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FEASIBILITY OF STABILIZATION SLUDGE FROM ALBORZ INDUSTRIAL CITY'S WASTEWATER TREATMENT PLANT BY AEROBIC DIGESTION METHOD

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Abstract

Aerobic digestion is one of the most common method of sludge stabilization. The aim of this study is the feasibility of Alborz industrial city's wastewater treatment plant's sludge stabilization by aerobic method in 2015. For evaluating the process and reuse application of Alborz industrial city's wastewater treatment plant's sludge in aerobic digester, this study used two manmade glass reactor with the dimension of 0.4×0.28×0.28m and volume of 31.36 lit and work volume of 25lit.

During the work process of reactor, for monitoring and controlling the process in certain days (3-10 days) DO, pH, VS, TS, $SOUR_{20}$, temperature, fecal coliform, total coliform and parasite eggs parameters were evaluated and at the end the evaluated level were compared with the stabilization criterion. It should be noted that all the sampling and tests stages have done based on the water and wastewater standard method. Evaluation the results of two separated loading of aerobic digester showed that the evaluated parameters during the digestion process in a bioreactor have done their role for stabilization.

The stabilization speed at the beginning of the digester was higher and at the end of the reactor activity was lower. In other words, over time the digestion process would be completed and the stabilization speed would be reduced. The overall conclusion of this study is that due to the fact that the treatment plant system designed based on the aerobic digestion and the amount of these basin's aerator were not enough (in all samples evaluated 0), therefore the aerator system of these basins should be modified in order to provide at least 1mg/l dissolve oxygen. Also, according to the fact

that the minimum time for aerobic stabilization is 40 days in 20°c, the retention time of these basins should increase. In the case of modifying the mentioned factors, the sludge pass the stabilization system properly and reach the class B standards and may reach the class A standard under some circumstances for some parameters such as fecal coliforms.

Keywords: Sludge stabilization, wastewater treatment plant, aerobic digestion rector, Alborz industrial city

Introduction

Unlike the output effluent of wastewater treatment plant which usually have desirable quality for discharging in to the environment, the sludge which are come from the pollutants concentration of sewage don't have the permission to enter the nature in a raw and unrefined form (1-3). In other words releasing the sludge in the environment due to the existing of various material such as those which resistant to microbiological degradation, toxic, perishable, and pathogens consider as a serious threat for the environment and lead to spread of infectious disease and environmental distraction (4-8). The importance of this fact cause the world's researches center to improve and recognized new methods of reducing produced sludge in treatment plants to minimum level. In this field, using the process which produce less sludge, presented as ideal solution for the efficient solving of this problem (9). The aim of the sludge treatment is to change the raw sludge with bad smell to a neutral and odorless sludge which could lose its water easily (10). Therefore, before disposal, some process should have done on it like dewatering and decreasing volatile solids. The process which have done on the sludge before disposing include concentration for dewatering and stabilization for reducing the volatile solids (11). Sludge treatment and disposal currently is one of the important technical challenges which have more than 50% of the basic cost and operation of wastewater treatment process (12, 13). Stabilization defines as a process which change the organic material of sludge to inorganic and cause stopping sludge's microorganism growth and microbial activity and stabilizing it (14). The important sludge stabilizing method include, alkalis stabilization (which almost stabilized with lime), composting, aerobic and anaerobic digestion (13).

Aerobic digestion may use for the disposal sludge treatment, the mixture of disposal activated sludge or trickling filter and primary sludge and the disposal sludge of extended aeration treatment plant. Aerobic digestion first used in treatment plant with the capacity of less than 0.2 m^3/s. but in recent years, this process used in treatment plant with more than 2m^3/s capacity (13). The aim of this study is the feasibility of sludge stabilization in Alborz industrial city's wastewater treatment plant by aerobic digestion method in 2015.

Material and Methods

- **Reactor's profile**

For evaluating the process of reusing the Alborz industrial city's wastewater treatment plant's sludge in aerobic digestion, in this study a manmade glass reactor with dimension of 0.4×0.28×0.28m and volume of 31.36lit and work volume of 25lit have been used with two diffuser aerator device which have four aerator hose that attached to it and one of them considered as a reserve (Figure1). The aerator have the efficiency to change the level of the inlet air to the reactor (high or low). If the dissolved oxygen fluctuate in the aerator, the dissolved oxygen could be held at least for 1mg/l. this amount of oxygen is the minimum required oxygen for the aerobic system activity. With a pH meter device the pH was monitored continuously and by the dissolved oxygen control device which equipped with digital thermometer, in addition to the continuous control of dissolved oxygen, the reactor's temperature was control too.

- **Lunching the reactor**

30 lit sludge was taken from the entrance place of sludge to the sludge dryer lagoons by a 50lit plastic container in 25 May 2015 and transported to the laboratory in less than 15 minute and 15lit of it transferred to the reactor. Then immediately the aerators switched on and work for 41 days without interruption. The other reactor was lunched in the same condition in 25 July 2015 and aerated in 40 days under a mesophilic condition. During the process work of reactors for monitoring and controlling in certain days (3-10 days) the DO, pH, VS, TS, $SOUR_{20}$, temperature, fecal coliforms, total coliforms and parasite eggs parameters were evaluated and at the end the evaluated parameters were compared with the stabilization criterion. It should be noted that all the sampling and tests have done based on the water and wastewater standard method (14).

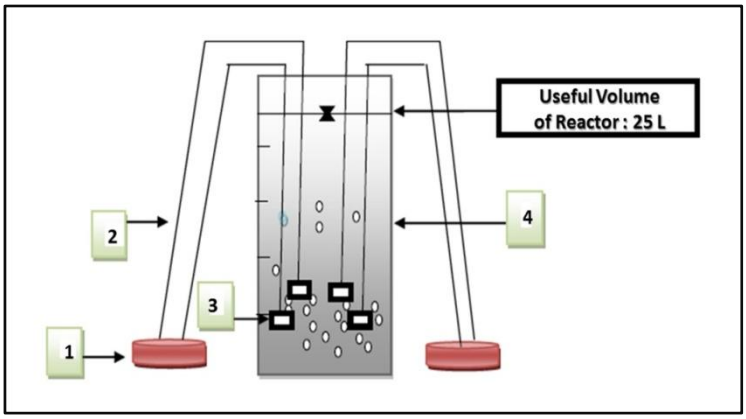

Figure-1. Schematic aerobic digestion reactor.

1- Aerator

2- Hoses connected to Aerator

3- Stone of Aerator

4- Aerobic digester reactor

Evaluating the two separated loading stage of aerobic digester showed that the evaluated parameters during the digestion process in bioreactor work for the stabilization. The stabilization speed at the beginning of the digester was higher and at the end of the reactor activity was lower.

Results

- **The trend of VS/TS ratio in aerobic digestion reactors(1 and 2)**

Figure-2: showed that the ratio of VS/TS, had reached the acceptable limit at least in sixteenth and at last in twenty fourth days and the average ratio of VS/TS in 21th day was 0.59.

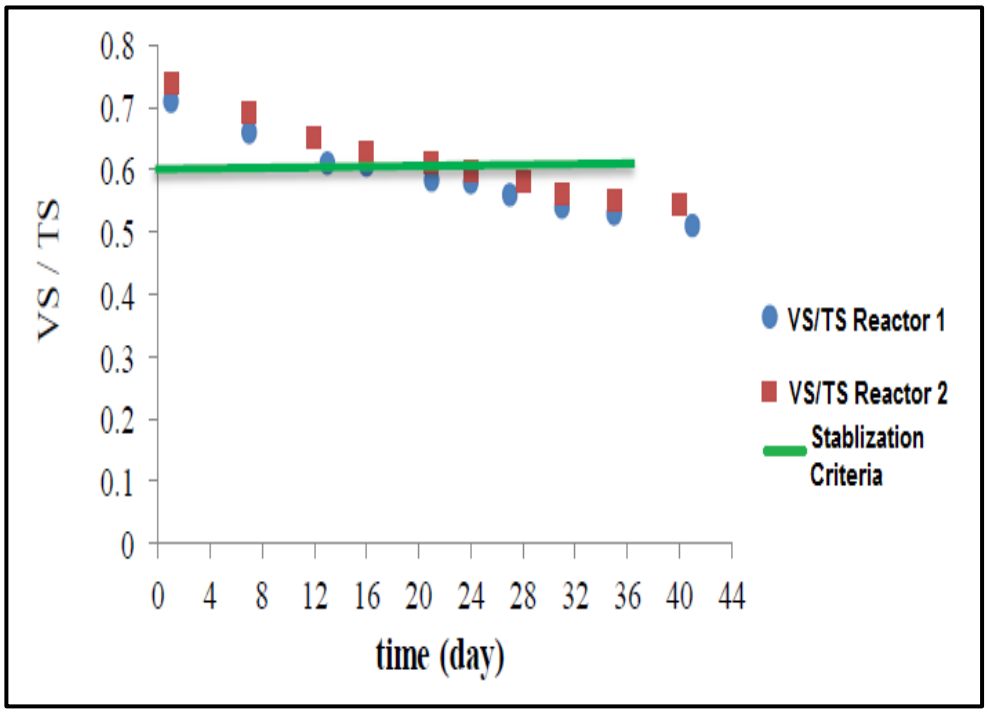

Figure-2.The trend of VS/TS ratio in aerobic digestion reactors (1 and 2) and compared with stabilization criteria.

- **The trend of $SOUR_{20}$ in aerobic digestion reactors(1 and 2*)***

Figure3 showed the ratio of $SOUR_{20}$ to the time. This factor reach the acceptable limit of stabilized sludge ($2mgO_2$ /g.h) at least in 21th day and at last in twenty fourth day. The average of $SOUR_{20}$ in twenty fourth day of sludge digestion was 1.93 mgO_2 /g.h which this level was lower than the acceptable limit in stabilized sludge.

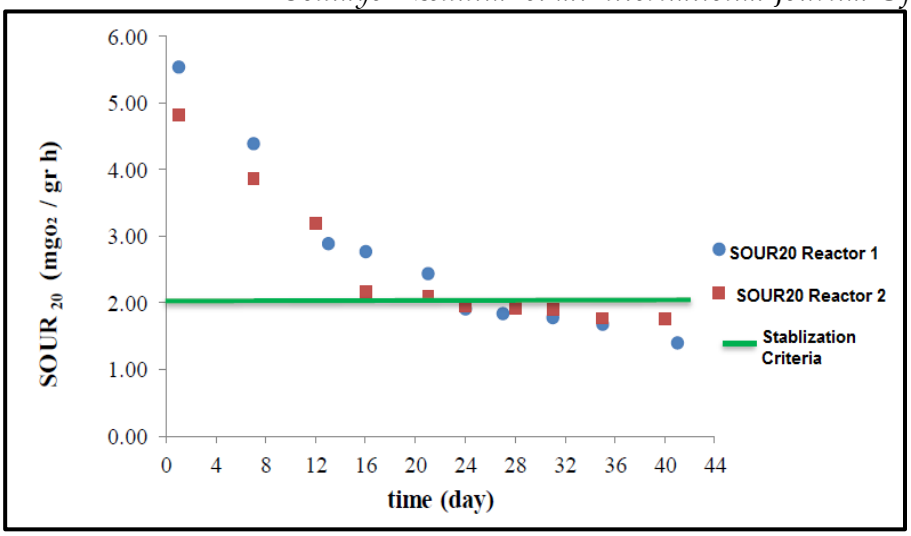

Figure -3.The trend of $SOUR_{20}$ in aerobic digestion reactors (1 and 2) and compared with stabilization criteria.

- **The trend of VS in aerobic digestion reactors(1 and 2)**

Figure4 showed the changes ratio of VS to time. As it revealed in the figure, for reactor number one the VS level was decreased from 1628mg/l to the 4110 mg/l which showed 12170mg/l loss of VS. Also, according to the primary level of VS in reactor number two which was 2203mg/l and the VS level at the end of the reactor activity which was 6390mg/l, the loss of VS was 15640 mg/l.

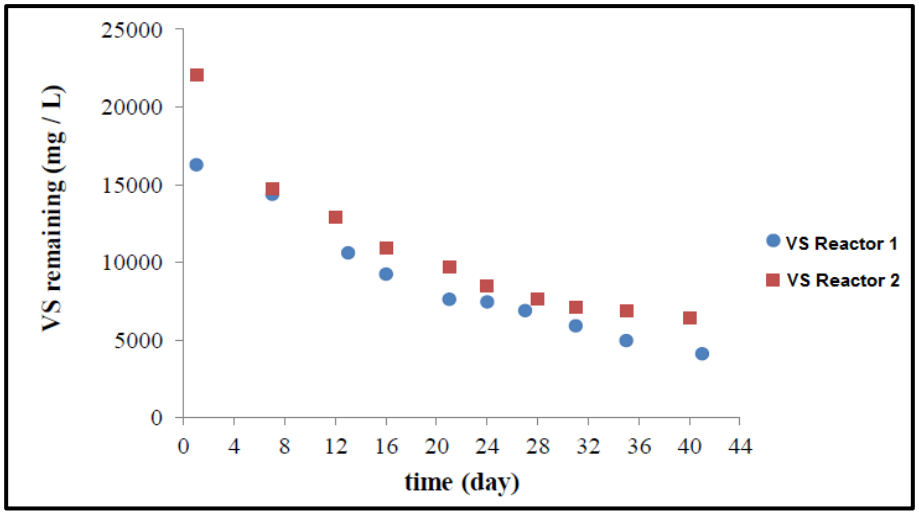

Figure -4.The trend of VS in aerobic digestion reactors(1 and 2).

- **The trend of VS removal in aerobic digestion reactors(1 and 2)**

Figure5 showed that the volatile solid reduction percentage at least in twelfth and at last in sixteenth day was reach its acceptable level of stabilized sludge (38%) and the average level of volatile solid reduction in sixteenth day was 48.87%. also the total average percentage of loss in reactor work period was 72.5%.

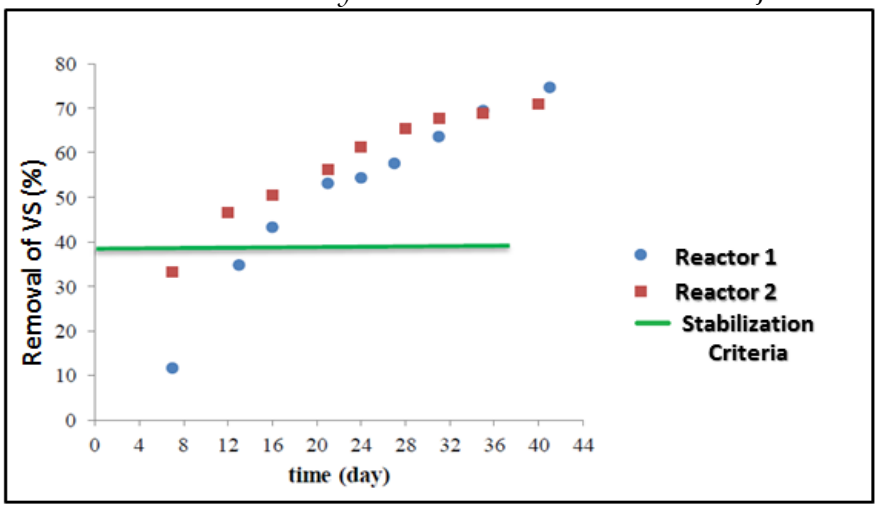

Figure -5.The trend of VS removal in aerobic digestion reactors (1 and 2) and compared with stabilization criteria.

- **The trend of TS in aerobic digestion reactors(1 and 2)**

Figure6 showed the changes ratio of TS level to the time. As the figure showed, for reactor number one the TS level reduced from 22940mg/l to the 8050mg/l which showed the 14890mg/l reduction of TS. Also according to the fact that the primary level of TS in reactor number two was 29780mg/l and the TS level at the end of the reactor activity was 11750mg/l, the reduction of TS was showed as 18120mg/l. the average loss of TS in both reactors was 64.2%.

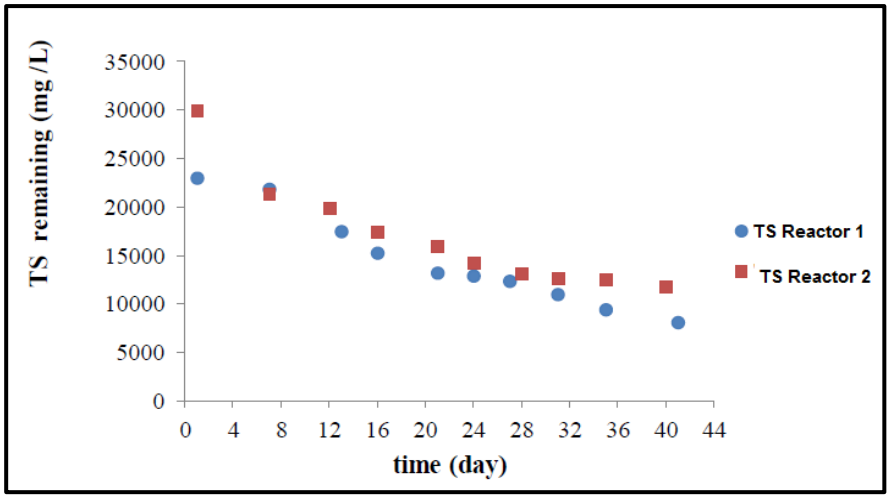

Figure-6.The trend of TS in aerobic digestion reactors (1 and 2).

- **The trend of Fecal Coliform (FC) in aerobic digestion reactors(1 and 2)**

Figure-7 showed the results of microbial tests ratio to time. According to the mentioned figure, the total average of fecal coliform for two reactors was 3.356×10^{6} MPN/g ds. The average of the fecal coliform in reactor number one was lower than the acceptable standard limit of class B (2×10^{6} MPN/g ds) and reactor number two at least in seventh day activity reach the acceptable limit of class B. the average of the fecal coliform in seventh day for two reactor was 4.63×10^{5} MPN/g

ds. Also the reduction level of fecal coliforms for reactor number one was 1.69×10^6 MPN/g ds (almost more than 55%), while the reduction level for this reactor in seventh day was 51% and in sixteenth day was at last 82%. The reduction level for fecal coliform of reactor number two was 4.88×10^6 MPN/g ds (almost more than 99%). This reduction level for seventh day of reactor was 71% and for sixteenth day was 85% and the average reduction for both reactors in seventh day was 61% and in sixteenth day was 85.5%.

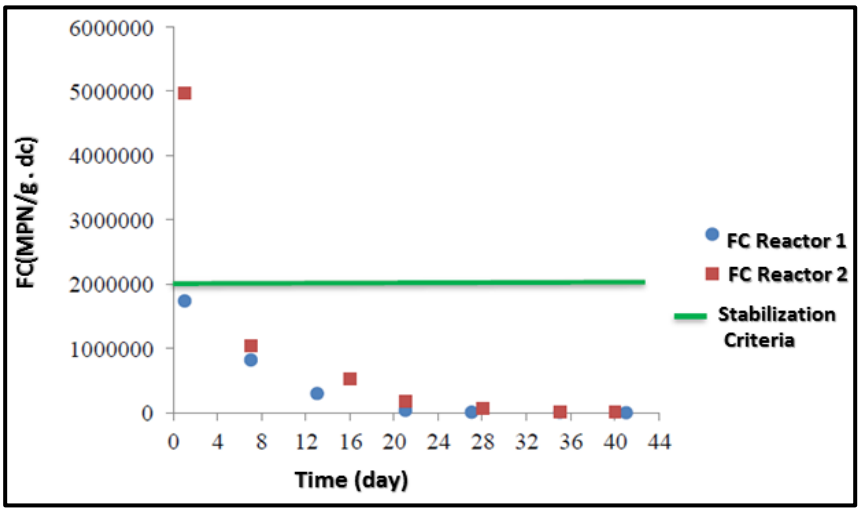

Figure-7.The trend of Fecal Coliform (FC) in aerobic digestion reactors (1 and 2) and compared with stabilization criteria.

- **The trend of Total Coliform (TC) in aerobic digestion reactors(1 and 2)**

Figure-8 showed the reduction of total coliform ratio to time. The average reduction of total coliform during the reactor activity was more than 99%. And this reduction in seventh day was 78%.

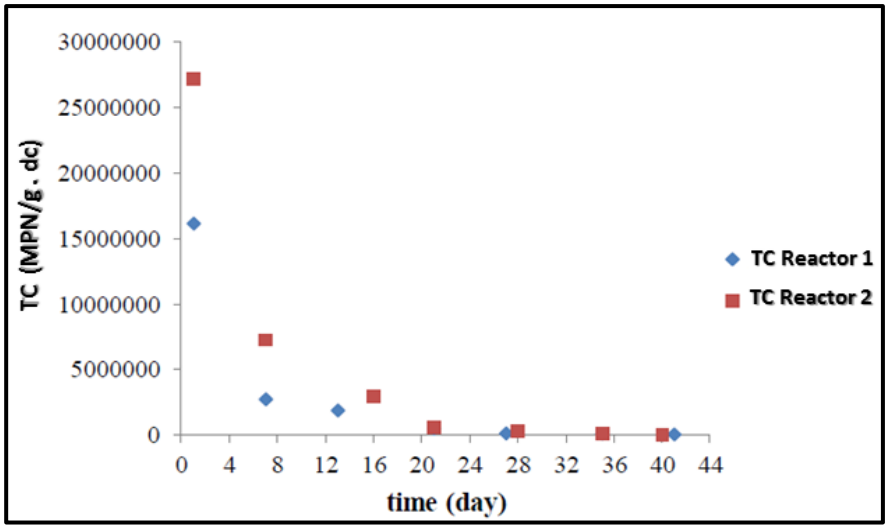

Figure-8.The trend of Total Coliform (TC) in aerobic digestion reactors (1 and 2).

According to the **figure-9** the average of the parasite eggs at the end of the digestion was 320 to 136 MPN/G ds which was higher than the standard limit of class A (1MPN/G ds).

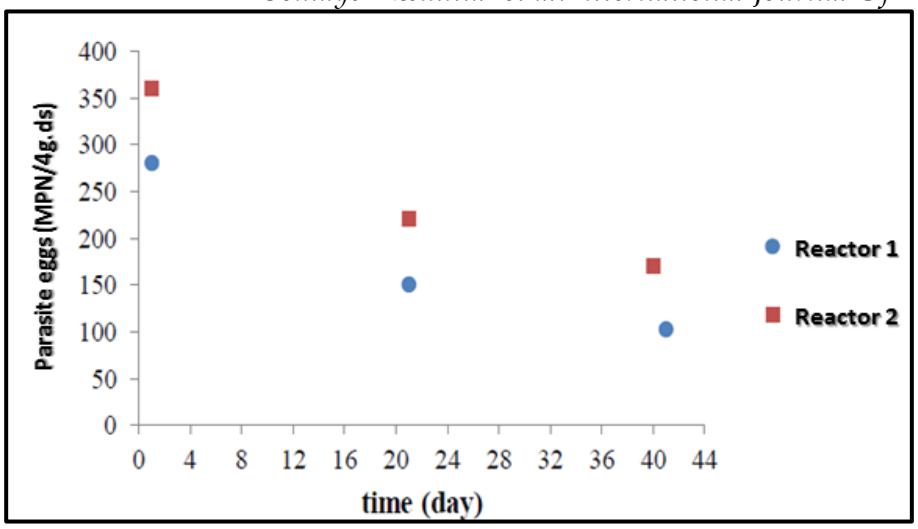

Figure-9. The trend of parasite egg in aerobic digestion reactors (1 and 2).

The analysis result of aerobic digestion sludge reactor revealed that the average of the BOD_5/COD ratio in sampling time was 40% and at the end of the reactor activity this ratio was averagely 16.35% (16.7% reactor number one and 20% reactor number two).

Discussion

Evaluation the results of the two separated loading stage of aerobic digestion showed that the evaluated parameters during the digestion process in bioreactor work for stabilization. The stabilization speed at the beginning of the digestion was more and at the end of the reactor was lower. In other words the digestion process was completed over time and the stabilization speed was reduced. Due to the fact that one of the aim of this study was evaluating the aerobic stabilization of reactors, for using these sludge in farm and surface disposal the filterable and microbial parameters were evaluated.

- **Comparing with the pathogens reduction**

The EPA divided the disposal sludge of wastewater treatment due to the microbial and parasitic criterion into two groups of A and B and determined the disposal and reusing method of them (15). The analysis results of input sludge to the aerobic digestions sludge dryer of Alborz industrial city showed that none of these digesters provide the microbial and parasitical condition of class A. but fecal coliforms level of sludge in reactor number one before beginning its activity was lower than the acceptable standard limit of class B and reactor number two after passing two day could reach the standard of class B. but because the consumption of the sludge which placed in this class is not desirable for agricultural l fertilizers they just used for modifying poor soils or burring in forest. According to the reduction level of fecal coliforms at the reactors final days and reducing the class A standard, considering the quality of obtained sludge as a great sludge of

class B is possible and for consuming this sludge, the regulation of class B, pathogens and places restriction which related to the type of the crops and harvesting time should implement precisely.

- **Comparing the reduction of vectors absorption regulation**

The regulation of reducing the vectors absorption for aerobic digestion of sludge estimated when the volatile solid percentage reduced during the stabilization more than 38% or when the oxygen absorption speed in 20°c was equal or more than 2mg O_2 /g.h or the VS/TS was more than 0.6. According to the reactors results analysis, the oxygen absorption speed in 20°c of reactor number one in twenty forth day was 1.8 mg O_2 / g.h and in reactor number two of 21th day was 2 mg O_2 / g.h. the volatile solid reduction percentage of reactor number one in sixteenth day (43%) and in twelfth day of reactor number two (46%) and VS/TS in reactor number one of sixteenth day (0.6) and in reactor number two of 21th day (0.6) reach the acceptable limit. According to the mentioned factor averagely in 21th day the vectors absorption reduction was estimated and this day should considered as a maximum require time for reaching the vectors absorption regulation. Movahedian et al. (2000) used the aerobic reactor for stabilizing Isfahan municipal wastewater mixed sludge which reach 40% of the volatile solid removing in eleventh day of retention time (16).

Evaluating the aerobic digestion efficiency of stabilization in Serkan municipal wastewater treatment plant by Farzadkia et al.(2005) showed that with seventh day retention time the stabilization have been done and the vectors absorption reduction regulation have been provide but for reaching the class B of the USEPA standard the aerobic digestion condition should be at least twenty two days (17).

In another study which have done by You ShJ et al (2011) and evaluating the mesophilic and thermophilic aerobic digesters for digesting a mixed of primary and secondary sludge, it was revealed that aerobic digesters remove27, 30, and 26 level of VS, TCOD and TS respectively after 15 days (18).

Also a study which have done by He P et al. (2013) showed that by anaerobic digester the volatile solid reduced for 66.1% after 86 days (19).

- **Apparent color and odor**

The apparent color observance in reactors showed that by being close to the final days of aerobic digestion the color of sludge changed from dark brown to light brown and its septic smell was reduced which showed that the aerobic reactors content pass the stabilization stages properly.

Conclusion

The overall conclusion of this study is that, due to the fact that the treatment plant system was designed based on the aerobic digestion and the amount of oxygen aerator in this basins were not enough (in all samples evaluated 0), therefore the aerator system of these basins should modified in order to provide at least 1mg/l dissolved oxygen. Also according to the minimum time of aerobic stabilization which was 40 days in 20°C, the retention time should increase in these basins. In the case of modifying the mentioned factors, the sludge pass the stabilization process properly and reach the class B standard and may reach class A standards in some condition and parameters like fecal coliforms.

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