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RESEARCH ARTICLE

PERFORMANCE EVALUATION OF MBR TECHNOLOGY WASTEWATER TREATMENT PLANT AT SOHAR PORT-A CASE STUDY.

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Abstract

The wastewater generated from the household is nearly 80% of their intake. Most of the wastewater treatment plants were using activated sludge process to treat sewage. The treatment efficiency of activated sludge process is less than 90%. The latest technologies in the wastewater treatment are sequencing batch reactor and membrane bioreactor. The problem of membrane bioreactor technology is fouling. Due to fouling the flux of the filtration is decreasing. The aim of this project is to evaluate the treatment efficiency of MBR technology. The influent and effluent samples were collected from the Sohar Port were collected and analyzed as per the standard methods for the examination of water and wastewater. The treatment efficiency was calculated. The mean BOD removal efficiency was 97.6%. The mean COD removal efficiency was 96.5%.

Introduction:-

Study area:-

The Sohar is a port city of Sultanate of Oman. The GPS coordinates for Sohar are latitude 24.3461° N and longitude 56.7075° E. The Sohar is a free economic zone with good number of industries. The population of Sohar is 2.2 million. The average consumption of water is 350 liters per day. The wastewater generated is nearly 80% of water consumption. The wastewater generated is 280 L/per capita/day. The total wastewater generated per day is 2.2 $x10^6$ x 280= 616,000 m^3. The study area was shown in fig 1.

Fig 1:-Study Area Sohar Port City

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The conventional activated sludge process (CASP) treatment consists of primary, secondary and tertiary treatment.The primary treatment consists of screens, grit chamber and primary clarifier. Nearly 30 to 35% of BOD load reduced in the primary treatment. The secondary treatment consists of an anoxic tank, aeration tank and secondary clarifier. The efficiency of secondary treatment is nearly 60%.The overall treatment efficiency of CASP is 90%. Activated Sludge process has different problems like growth of filamentous bacteria and foaming. However it can be controlled by adding poly aluminum chloride coagulant (Pal.P 2014).The tertiary treatment deals with filtration and disinfection. The nature, composition and the biodegradability of organic matter plays an important role in the wastewater treatment (Ahansazan.B 2014). The conventional activated sludge process cannot be used for certain wastewaters. The leachate from landfill contains heavy metals and other dissolved organic matters. The MBR technology can be used to treat the leachate from the landfill (Ester Coppini).By using the MBR technology the treatment efficiency is increased by more than 96%. The bottle neck of MBR technology is fouling (Oliver Terna Iorhemen, 2016). The increased suction on the membranes is causing fouling (Shim J, 2002). The CASP have many problems like removal of nitrogen, phosphorous and low sludge settleability (Andrade, 2013). The conventional wastewater treatment technologies which have like coagulation, sedimentation, aeration, clarification and chlorination have high operating cost (Jayashree 2012). The MBR technology revolutionized the wastewater treatment. (Naghizadeh.2011).

Methodology:-

The MBR process flow diagram is as shown in Fig 1.Six numbers of each influent and effluent samples were collected from the Sohar STP and analyzed for pH, conductivity, COD, BOD, SS, DS and TS.

Estimation of pH:-

The pH meter calibrated by using pH 7.0 and 9.2 buffer solutions. After calibration the influent and effluent samples were analyzed for pH values.

Estimation of conductivity:-

The conductivity values were estimated with conductivity meter with cell constant 1. The values were expressed in mS/cm.

Estimation of BOD:-

The initial dissolved oxygen (D.O) values of influent and effluent samples were measured by using the Dissolved Oxygen meter. The samples were diluted and kept in an incubator at 20^0C for five days. The D.O values were measured after 5 days.

BOD mg/l = $(D.0_1 – D.0_5)$ x Dilution Factor.

Estimation of COD:-

The COD is estimated with COD photometer by using COD veils of 0-1500 mg/l range.

Two milliliters of wastewater sample transferred quantitatively into the COD veil. One blank along with 6 samples were heated at 150^0C for 2 hours. The COD veils were cooled to room temperature. The blank COD veil was inserted in the photometer and the photometer reading adjusted to zero. The samples were inserted into the photometer and milligrams COD values were noted.

Calculation:-

COD mg/l = milligrams COD x 1000/ sample volume (2ml)

Estimation of Suspended Solids:

The wastewater 100 ml sample filtered through a Whatman No 40 filter paper. The filter paper was dried at 1050C and cooled in a desiccator.

Calculation:-

SS mg/l = [(residue on filter paper) –(tare mass of filter paper)] x 1000/ volume of sample (100ml).

Estimation of Total Dissolved Solids

The wastewater 50 ml sample is filtered through a Whatman No 42 filter paper. The 50 ml filtrate transferred quantitatively in to a previously dried and weighed evaporating dish. The dish was kept on a water bath. The filtrate was evaporated to dryness.

Calculation:-
TDS mg/l = (Mass of dish plus residue grams– mass of dish grams) x 10^6 / sample volume (50 ml)
Estimation of Total Solids
The unfiltered wastewater 50 ml sample evaporated to dryness on a water bath.

Calculation:-
TS mg/l = (Mass of dish plus residue grams– mass of dish grams) x 10^6 / sample volume (50 ml)
TDS can also be calculated as given below.
TDS = Total solids – Suspended solids.

The Process:-
The influent is passed through the screens to separate all suspended materials like paper, plastic. The influent is passed through equalization tank, anoxic tank and aeration tank. The aeration tank outlet is passed into the MBR compartment. The effluent is collected by creating suction in the MBR compartment. The effluent is disinfected by chlorination or zonation or UV sterilization.(Metcalf & Eddy). The process flow diagram was shown in fig 2.

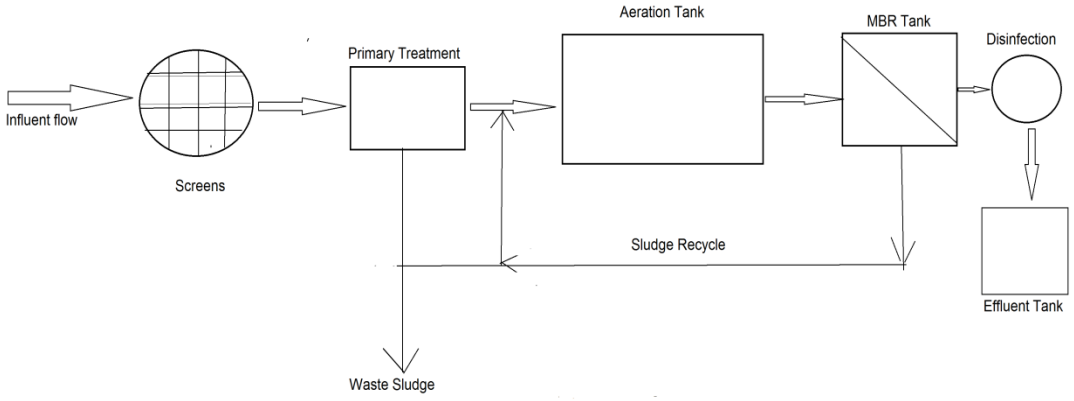

Fig 2 Process flow diagram of MBR technology

Results:-

The Influent samples analysis:-
The influent samples pH values varied from 6.89 to 7.1.The sample 2 has the lowest pH 6.89 and the sample 4 has the highest pH 7.1.The conductivity values varied from 6.44 mS/cm to 8.4 mS/cm. The sample 4 has the lowest value 6.44 mS/cm and the sample 1 has the highest value 8.4 mS/cm. The BOD values varied from 250 mg/l to 340 mg/l. The sample 5 has the lowest BOD value 250 mg/l and the sample 2 has the highest BOD value 340 mg/l. The COD values varied from 484 mg/l to 710 mg/l. The sample 1 has the lowest COD value 484 mg/l and the sample 4 has the highest value 710 mg/l. The suspended solids varied from 129 mg/l to 498 mg/l. The sample 3 has the lowest value 129 mg/l and sample 1 has the highest value 498 mg/l. The total dissolved solids values varied from 910 mg/l to 998 mg/l. the sample 3 has the lowest value 910 mg/l and the sample 2 has the highest value 998 mg/l. The total solids varied from 1039 mg/l to 1432 mg/l. The sample 3 has the lowest value 1039 mg/l and the sample 1 has the highest value 1432 mg/l. The analysis of influent samples shown in Table 1.

Table 1:-Analysis of influent samples

Parameter	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Sample-6
pH	6.95	6.89	6.98	7.1	6.92	6.99
Conductivity mS/cm	8.4	7.18	7.12	6.44	6.88	7.10
BOD mg/l	337	340	270	290	250	310
COD mg/l	484	490	560	710	650	490
S.S mg/l	498	289	129	309	204	180
T.D.S mg/l	934	998	910	920	924	926
T.S mg/l	1432	1287	1039	1192	1064	1092

The effluent samples analysis:-

The effluent samples pH values varied from 7.42 to 7.51.The sample 1 has the lowest pH 7.42 and the sample 4 has the highest pH 7.51.The conductivity values varied from 1.5 mS/cm to 1.8 mS/cm. The sample 4 has the lowest value 1.5 mS/cm and the sample 1 has the highest value 1.8 mS/cm. The BOD values varied from 4 mg/l to 10 mg/l. The sample 5 has the lowest BOD value 4 mg/l and the sample 1 has the highest BOD value 10 mg/l. The COD values varied from 18 mg/l to 20 mg/l. The samples 2 and 4 have the lowest COD value 18 mg/l and the samples 3 and 5 have the highest value 20 mg/l. The suspended solids varied from 6 mg/l to 9 mg/l. The samples 4 and 6 have the lowest value 6 mg/l and sample 3 has the highest value 9 mg/l. The total dissolved solids values varied from 860 mg/l to 912 mg/l. the sample 5 has the lowest value 860 mg/l and the sample 6 has the highest value 912 mg/l. The total solids varied from 891 mg/l to 944 mg/l. The sample 3 has the lowest value 891 mg/l and the samples 5 and sample 6 have the highest value 944 mg/l. The analysis of effluent samples shown in Table 2.

Table 2:-Analysis of effluent samples

Parameter	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Sample-6
pH	7.42	7.44	7.45	7.51	7.49	7.43
Conductivity mS/cm	1.8	1.6	1.6	1.5	1.6	1.7
BOD mg/l	10	4	6	6	4	6
COD mg/l	19	18	20	18	20	19
S.S mg/l	8	7	9	6	8	6
T.D.S mg/l	900	890	870	882	860	912
T.S mg/l	920	919	891	938	944	944

The Treatment Efficiency: Treatment Efficiency calculation:

Treatment efficiency % = $C_i - C_e / C_i \times 100$

Where Ci = Parameter influent concentration mg/l

C_e = Parameter effluent concentration mg/l

The BOD reduction efficiency varied from 97% to 98.8%. The sample 1 has the lowest value 97% and the sample 2 has the highest value 98.8%. The COD reduction efficiency varied from 96% to 97.4%. The sample 1 has the lowest value 96% and the sample 4 has the highest value 97.4%. The Nizwa new STP BOD and COD removal efficiency was 97 % and 94% respectively.(Satyanarayana 2015). The treatment efficiency values were shown in Table 3 and Fig 1.

Table 3:-Treatment Efficiency

Parameter	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Sample-6
BOD -%	97	98.8	97.7	97.9	98.4	98
COD - %	96	96.3	96.4	97.4	96.9	96.1

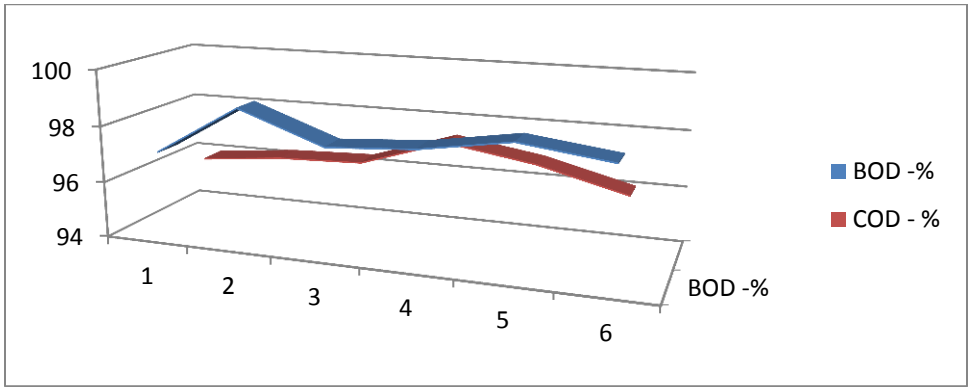

Fig1:-Treatment efficiency values.

Conclusions:-

The average BOD reduction efficiency was 97.97% and the COD reduction efficiency was 96.51%. The pH, BOD, COD and Suspended solids were within the prescribed standards. The conductivity and total dissolved solids values were below the prescribed water standards for agriculture use. The treated effluent can be used for agriculture purpose.

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