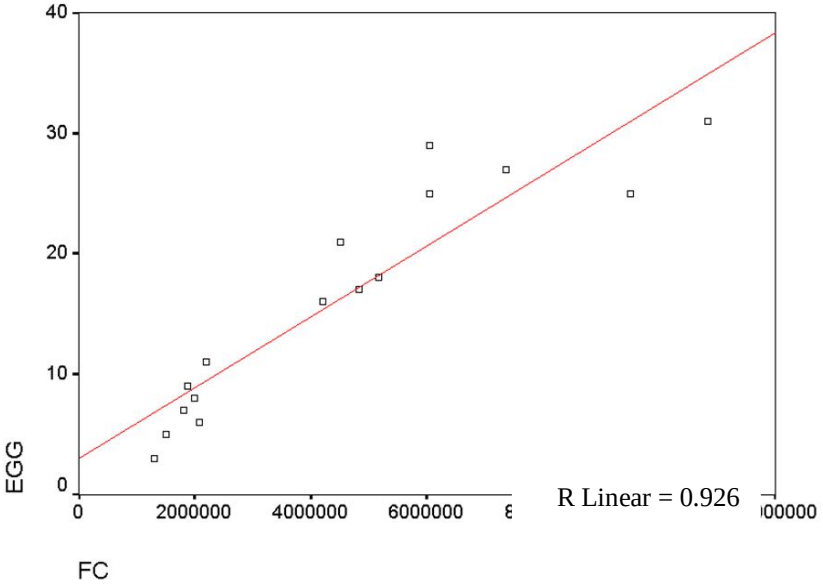

Figure 2. Regression graph for parasite eggs and Fecal Coliform for Ch & B Wastewater Treatment Plant sludge

The results of this study showed that strong statistical relationships were found between parasite eggs and Fecal Coliform of the samples with the Pearson correlation factor of 0.926 and on the other hand for parasite eggs and total Coliform is 0.919. These results show in Figure 1 and Figure 2 that they show Regression graph for each parameters in this study.

DISCUSSION

In this research, we measured average of Total coliform and Fecal coliform. As it was evident in the beginning, the difference between total coliform and fecal coliform quantities of the two seasons was considerable. It shows a high difference between Total coliform average and Fecal coliform average in winter and summer. But this difference may be from cold weather because it is the coldest city in Iran .On the base of independent statistical t-test, this research shows a high difference between Fecal coliform and Total coliform in two index seasons winter

and summer ($P < 0.05$) that it can be observation in diagram1 .In order to investigate the sludge in its lowest and the highest rate of evaporation, in the freezing cold winter and burning hot summer respectively, two winters and two summers were selected as the timeframe. However this high difference between fecal coliform in summer and winter may be caused by cold weather because it's the coldest area in Iran (sometime,-30^0 in winter)

As the part of the findings pointed out so far, The average quantities of sludge fecal coliform in winter of Shahrekord, Farsan and Brojen Wastewater Treatment Plants were 1.63×10^6, 1.93×10^6 and 1.98×10^6 respectively. The produced sludge was in class B and is also based on EPA standard. Under the U.S environmental protection that decrease in energy sewage sludge can be used for agricultural though with some limitations. It can be propose that food products which have contacts with soil should not be harvest 14 months before the time of use in the earth. In the state that sludge is on the surface soil for more than 4 months. Other products that are under soil should not be harvest before 38 months. Products must at least be 30 days in the earth and animals must not be allowed to graze before 30 day in that field. The quality of bio removal sludge in this province is lower than US.EPA. So, we should not use them in agricultural. The average quantities of sludge Fecal coliform in summer of Shahrekord, Farsan and Brojen Wastewater Treatment Plants were not in any class of based on EPA standard because they were higher than 2×10^6 MPN per gram total solid. At the other hand about Parasite eggs it wasn't correction in two class based on EPA standard (40 CFR part 503).

The results of this study showed that strong statistical relationships were found between parasite eggs and Fecal Coliform of the samples with the Pearson correlation factor of 0.926 and on the other hand for parasite eggs and total Coliform is 0.919. Regarding to all the consultant Pearson correlation factor from this study are less than 0.9 than this implicit parameters have a proper statistical relationships. Since the best statistical relationships between parasite eggs and Fecal Coliform. There were other researches about this subject, to name a few: Mesdaghi and Nadafi (2004) which compare sludge specification of Shush with environments standards.[13] Movahediyan, Takdastan and Bina (2000) wrote an article about hygiene typical sludge in Isfahan which accordance with EPA Standards.[14] Farzadkia and Taherkhani (2001) test the quality of sludge Wastewater Treatment Plant in Hamedan that there were many differences to EPA standards.[15]

In most of tests had been shown that they weren't in class A, but some of them were in class B of USEPA regulations title 40 CFR parts 503. Mirhosseini, Moghaddam and Maknon survey the sludge in Shush, Sharak Gharb and Shahid Mahalati Wastewater Treatment Plants in 2006. Takdastan, Movahedian and Bina tested sludge samples for assigning the Fecal coliform in sludge from Isfahan and Shahin shahr in 2001. Found to dry sludge is in class B. Our research in CH & B in winter on Wastewater Treatment Plants supported these results. Therefore the sludge product of Wastewater Treatment Plants in some researches showed none of the classes of the regulations title 40 CFR parts 503 standard like Imandel, Torabian, Hasani in 2000, Farzad kia and Taher khani tests in 2001, also Nadafi and Mesdaghinia that CH & B tests verify it.

Horooki and Tomolazo (1997) in Japan showed that digest of the sludge aerobic exercises, under conditions mesophilic can reduce energy regulations.[16] Estrada and Gomez (2005) from Spain, on the other hand, survey on sludge of food and sewage infiltration in 80days.they show that sludge of confirm is better than food. It is suggested that constitutional review processes in Wastewater Treatment Plant and removal of dirt, for better quality of sludge.[17]

Conclusion

This Wastewater Treatment Plants were done as a model which can be used to increase staying dry sludge in beds or place of the public spot light, the risk to prevent a suitable. For sludge tested in summer, the findings in credible sources like PFRF can be used. It is essential to include dried help heat, heat treatment. Thermophilic digest aerobic exercises, radiation by Gamma and Beta rays and pasteurization. also, Wastewater Treatment Plant workers, farms workers and people relative it should be in the corresponding health points and use of dirt and limitation of its consumption trained. It is suggested to continue this research, in addition to the example of fertilizer, the soil of farms that sludge is using as fertilizer use their products are taking to test. To be real effects of the use of this sludge. The produced sludge in winter was in class B and is also based on EPA standard under the U.S environmental protection that decrease in energy sewage sludge can be used for agricultural though with some limitations. And it can caused by low temperature in this province.

The result of this study show that it is the strongest statistical relationships were found between parasite eggs and Fecal Coliform of the samples and Pearson correlation factor from this study in two analyses are more than 0.9 that these implicit parameters have a proper statistical relationships. With regard to the simplicity of the test of counting parasite, we can use these statistics to predict quantities of coliform. The results predicted for status of

sludge in Wastewater Treatment Plant in the dirt active use. And it can help to examination and statistical analyses supported from other Wastewater Treatment Plant.

Acknowledgement

I am grateful to the officials and employees of Water and Sewage Company of Iran, Chaharmahal va Bakhtiari province for their sincere cooperation.

REFERENCES

1) Singh RP, Agrawal M. 2008. Potential benefits and risks of land application of sewage sludge. Waste Manag 28: 347-358.
2) Tchobanoglous.G, Louis Burton. F, H. David Stensel, 2003. Metcalf & Eddy. Wastewater Treatment Disposal and Reuse. 4th ed. Mc Graw Hill Inc. P: 1068-1200.
3) Gabriel Bitton. 2005. Wastewater Microbiology: Microbiology of wastewater treatment John Wiley & Sons Inc. P: 213-371.
4) Ludovico .S, 2007. Sludge management: Current Questions and Future Prospects. Proceedings of IWA Special Conference on Facing Sludge Diversities, Challenges, Risks and Opportunities. IWA Antalya. P: 28-31
5) Iran Environmental Protection Agency (Iran EPA). 2001. Laws and Regulations for environmental protection. Iran EPA, Tehran, Iran, pp. 496-499
6) Farzad keya M, 1998. Presentation Proper Pattern for Stabilize Wastewater Sludge in Tehran City. Environmental Health PHD Thesis of Tehran University of medical Sciences.
7) Turovskiy. IS, Mathai. PK. 2006. Wastewater Sludge Processing. John Wiley & Sons, Canada. P: 1-45.
8) Golipour Shoili A, Farrokhi M, Neizehbaz H, Alizadeh. 2011. Selection of optimum option for sludge disposal in the Guilan province of Iran using rapid impact assessment matrix. International Journal of Water Resources and Environmental Engineering, 3(12), P: 288-297
9) Mirhosseini. G, Alavimoghaddam M, Maknon R. 2007. Investigation of Application of Tehran Municipal Dried Sludge in Agriculture. Journal of Environmental Sciences.,4 (4): 47 -56- Persian
10) Sabine L, B S. Everitt. 2004. A handbook of statistical analyses using SPSS. Chapman & Hall/CRC Press LLC. P: 1-66.
11) US EPA, 2005. Method 1681: fecal coliforms in sewage sludge (biosolids) by multiple-tube fermentation using A-1 medium.EPA-821-R-04-027
12) APHA, AWWA, WEF, 1998. Standard method for the examination of water and wastewater. 20th Ed. Part 9000: Microbial Examination.
13) Mesdaghinia. A, Panahi Akhavan. M, Vaezi. F, Naddafi. K, Moosavi. GH. 2004. Waste Sludge Characteristics of a Wastewater Treatment Plant Compared with Environmental Standards. Iranian J Public Health. 33(1): 5-9.
14) Takdastan. A, Mvahedian. H, Bina. B,. 1999. Evaluation of Digested Sludge Sanitary Indices In Isfahan Wastewater Treatment Plant and comparing to Environmental Standard For Reuse. Journal of Isfahan Water and Wastewater; 36(3): 18-24- Persian
15) Farzad keya M. 2003. Survey Efficiency Aerobic Digestion for Sludge Stabilization in Sarkan Wastewater Treatment Plant. Journal of Hamedan University of medical Sciences. 10(4): 31-37- Persian
16) Haruki , W., and Tomolazu, K. 1997. Inactivation of Pathogenic Bacteria Under Mesophilic and Thermophilic Condition " , Wat Sci Tech.,36:25-32.
17) Estrada IB, Gomez X, Aller A, Moran A. 2006. Microbial monitoring of the influence of the stabilization degree of sludge when applied to soil. Bioressour Technol 97: 1308-1315.