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The Efficiency of Anaerobic Digesters on Microbial Quality of Sludge in Isfahan and Shahinshahr Waterwaste Treatment Plant

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ABSTRACT

Anaerobic digestion is among the oldest processes used for stabilization of solid and biosolids. In this survey 12 samples were taken from the digested anaerobic sludge of Isfahan and ShahinShahr WWTP and total solids, volatile solids, total coliform, fecal coliform, *Salmonella* and viable parasite ova tests were done. Results were compared with the 503 sections of the 40 CFR regulation of the US EPA .The result showed that the average reduction rate was 30% for volatile solids, 4.5×10^7 MPN/g. dry solids (DS) for total coliform, 5.6×10^6MPN/g.DS for fecal coliform, 24MPN/4g.DS for *Salmonella*, and 27 number/4g.DS for viable parasite ova of digested anaerobic sludge in Isfahan. In Shahinshahr WWTP, the average of reduction was 39% in volatile solids, 2.13×10^7MPN /g.DS in total coliform, 1.16×10^6 MPN /g.DS in fecal coliform ,11 MPN/4g.DS in *Salmonella* and 16 number/4g.DS for viable parasite ova of digested anaerobic sludge . Therefore the digested sludge in Isfahan did not meet the requirements of pathogen reduction in class A and B as well as the reduction requirements for vector attraction, while the digested sludge in ShahinShahr met the requirements of pathogen reduction in class B and vector attraction. So, agricultural use of digested sludge should be made by limiting the kind of crops as well as controlling the harvesting time. The results from the two anaerobic digesters of Isfahan and Shahin Shahr showed that there was a significance correlation between the reduction of volatile solids with total coliform, fecal coliform and *Salmonella* ($P<0.05$, $r>0.9$), while there was no significance correlation between the reduction of volatile solids and viable parasite ova.

Keywords: *Wastewater sludge, Anaerobic digestion, Pathogen reduction, Vector attraction*

INTRODUCTION

Wastewater treatment always consists of two separated parts, effluent and sludge, among which the treated effluents can be discharged into the environment. The objective of wastewater treatment is to remove pathogens and disinfect effluent prior to discharging into water resourses (Metcalf and Eddy, 2001). The effi-

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their physical and biological properties. The produced sludge needs to be treated before being disposed or reused (USEPA, 1992; Metcalf and Eddy, 2001). The raw sludge contains a variety of pathogenic microorganisms such as bacteria, virus, protozoae and parasites. The amounts of these organisms are much more than the wastewater (USEPA, 1992; Michael, 2001). In order to reuse the sludge for agricultural and non-agricultural purposes or surface disposal, the sludge should be treated by processes such as anaerobic digestion (Michael,

2001; Eliot, 2003). Anaerobic digestion reduces the majority of pathogenic agents. If can be carried out under mesophilic or thermophilic conditions. Primary or secondary sludge is fed intermittently or continuously into sealed vessels that preclude free oxygen. Although the primary purpose of anaerobic digestion is solid reductions, other benefits are methane production and pathogen reduction. According to the USEPA, mesophilic anaerobic digestion is considered as a part of process to significantly reducing pathogens (PSRP) (Dahab et al., 1996; Eliot, 2003).

Dahab et al, 1996 determined the concentration of fecal coliform and *Salmonella* in primary sludge in nine different waste water treatment plants. Fecal coliform densities varied from 12 to 61 million MPN/g of total solids (TS). The average was 36 million MPN/g of TS. *Salmonella* densities varied from 217 to 1000 MPN/g of TS for eight of the treatment plants. At the ninth plant, the level was 3140 MPN/g of TS (Dahab et al., 1996).

MATRIALS AND METHODS

In this study periodically sampling of raw and digested sludge of Isfahan and Shahinshahr WWTPs were done. The samples were examined by total and volatile solids tests according to Standard Methods of 1992. Total and fecal coliforms were enumerated using Standard methods, 1992 , section E and USEPA 1992, *Salmonella* (Standard method 1992 section 9260 D and USEPA1992) and parasite ova were enumerated (USEPA, 1992; APHA. AWWA. WEF, 1992).

RESULTS

The results of total and volatile solids, total and fecal coliforms, *Salmonella* and parasite ova tests in the raw and digested sludge of Isfahan and Shahinshahr wastewater treatment plants are summerized in Tables 1 and 2. The results showed that the reduction average of digested sludge of Isfahan treatment plant for volatile solids, total coliform, fecal coliform, *Salmonella* and parasite ova were 30%, 4.5×10^7 MPN/g. DS, 5.6×10^6 MPN/g. DS, 24 MPN/4g. DS and 27 number/4g. DS, respectively and in Shahinshahr the reduction average was 39%, 2.3×10^7 MPN/g. DS, 1.16×10^6 MPN/g. DS, 1 MPN/4g. DS and 16 number /4g. DS, respectively. Result of comparing the fecal coliform in digested sludge at Isfahan and Shahinshahr WWTP with pathogen reduction requirements of class A are shown in Fig.1. Comparison between the numbers of fecal coliforms in digested sludge at these two treatment plants with pathogen reduction requirements of class B are shown in Fig.2. Also comparison between the declining percentages as with vectors attraction reduction requirements to standard is shown in Fig 3.

Table 1: Wastewater sludge characteristics in digester effluent of Isfahan WWTP

Sample No.	Total solids (%)	Volatile solids (%)	Reduction of volatile solids (%)	Total coliform (MPN/g.Ds)	Fecal coliform (MPN/g.Ds)	*Salmonella* (MPN/4g.Ds)	Parasite ova (No./g.Ds)
1	2.13	67.83	29.49	5.62×10^7	5.16×10^6	23	28
2	2.28	69.88	28.7	3.94×10^7	4.82×10^6	19	32
3	1.98	69.01	30.14	4.34×10^7	4.5×10^6	24	26
4	1.9	69.5	32.02	4.75×10^7	7.36×10^6	29	23
5	2.39	66.45	29.93	4.26×10^7	7.1×10^6	23	29
6	1.63	66.13	30.53	4.32×10^7	4.9×10^6	27	21
Mean	2.14	68.13	30	4.53×10^7	5.6×10^6	24	27

Table 2: Wastewater sludge characteristics in digester effluent of Shahinshahr WWTP

Sample No.	Total solids (%)	Volatile solids (%)	Reduction of volatile solids (%)	Total coliform (MPN/g.Ds)	Fecal coliform (MPN/g.Ds)	*Salmonella* (MPN/4g.Ds)	Parasite ova (No. /g.Ds)
1	2.24	65.86	39.2	1.56×10^7	1.08×10^6	7	19
2	2.5	65.82	38.7	2.36×10^7	1.4×10^6	10	17
3	2.34	66.22	40.1	2.08×10^7	1.2×10^6	12	21
4	2.3	66.84	38	2.17×10^7	1.19×10^6	10	9
5	2.39	65.63	38.39	2.09×10^7	1.08×10^6	13	14
6	2.46	66.63	39.12	2.03×10^7	1.02×10^6	15	18
Mean	2.37	66.19	39	2.13×10^7	1.16×10^6	11	16

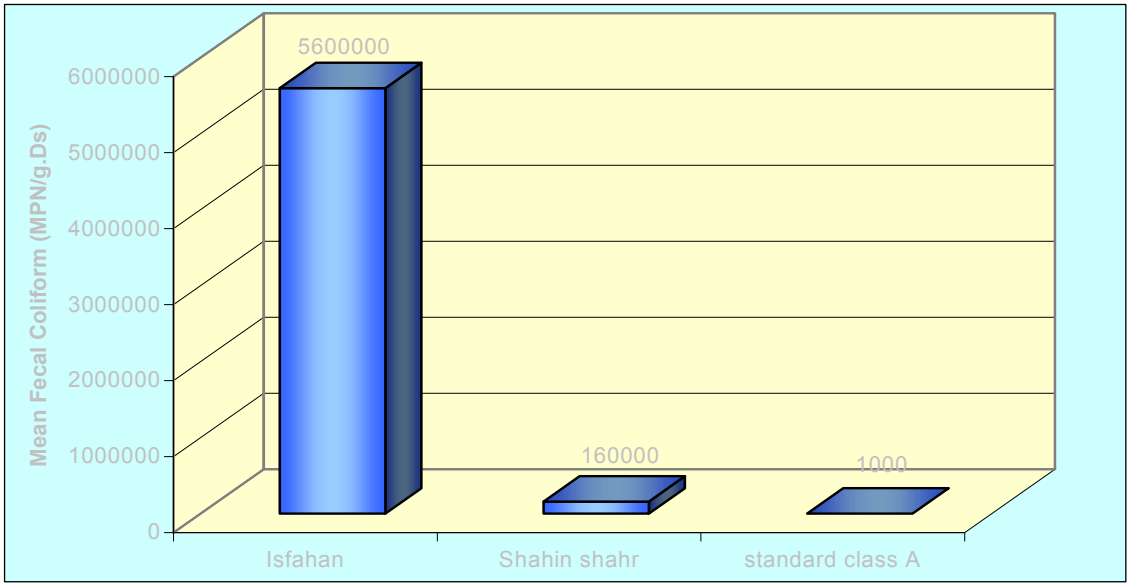

Fig. 1: Comparing fecal coliform in digested sludge at Isfahan & Shahinshahr WWTP with pathogen reduction requirements of class A

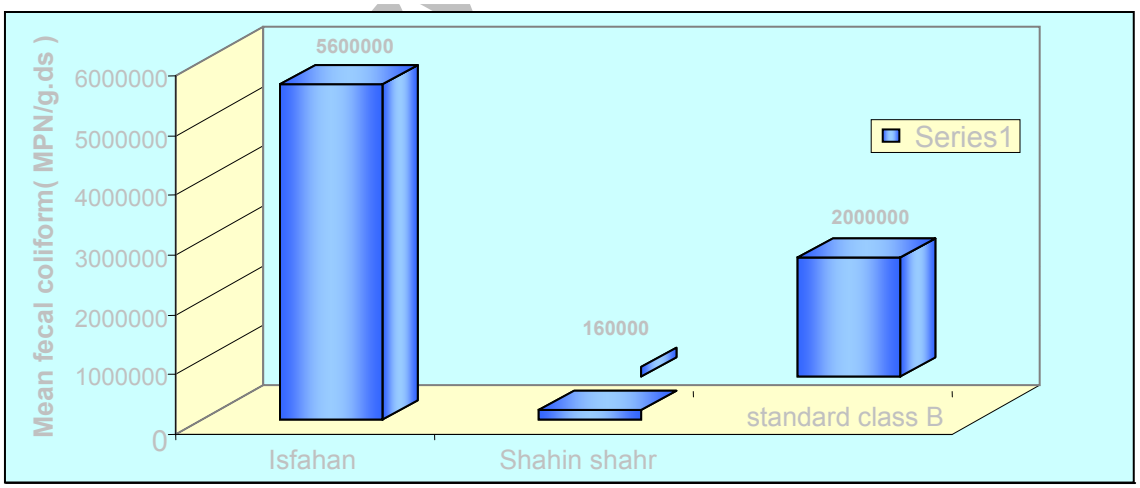

Fig. 2: Comparison between fecal coliform in digested sludge of Isfahan & Shahinshahr WWTP and pathogen reduction requirements of class A

Statistical analysis of the findings showed that there was a significance relation and strong correlation between the reduction of volatile solids and total as well as fecal coliform ($P<0.05$, $r>0.9$). Comparing the fecal coliform in digested sludge at Isfahan and Shahinshahr WWTPs with pathogen reduction requirements of class A is shown in Fig.1. The number of fecal coliforms in the compared treatment plants was more than standard level, thus this sludge may not the used for agricultural purposes and is not suitable for packing and sale. Comparison between the numbers of fecal coliforms in digested sludge at these two treatment plants with pathogen reduction requirements of class B are shown in Fig.2. The number of fecal coliform in our samples was less than standards levels, therefore by regarding time and crops limitation, this sludge could be used for agricultural purposes.

Comparing the declining as with vectors attraction reduction requirements to standard is shown in Fig.3. The mean reduction percentage of volatile solids at Isfahan treatment plant is less than the standard level, but it is more than the standard level at Shahinshahr, thus this WWTP meet the requirements.

Berg and Berman(1980) reported that anaerobic digestion inactivated 1.44 to 2.3 Log of Fecal coliform, 1.05 to 1.36 Log of Entrovirus and 0.92 to 2.08 Log of *Salmonella*. Also Ponoguti et al (1997) indicated that anaerobic digestion reduced many pathogenic organisms and indicator bacteria by 1 to 3 Log (Ponugoti et al., 1997; Berg, 1980).

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