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Research Article

ASSESSMENT OF WASTE SLUDGE SPECIFICATIONS OF WASTEWATER TREATMENT PLANT IN SOUTH OF TEHRAN– WITH ENVIRONMENTAL STANDARDS

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ABSTRACT
Sludge production is unavoidable problem arising from the treatment of municipal wastewater. This sludge contains considerable amounts of organic matter, pathogens and chemical contaminants which it is not properly handled and disposed may produce extensive health hazards. Tehran Wastewater plan, as one of the greatest environmental project, has a goal, to save this mega-city from unpleasant conditions of unsanitary and traditional discharge of waste water in various parts of the city. This study has been collected from the keywords of in topic search: wastewater, treatment, plant and environment of ISI and national guideline database. The average values determined for results of qualitative analyses of disposed sludge in comparison with USEPA - 40 CFR 503 standards.). According to standard class A Pathogen Reduction, less than 1000 fecal coliforms per gram of total solids or less than 3 Salmonella per 4 grams of total solids of the sludge has been recommended. But the geometric average values of fecal coliforms of south of Tehran disposed sludge are much more than this limit, so standard class A cannot be met. Besides, there would be no need to inspect the other part of this standard related to associate alternatives. We concluded to have communication with environmental protection organization to provide the possibility of online monitoring by Tehran province water and wastewater organization.

Keywords: *Wastewater, Treatment, Plant, Environment*

INTRODUCTION
Sludge production is unavoidable problem arising from the treatment of municipal wastewater. This sludge contains considerable amounts of organic matter, pathogens and chemical contaminants which it is not properly handled and disposed may produce extensive health hazards (Arumugam, 1976). Sludge disposal is now recognized to be as one of the most important problems by all environmentalists and in this regard new standards have been established by USEPA in 1989. Moreover, more concise and restrictive regulations are executed every year for this purpose. Incineration, for example, has been confined and dump in sea has been prohibited in EU and USA. Instead, land application of the sludge has received much more attention (Bryant and Wiseman, 2003). This method, namely land application of the sludge, may cause various health and environmental problems, which should be considered as well. USEPA regulations title 40 CFR parts 503 describes the matter and explains: definitions, purpose and applicability, general requirements, pollutant limits, management practices, operational standards, pathogen and vector attraction reduction, sampling and analysis, frequency of monitoring, recordkeeping, and reporting (Zanoni and Rutkowski, 1972). The tremendous speed of population growth (often doubling within only 10-20 years) in many major cities of developing countries is much faster than the speed at which city authorities can increase services. Growing cities often destroy their own water sources, while the new sources farther away rapidly become in surmountable costly to use. Such is the case in Tehran. As is happening in many

mega cities worldwide, metropolitan Tehran is experiencing rapid urban growth, with serious concerns being raised regarding the environmental sustainability of this development, and the potential detrimental impacts on the quality and quantity of groundwater resources.

Tehran, with an existing population of over 7 million people covers an area of approximately 730 km^2 and lies within the Tehran basin on the semiarid plains to the south of the Alborz Mountains, with a varied terrain; from steep hilly areas in the north to plains in the south. The average slope of the area ranges from 1.3 to 5 percent.

The mean annual precipitation is only 250 mm and occurs mainly during the winter and spring. No rivers of any size pass through the basin, but groundwater is contained in the extensive alluvial aquifer that underlies the basin.

What is needed is to move away from the technical-fix dominated, and largely supply-oriented management structure of water resource management. The focus has to be extended from blue water flow to incorporate also green water issues, and from water quantity to incorporate water quality as well. An integrated approach is necessary for environmental management and water management of mega cities like Tehran. Urban planning, as it relates to water, should encompass the integration of the physical land beyond the city limits, considering both the river basin where the city is located and the surrounding region affected by and interacting with the city.

Planning should also incorporate a multi sartorial framework (Calvert and Parks, 1934; Goldstein and Moberg, 1973). All sorts of interdependency linkages and implementation barriers need to be addressed in an overarching and integrated manner.

The conventional setup of sect oral water management. Implementation of Tehran waste water plan was discussed when water pipeline operation started in 1948. The studies of this plan were begun with United Nations Development Program (UNDP) and World Health Organization (WHO) in 1971 and these studies were approved in 1995 and in October of the same year, the implementation was started; this plan was revised in an International Tender because of the project importance and related crisis, and was finally approved in 2011.

The Executive operation of Tehran Wastewater Project in an area of 700000 hectare, back in 1995 started in all 22 Tehran municipality districts, and it intended to cover all 11 million inhabitants by 2032. This Project based on priorities, has been divided in 5 separated implementation phases. In this project, construction of 9000 Km of wastewater collecting networks, 76Km of wastewater transmission tunnels, installing more than 900,000 wastewater connections, and construction of 20 modules of wastewater treatment plant are planned. Due to extremely expensive costs of this project, implementation problems and also financial limitations, receiving loans from international bodies was considered. Finally in 2005, Tehran Water and Wastewater Company was able to receive 145 M$ which was the first phase of a loan from International Bank. Qualitative objectives (Hadi *et al.*, 2011):

1- Protection of the environment
2- Promotion of public sanitary level
3- Preventing contamination of underground water resources considered as a part of water supply reservoirs.
4- Transferring heavy costs of medical treatment to the low costs of disease prevention
5- Expansion of green zones and clean air to improve public behavior in a delightful surrounding.
6- Preventing usage of raw sewage in irrigation, (this problem is already solved)
7- Changing water consumption trend from a single wasteful cycle to a multiple and useful cycle.
8- Replenishing water beds around Tehran with the effluent.

Tehran Wastewater plan, as one of the greatest environmental project, has a goal, to save this mega-city from unpleasant conditions of unsanitary and traditional discharge of waste water in various parts of the city. This project as of now under the title of "city of Tehran, waste water network construction project" is being carried out.

In Tehran, waste water has been generated in households and trade centers since very long time ago and traditionally it has been discharged in rivers, flood channels and underground water aquifers. This trend was polluting these precious and limited underground water aquifers and was turning them into dangerous and extremely polluted resources.

We can hope, by caring out this project and properly collect and discharge waste water, to be able to manage these environmental disasters and prevent Tehran citizens from afflictive illnesses. By bringing into operation the sewage tunnels and main transfer lines and by transferring urban produced waste water to south of Tehran waste water treatment center, a giant step toward increasing public health will be taken.

This process will have a definite effect on reduction of medical treatment costs of fighting various illness, plus it will provide a change to reinvigorate underground water tables and also prevent farmers form irrigating the vegetable crops by row - waste water.

A favorable condition for expansion of urban greenery and freshening its weather are also consider other by- product of implementing of this project. By utilizing 9000 km of main and auxiliary network, almost all of waste water which is produced in households will be transferred to various waste water treatment centers. This will also makes it possible to transfer produced waste water from northern parts of Tehran to southern areas and after treatment to utilize it for agricultural purposes. Special conditions which exist in Tehran like heavy traffic in main streets, ground slope, variable types of soil and also lack of underground installations diagrams, created various problems.

Some other problems that were faced were old Qantas of Tehran, water, phone and natural gas installations and unstable soil. These and other challenges were solved and removed by innovative and perseverance approaches of Tehran waste water company. West main waste water line is considered one of the most important parts of Tehran waste water system.

Its length is 40 km and it is completely implemented. This massive project which start at Velanjak and Mahmudeyah areas – specifically at Paseyan Ave goes through Vali-Asr, Fatemee, Hajab, Aboureehan, Jumboree, Kargar, Modares, Shoosh, and Shaheed rajaee avenues and ends at south of Tehran waste water treatment center.

By bringing this line into operation, primary estimates shows more than 11000 hectares of north western, central, and south western parts of Tehran will be under the coverage of waste water network. Discharge rate of this line at connection point to treatment center will be 4.2 m3/s, the average depth of excavation is estimated up to 7 meters.

In different sections of this network, various types of pipes have been used, from concrete pipe with exposit coating to polyethylene pipes of various size from 1200 to 2000 mm diameters. In Velanjak and Mahmoudeyah areas, pipes from 600 to 800 mm diameters have been utilized. Polyoratan was selected as main internal coating agent after necessary tests were conducted. A fine example of above mention approaches was the problem which surfaced at junction point of west waste water line with an old Qanat in front of National Radio and Television center.

A large volume of water seep through excavation site, with innovative solutions proposed by project executives, an internal shell case was constructed for the Qanat and implementation of project was successfully continued. Long junction has to be put in place and the whole project has to be done at night. Once the work permit was issued, several workshops were simultaneously brought in operation and each workshop was held responsible for one section of the whole job.The whole project was well organized and we were able to finish the job within the specific time Frame. Since this main wastewater line is completed, it has enable us to connect auxiliary constructed network in various northern areas like Velenjack, MahMoudeyah, Zafaraneyeh, Western and eastern shoulders of Vali-asr ave and in Central area like Fatemi square,Hejab Ave, Wayside Abourayhan ave and in southern area like Kargar, Shoushe, Shaheed Rajaee avenues. Another example of innovative approach to solve problems was at junction point of shaheed Gomnam and Golhal square which we confronted, traffic police only allow the crew to work between 11 P.M. to 5 A.M. That shows in Figure 1;

Figure 1: South of Tehran wastewater treatment plant

Due to heavy traffic in that area 320 meters. While during construction phase of this line, difficult jack piping method was utilized, but because of proper planning, the project did continued. In some areas we were faced with heavy traffic and round the clock BRT bus system and also in some area we were faced with fine sand slid. For advanced countries, the monitoring of sludge before its application on land is a routine compulsory practice. South of Tehran plant is located in Rey place in the south of Tehran city, and has an average inflow of 388 m^3 h-1. There are four tanks for aeration of wastewater and three tanks for clarification, which establish the activated sludge units of this Plant. The waste sludge of these units is directed to 10 drying beds. The sludge retention at these beds is 2 to 3 months in summers and 3 to 5 months in winters, and there is no another sludge stabilization process in south of Tehran Plant. After drying, the sludge is kept at depot and before final disposal is mixed with soil. Finally, it is applied on agricultural lands of Rey region. According to USEPA - 40 CFR 503 standards, the sludge should be examined for the following criteria: Pathogen Reduction, Vector Attraction Reduction, and Pollutant Limits. Qualitative analysis of the sludge before its land application is a very important task that should be fulfilled by comparison of results with existing standards and later selection of disposal site and evaluation of disposal parameters such as loading rate (Goldstein and Moberg, 1973). In order to treat some part of the total wastewater collected in city of Tehran, south of Tehran wastewater treatment center was designed with eight treatment units for a population of 4.5 million. The applied technology in this treatment plant is based on world’s new standards and all the specifications and standards in design, construction and operation have been guaranteed by the manufacturer. The average wastewater intake capacity for first to fourth units of this treatment facility is 450,000 m3 per day. The area needed to construct this project is 110 hectares and is located 1.5 Km in south west of Shahr-e-Rey and about 600 meters away from eastern north of Tehran refinery. This treatment center has occupied about 31 hectares of land and is enable to treat waste water produced by 2.1 million inhabitants of Tehran. The Produced back wash is guided to Varamin canal, which subsequently is transferred to Dasht-e-Varameen irrigation network and is utilized to irrigate about 50,000 hectares of agricultural land In addition the produced sludge is being used as a fertilizer for 600 hectares of agricultural land. Some of the special features of this project which makes it distinct from other similar projects are as follow:

- Biological removal system of azote by trickling filters and selectors
- Power generators which use bio-gas has been utilized, they generate 40GIGAWATT/HRS electricity a year, which results in almost 2 million U.S dollars of saving in electricity costs.

- Proper treatment process has been selected in such way that saves an enormous amount of electricity costs. The maximum amount of power needed for waste water treatment center is about 5300 KW. This amount is almost 30% less, in comparison with similar projects.
- Odor control system has been utilized in such way that odor is controlled in all units that have the possibility of having stench odor.
- Noise control system for all units which have noises above standard level
- Anti-corrosion steel instead of galvanized steel have been used for all metal parts that are in constant touch with water (Hadi *et al.,* 2011; Hadi *et al.*, 2011).

MATERIALS AND METHODS

This study has been collected from the keywords of in topic search: wastewater, treatment, plant and environment of ISI and national guideline database. The city of Tehran is located on an alluvial plain. The alluvium is composed of sand, ballast, and clay, with high permeability in the northern areas of Tehran, due to the concentration of sand and ballast, and poor permeability in the south, due to clay content. The water table north and south of the city is at a depth of approximately 70 m and 3 to 4 m, respectively. Because of the huge costs involved in a rapidly expanding city, the development of the sewer system did not keep pace with the construction of buildings and highways. The city lacks municipal sewage facilities; hence, the only method of sewage disposal for domestic waste is through seepage pits and leaching cesspools. There is a potential for waste from these leaching cesspools to leach into the underlying aquifer. The extensive use of cesspools in Tehran has caused the water table to rise. The seepage pits within the city limit is about 20 m. The level, however, varies from the north to the south. Southern seepage pits and leaching cesspools are more likely to break through to the aquifer because of the shallow water table and because of saturated soil conditions during periods of heavy rainfall. In the south, where soil content is high in clay, the water table is close to the surface. In these areas, a network of Pumping wells and a proper collection system have been built to transport and dispose of the pumped groundwater to keep adequate distance between the seepage pits and the water table. In some areas, these facilities have resulted in differential soil settlement, causing additional structural and environmental damage (Sadatipour, 2004). Sixty to seventy percent of Tehran's water ultimately penetrates the ground because of the lack of a sewage system. Consequently, the water table is rising rapidly throughout the city; the average rate is approximately 1 to 2 meters per year, but in some areas the water levels have risen 10 meters in only four years.

Contamination from rising groundwater and wastewater intrusion are significant factors potentially limiting groundwater use. The direction of groundwater flow is basically toward the south and southeast, with a mean velocity of approximately 0.2 m/day. A sewage collection and treatment system has been planned and designed in two stages.

The first phase, which is expected to be completed by the year 2015, will cover 15,000 hectares of the city, consisting of 10,000 hectares in the south and about 5,000 in the north, and serving about 2 million people. The second phase of the project will cover the remaining part of the city and has an unknown completion date. The project calls for two treatment plants to be located in the south and west sections of the city. Effluent from these plants will be used for irrigation while the sludge from the treatment works will be used as fertilizer (Smith *et al.,* 1989; Wei-sheng *et al.,* 2000).

RESULTS AND DISCUSSION

Results

The average values determined for results of qualitative analyses of disposed sludge in comparison with USEPA - 40 CFR 503 standards are given in Table 1. As none of the Vector Attraction Reduction conditions is respected at south of Tehran Plant, so the sludge produced cannot be examined in this regard. Nevertheless, this sludge should be observed for the required criteria of Vector Attraction Reduction before it could be applied on lands.

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

Characteristics	Unit	Mean values	Recommended values (Standard 40-CFR 503)
pH	-	7.3	
Total Solids	%	67.1	
Total Volatile Solids	% TS (a)	49.2	
Total Kjeldahl Nitrogen	% TS	1.71	
Total Phosphorus	% TS (b)	0.9	
Total Coliform	MPN/1gr ds	22,500,000	Class A: < 1000
Fecal Coliform	MPN/1gr ds	2,196,531	Class B: <2,000,000
Helminth Eggs	N / 4gr TS (c)	-	
Heavy Metals | Cd		0.15	82
Cr		120.5	3000
Cu		1392.6	4300
Ni	mg / kg DS (d)	312.4	420
Pb		271.3	480
Zn		491.8	-

(a) Percent of Total Solids (c) Number per 4 gram of Total Solids
(b) Most Probable Number per 1 gram of dry solids (d) Milligram per kilogram of dry solids

Discussion

The following conclusions are developed for disposed sludge of south of Tehran samples after comparison with standard 40CFR 503: Pathogen reduction in comparison with standard. The sludge having the Pathogen Reduction Standards of class A and B is suitable for applying on agricultural lands and soil amendment. Time restrictions are placed on harvesting crops, grazing of animals, and public access to site on which class B sludge is applied (Smith *et al.,* 1989). These restrictions are recommended in order to be sure for enough reduction of resistant pathogens and helminthes egg (Wei-sheng *et al.*, 2000). According to standard class A Pathogen Reduction, less than 1000 fecal coliforms per gram of total solids or less than 3 Salmonella per 4 grams of total solids of the sludge has been recommended.

But the geometric average values of fecal coliforms of south of Tehran disposed sludge are much more than this limit, so standard class A can not be met. Besides, there would be no need to inspect the other part of this standard related to associate alternatives. The class A treatment alternatives include treating the sludge for a specified time and temperature combination, heat-enhanced alkaline stabilization, treatments by Process to Further Reduction Pathogen (PFRP), and use of processes that are proven to reduce virus plaque-forming units and helminthes ova to less than 1 per 4 grams of sludge (Smith *et al.*, 1989). PFRPs include composting, heat treatment, thermophilic aerobic digestion, beta-ray irradiation, and pasteurization, which none of them is applied on south of Tehran Plant. According to class B standard of Pathogen Reduction, the geometric mean value of fecal coliforms for at least 7 samples has been recommended to be less than 2 million per gram of sludge solids, or there would be need to treat the sludge by Process to Significantly Reduce Pathogens (PSRP) or similar processes.

The PSRPs include aerobic digestion, air drying, anaerobic digestion, composting, and lime stabilization (Smith *et al.,* 1989). But for Rey disposed sludge this geometric mean value is slightly more so it is not expected that class B standard would be regarded. If the sludge drying which itself is a PSRP process could be proceed perfectly, the class B standard would be attained because the insignificant difference will become diminished. According to USEPA, the sludge drying in air could be considered as one of the PSRP processes if the minimum retention time of 3 months for drying is regarded and the average value of daily temperature in this period is not dropped below zero.

Vector attraction reduction in comparison with standard. In order to dispose bio-solids (class A and class B) which complying with standard 40CFR 503, one of the twelve alternatives for Vector Attraction Reduction must be met (Zanoni and Rutkowski, 1972). As none of the conditions required for Vector Attraction Reduction is respected at south of Tehran

Treatment Plant, so the sludge cannot be examined in this regard. The disposed sludge should be applied on lands only after observing the requirements (conditions 9 to 11), which are related to application methods (Zanoni and Rutkowski, 1972). Comparison with pollutant limits standard to be land applied, bulk sewage sludge must meet the pollutant Ceiling Concentration Limits and Cumulative Pollutant Loading Rate for determining the application rates. Application rate for bulk sewage sludge applied to lawn and home gardens is Pollutant Concentration Limits based on average value in month, and for sewage sludge sold or given away in bags it must meet the Pollutant Concentration Limits or the Annual Pollutant Loading Rates (Smith *et al.,* 1989).

Design sludge loading rates for application to agricultural or to non-agricultural lands will be controlled by the pollutant limits or by the nutrient loading rates (nitrogen and phosphorous limits) necessary to meet vegetation requirements (Goldstein and Moberg, 1973). As it is presented in table 1, the heavy metals concentrations of disposed sludge are less than the Ceiling concentration of 40 CFR 503 standard. The metal concentrations and nutrient contents of the sludge disposed from drying beds of this Plant are used in determining the loading rate of the sludge for land application.

Conclusion

The output Debbie of this treatment plant is 450 thousand cubic meters per day that continuity of this large volume during the year provided confidential water resource for farmers of this district. in addition to agricultural usage of the wastewater it is used for injection into aquifers in order to compensate the declining the underground water resources in Varamin and Rey plain.

Nevertheless to online monitoring system, an equipped laboratory is located in this treatment plant which is controlling constantly the effluent indexes. Also we concluded to have communication with environmental protection organization to provide the possibility of online monitoring by Tehran province water and wastewater organization.

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