Investigation of Sahebgharanieh Wastewater Treatment Plan Operation in Tehran and Appropriate Method's for it's Upgrading

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ABSTRACT

This research, in addition to survey the existing data on the quality of Sahebgharanieh wastewater treatment plant's effluent in the previous years, by runing a three months monitoring stage, studies the conditions of the final settling and aeration basin and the variations of the influent and effluent quantity and quality in removing of major pollutants (BOD, COD, TSS), while scrutinizing the primary criteria for designing this WWTP, so that by this means; the difficulties and defects that plant is faced with will be recognized, and finally by finding the roots of these problems; appropriate methods shall be presented for upgrading and optimizing wastewater plant's operations. The outcomes of this research show that this WWTP faces enhanced hydraulic lodas, which especially at peak currents; disturbs the sludge blanket and leads to the carry-over of biological solids in to the effluent. In addition the plant lacks of wastewater disinfection facilities and numerous operational problems such as additional sludge recycling to the system, shortage of dissolved oxygen and mixing in the aeration basins. Discharging of solid loads resulting from constructional operations and the fuel leftovers in the network, is one of the other difficulties that the wastewater plant has.

INTRODUCTION

In recent years, the destructive impacts of mankind activities on earth, have been intensified more than ever. In line with the Intensification of wastewater discharges in the environment, environmental regulations have also been expanded, and have become stricter than before. In trying to comply with these regulations; engineering sciences in regard to the living environment have been developed and novel technologies have been provided. Wastewater treatment, is an important branch of environment health science, which benefits from the fundamental principles and engineering principles, in water pollution issues. One of these principles, is compliance with the standards, accepted in regard to the discharging of Wastewaters form Wastewater treatment plants (13). Meanwhile, the effluent and efficiency of a WWTP for provision of allowed standards for evacuation of wastewater has become highly important, due to intensification of water and soil sources pollution. This issue, has become further acute, especially in the inappropriate operation of the wastewater plants, and/or initial poor design of it. In these regards, the upgrading technics; is on of the appropriate options in solving these problems of concern in wastewater treatment plants.

With the execution of upgrading operations, the authorities tried to eradicate the initial design's defects and to treat the wastewater with further precision. Meanwhile, one can take action, in order to enhance the hydraulic and the organic capacity of the WWTP (19). The major methods, which are applied for upgrading a wastewater plant, cover and expanded scope, in such a manner that any modification which would lead to the optimization of operations and the quality of effluent, would be considered as upgrading operations, such as convertion of different biological modifications to one another, enhancing dissolved air floatation (DAF) unit; optimization of the relationship between settling and aeration basins; application of activated carbon powder (PACT system) (1) and pure oxygen (3); application of chemical agents in biological treatment (5), process reformation for effective removal of phosphorous and nitrogen (10), UV disinfection (9), application of biological selectors (17), application of fluidized bed of activated sludge (16), resumption of energy gained form sludge stabilization (4), application of ceramic and plastic diffusers (15), application of water hyacinth in stabilization lagoon (11), flow equilization (8), optimization of energy consumption in the wastewater plant; changes and correction of the operational pattern and even, application of new managements methods (12), are all considered as upgrading methods. Additionally, new methods such as clarifier analysis by stress testing and hydraulic analysis, and analysis of reactor complete mixing by tracer testing, have been innovated for analyses of activated sludge systems operation; which in addition to their speedy recognition of difficulties, enhance the precision of study and the assessments (2).

MATERIALS AND METHODS

This research was experimental and application type and has been executed in a full scale wastewater treatment plant. Therefore, the research methodology and it's outcomes after the essential modifications, could be applicable for similar wastewater treatment plants. In general, the methodology of this research included:

1. Studying statistical figures of the past two years of the wastewater plant major pollutants (BOD, COD, TSS) in effluents;
2. Monitoring of WWTP, Sampling and taking the essential tests for 3 months;
3. Determination of the wastewater plant's existing position by application of data from the monitoring stage, and their comparison to the previous figures;
4. Determination of initial criteria for designing the wastewater treatment plant, preparation of maps, and details;
5. Recognition, and root finding of major difficulties of the system, due to the outcomes of monitoring stage;
6. Presentation of solutions and appropriate methods for solving the problems, and upgrading the WWTP;
7. Seeking of potential opportunities for execution of upgrading methods, due to financial and timing related restrictions.

Sampling

Each week, two sets of samples, each including three samples (one sample of the influent, one sample of the effluent, and one sample of the aeration basin's sludge) were obtained. In each sampling, in addition to taking the samples; activities such as measuring temperature of the influent, effluent, air, and sludge temperature were considered in order to identify the rate of modifications. In addition, the momental and total inlet debi were measured in the past 24 hours by using of flow measuring tool, and the settlable solids of sludge, by the application of a calibrated cylinder. Composite samplings were also taken every hour from the influent and effluent, from 6 a.m. untill 8 p.m. Also, composite sampling were used once again after selecting the upgrading methods for designing equalization basin. In the monitoring stage, the following fundamental parameters were studied: COD, BOD_5, TSS, MLSS, MCRT, RAS-SS, DO, HDT (hydraulic detention time), VLR (volumetric loading), F/M, SVI, and MLVSS. Sampling and conditioning of samples were based on WEF guidlines (20) and laboratory methodologies, based upon standard bookish methods, for water and wastewater experiments (18), and computation methods were based upon reference books on wastewater treatment (13,14,21).

RESULTS

Summaries of the results are shown in Table1 and Fig. 1 to 6.Fig.1, shows that the efficiency of BOD removal, completely influenced by the inlet flow, declines in the peak flow rate. Fig.2, shows the relation between concentration changes of pollutants and the inlet flow, and the peakconcen- tration of pollutants' materialization, is approved, just a while after the presence of peak flow rate. Fig.3, shows the increase of pollutants concentration, following the entry of the peak flow to the WWTP; due to direct sludge carry-over. Fig. 4, shows the total and soluble COD variation in the effluent, which manifests the volume of waste sludge tank, and periodof it's discharging; the daily removed volume of sludge was estimated as nearly 0.8 m^3/day, differs significantly with the intial criterion of 1.5 m^3/day. Variations of sludge's age in the plant faced numerous problems, because of the direct sludge carry-over of the system, at peak flow rates. Irrespective of this issue, the average of sludge age in the plant was estimated to be nearly 100 days; which differed significantly with the primary criterion being 30 days, and again, manifests insufficient removal of the waste sludge and the additional recycling of solids. In accordance to the maximum and minimum established inlet flow rates (560 m3/day & 495 m^3/day), the maximum and minimum aeration period, with regard to the 500 m^3 volume of the aeration basins, was computed, as being 21 and 24 hours; which was in line with the optimized values for extended aeration modification. In regard to above-stated issues, problems and defects of the Sahebgharanieh WWTP were classified and summarized as follows: 1-Excess hydraulic loading to the aeration and final settling basins, specially at peak flow rate. 2- Non-execution of wastewater disinfection process. 3- Shortage of dissolved oxygen and incomplete mixing in the aeration basin. 4- Insufficient and infudamental removal of waste sludge. 5-Direct carry-over of biological solids and sludge scaping from the final settling basins. 6- High concentration of inert solids in theaeration basins due to the additional sludge recycling. 7- Non-existence of an appropriateoperational pattern and lack of attending upon teaching of the operators. 8- Absence of

the sampling period and the initial design flow rate. In fact, the plant is faced with hydraulic overloading. Fig. 6, shows the concentration of BOD5 of the effluent through the years 1997, 98, and 1st half of 1999. The increasing slope of BOD, manifests the declining quality of the effluent. Table 1 shows the outcomes of the research upon basic parameters and initial criteria for designing the WWTP. Comparison of the average of parameters with the primary design, manifests the inappropriate existing operation of the WWTP.

DISCUSSION

In accordance to the outcomes of the survey, it was observed that the efficiency of the WWTP in removal of the major pollutants, seemed appropriate except in cases, which the plant faced excess hydraulic loading. Although, plant was faced with a normal incoming and average concentration of organics, concentration of COD and BOD, in the effluent, highly influctuated, but the soluble concentration of these pollutants, was slightly variable. This issue meant that the reason behind this problem, was due to suspended form. These fluctuations created when the WWTP faced intensified excess loading. In simple words the hydraulic overloading leads to the distortion of the sludge blanket and had caused the sludge carry-over from the final seetling basins. Changes of DO, manifested the shortage of it in the aeration basins. In addition, DO distribution through all the basins sections were not equal, since the aeration reactor, does not possess complete mixing. The average influent flow was 524 m^3/day, which in regard to the initial designing criterion (being 480 m^3/day) clearly showed the increasing hydraulic load. In addition, due to the low population of the covered region, the variation of inlet flow was also high. Due to

Recommendations (Upgrading Technics)

Due to the existing problems, the following upgrading methods are suggested for the wastewater treatment plant: Equalization of the influent flow, disinfection of the effluent flow, increasing the number or efficiency of blowers, replacement of failed deffusers, setting of an appropriate operational pattern, replacement of the fine bar screen (No:2) between the coarse screen and parshall flume, construction of a laboratory and registration of data. Computation of needed reservoir's volume for equalization, is basedupon the drawing method and cumulative volume flow chart. The requirement volume is evaluated as 70 m^3, which is considered as nearly 80 m^3, with regard to an additional 10%, for flow variations. In order to lower the costs, non-applicable liquid chlorine reservoir can be used, which should be developed for equalization. The inlet flow to the equalization basin upon the weighing, and the outlet flow is by 2 submercible pumps with 22 m^3/hr pumping rate. Due to the harmful impacts of the remaining chlorine in the wastewater upon the receiving waters; applying UV radiation in wastewater disinfection, has become more popular. Erection and commissioning of a UV disinfection unit with a submercible lamp, was made by a domestic company, which manifested a decline of 99.9% , both in the fecal coliforms and hetrotrophic bacterias. By adding the 2nd bar screen to the opening of the inlet raw wastewater channel, between the 1st bar screen and parshall flume, which leads to the storage of the flow behind the final settling basins, shall be eradicated. Fig. 7-A shows schematic diagram of the wastewater treatment plant, prior to upgrading and Fig. 7-B, after upgrading.

Fig 1. **Efficiency of BOD_5 removal versus influent flow within sampling period**

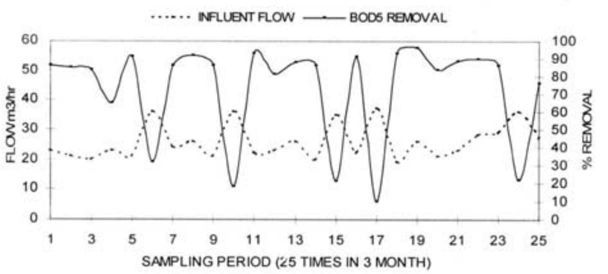


Fig. 2. **Variation of TSS, COD and Flow in influent within sampling hours**

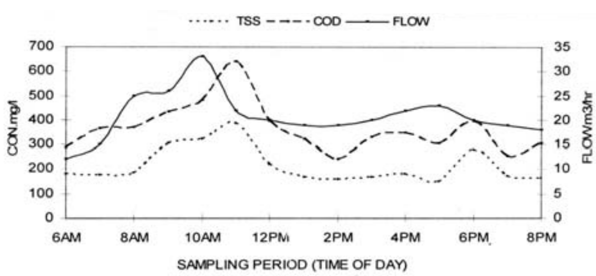
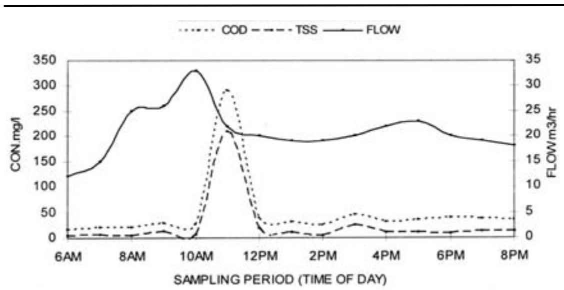
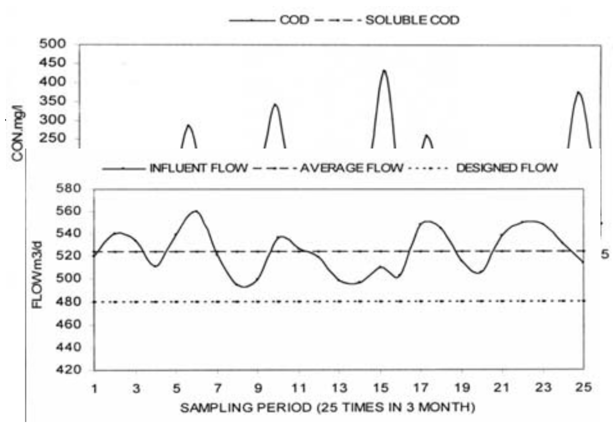


Fig. 3. **Variation of COD, TSS & Flow in effluent within sampling hours**





ig. 6. **Variation of BOD_5 in effluent within 1997(1376), 998(1377) and 1st half of 1999(1378)**

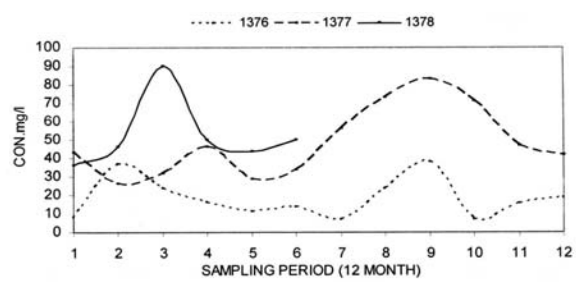


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Fig. 4. **Variation of COD and Soluble COD in effluent Within sampling period**

Table 1. **Variations of the basic parameters of the WWTP in the monitoring and sampling period**

arameters	**Unit**	**Max**	**Min**	**Ave**	**SD**	**Criterion initial**	**Typical Value***
BOD_5 removal	%	96	10	73.2	27.7	80-85	75-95
COD removal	%	95	9	72.6	29.5	----	----
TSS removal	%	96	14	75.2	26.4	----	----
Influent BOD_5	mg/l	271	100	173.4	51.7	160-170	----
Influent COD	mg/l	495	220	349	88	----	----
Influent TSS	mg/l	399	83	210	81.7	----	----
Effluent total BOD_5	mg/l	210	10	47.3	59	30	----
Effluent soluble BOD_5	mg/l	32	10	18.4	5.2	20	----
Effluent total COD	mg/l	430	19	101	125	50-60	----
Effluent soluble COD	mg/l	49	18	32.3	8.4	----	----
Effluent TSS	mg/l	230	11	55.8	74.3	30	----
DO (max) Aeration tank	mg/l	0.81	0.55	0.68	0.076	----	2
DO (min) Aeration tank	mg/l	0.6	0.26	0.38	0.075	----	1
SVI index	---	127	88.6	109	10.2	----	150>
F/M ratio	1/d	0.13	0.04	0.073	0.026	0.13-0.15	0.05-0.015
Volumetric Loading	$kg/m^3/d$	0.28	0.1	0.18	0.06	0.16	0.4-0.16+
MLSS Concentration	mg/l	5950	3890	4692	532.8	2000	2500-6500
MLVSS/MLSS ratio	---	0.6	0.47	0.51	0.027	0.8	0.8
Return Sludge SS	mg/l	7605	6120	7041	457	7000	----
Daily Influent Flow	m^3/d	560	495	524	19.2	480	----
Momental Influent Flow	m^3/hr	38	12	21.87	8.5	----	----
Sludge Age	d	---	---	100	---	30	20-30
Return Sludge Percent	%	---	---	110	---	30-35	25-150‡
Aeration Time	hr	24	21	---	---	25-26	18-36

+ In some references, it's stated as 4000 up to 10000 mg/l (6);
‡ Adapted by the references No. 20

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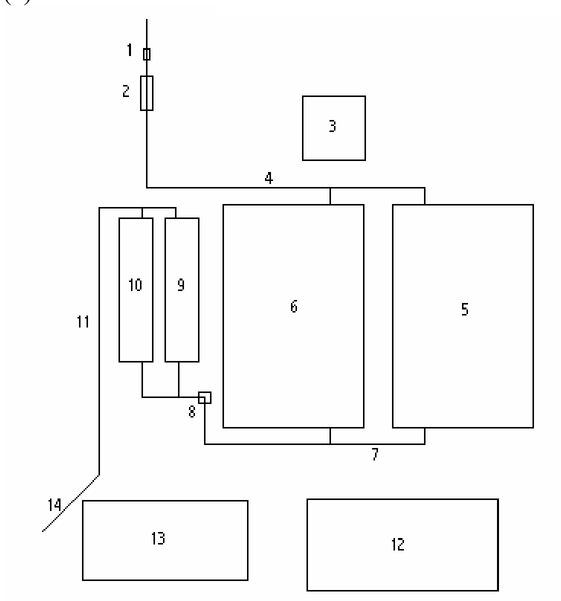
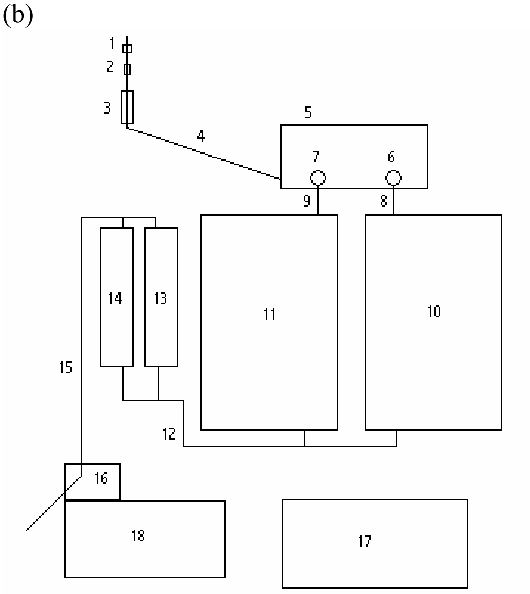
Fig. 7. **Schematic diagram of the Sahebgharanieh WWTP (a:before upgrading, b: after upgrading)**

(a)



1. Coarse bar screen
2. Pars hall flume
3. Liquid chlorine tank
4. Raw sewerage influent
5. Aeration basin 1
6. Aeration basin 2
7. Mixed liquor line
8. Fine bar screen
9. Secondary settling 1
10. Secondary settling 2
11. Treated effluent channel
12. Blowers room 1
13. Blowers room 2
14. final effluent

(b)



1.Coarse bar screen
2. Fine bar screen
3. Parshall flume
4. Raw sewerage open channel
5.Equalizationbasin
6,7. Submercible pumps
8,9. Pipeline to aeration basins
10,11. Aeration basins
12. Mixed liquid open channel
13,14. Final settling basins
15. Treated effluent channel
16. UV disinfection unit
17,18. Blowers rooms

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