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Efficiency assessment of effluent treatment plant (ETP) treating an automobile industry effluent (Sidcul) Haridwar

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Abstract

Water is an integral part of life on this planet but nowadays this precious thing is continuously getting polluted due to different activities. Industrial sector is one and most polluting agent among all of them. The effluents generated from the automobile industries, creates an environmental hazard near the disposal site and in its vicinity. Workers are exposed to occupational and other health hazards when they are exposed to the air and drinking water, which may get polluted due to spraying of the paints. Mostly alkyd paint is used for painting process. A large amount of water is used and polluted during such industrial processes. Wastewater of the automobile industries not only contains high levels of suspended and total solids such as oil and grease and colouring, at various stages of manufacturing but also, a significant amount of dissolved organics, resulting in high BOD or COD loads. The study reveals the performance evaluation of effluent treatment plant and its treatability. During the present study the samples were collected from each site at an interval of 10 days from an automobile industry located in IIE, SIDCUL Haridwar. The collected samples were analysed for Temperature, Total solid, Total dissolved solids, Total suspended solids, pH, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand and oil & grease. During the present study oil & grease in untreated effluent ranged from 19mg/l to 28mg/l and in treated effluent from 1.9mg/l to 4.1mg/l. Chemical oxygen demand in untreated effluent ranged from 2300mg/l to 2700mg/l and in treated effluent from 38mg/l to 57mg/l. pH in untreated effluent ranged from 7.1 to 8.3 and in treated effluent from 6.7 to 8.3. The results revealed that the performance of effluent treatment plant of automobile industry is satisfactory.

Key Words: Automobile industry, COD, Oil & grease, Efficiency

Introduction

Water is essential to all forms of life and makes up 50-97% of the weight of all plants and animals and about 70% of human body. Water is also a vital resource for agriculture, manufacturing, transportation and many other human activities. Despite its importance, water is the most poorly managed resource in the world (Chutter,1998). The availability and quality of water always have played an important role in determining the quality of life. Water quality is closely linked to water use and to the state of economic development. Ground and surface waters can be contaminated by several sources. In urban areas, the careless disposal of industrial effluents and other wastes may contribute greatly to the poor quality of water (Mathuthu *et al.,* 1997).

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Industries produce millions of cubic meters of effluent every year and the wastewater produced may be released into the surrounding water bodies, treated on-site or at municipal treatment plants. The determination of organic matter in the wastewater generated is very important to avoid any negative effect on the aquatic ecosystem. In recent years, with the increased demand for automobiles, the auto industry has evolved rapidly in the world. This growth not only has increases the number of vehicles but also it has emitted toxic and hazardous substances to the environment (Ansari *et al.,* 2013). The automotive industry has different units such as cooling, welding, paint hall, washing, and so on. Some part of the water used in these units becomes waste after the use. The major wastewater produced in automotive industry contains contaminants such as paint, heavy metals, phosphate, suspended solids, COD, BOD, detergent, oil, and lubricant.The automobile industry's wastewater not only contains high levels of suspended and total

solids such as oil, grease, dyestuff, chromium, phosphate in washing products, and colouring, at various stages of manufacturing but also, a significant amount of dissolved organics, resulting in high BOD or COD loads.

Status of Automobile Industry

The Indian auto industry is one of the largest in the world. The industry accounts for 7.1 % of the country's Gross Domestic Product (GDP). The Two Wheelers segment with 81 percent market share is the leader of the Indian Automobile market owing to a growing middle class and a young population. India is also a prominent auto exporter and has strong export growth expectations for the near future. In April-March 2016, overall automobile exports grew by 1.91 per cent.

Material and Methods

Description of Study Area

SIDCUL is a massive industrial area 5Kms. away from Haridwar spread over 2034 Acres, developed by State Industrial Development Corporation Uttarakhand Limited (SIDCUL), a state government body. With big enterprises like Hindustan Liver Limited, Dabur, Mahindra & Mahindra, Havells, moving in SIDCUL is set to develop into another industrial township within the city 3Kms. away from the Delhi-Hardwar National Highway, SIDCUL lies adjacent to the BHEL Township. Neel Metal production Ltd is located in Integrated Industrial Estate (IIE), in plot no 4-6, 11-16 of sector 5, BHEL Haridwar. The Coordinates of the industry are $29^0 57' 46'' N\ 78^0 18'' E$**.** It is one of the fastest growing companies of JBM group with diversified product profile established 8 plant at various location It has its corporate office is in opposite Qutub Minar, Delhi. Company deals in Product such as Sheet metal stampings and machined component, welded assemblies. The capacity of effluent treatment plant (ETP) located in the industry is 65KLD while the capacity of sewage treatment plant is 25KLD but in this study we are focusing on effluent treatment plant (ETP). The water which is used for washing and cooling in different section of the plant comes for treatment in this treatment plant.

Sampling Methods

Monitoring and analysis was done to understand the performance evaluation of the ETPs. Sampling and testing has been Carried out as per the standard methods prescribed in APHA (2012) and Trivedy and Goel (1986), Khanna and Bhutiani (2007) for the examination of the water and waste water. During the present study the samples were collected from an automobile industry located in IIE, SIDCUL Haridwar.The samples were collected from each site at an interval of 10 days starting from 10 Jan 2016 to 11 June 2016. Total 16 observations were made during the course of study. 2 Liters of sample were collected from each site from the depth of 30 cm from the surface of water in the plastics Jerry cans. Jerry cans were thoroughly rinsed 5 or 6 times with the water before keeping the sample. Caps of cans were removed after dipping the can and also closed in the water after filling up of can. Care was taken to avoid bubbling and entry of leaves, twigs or debris into the sampling bottle. Temperature was analyzed on the sampling site and DO was also fixed on the sampling site. Most often, removal efficiency is expressed as percentage:

$$\% \text{ efficiency} = Ci - Ce / Ci \times 100$$

where; Ci is the concentration of the waste material in the influent and Ce is the concentration in the effluent. Percentage efficiency values are used to compare different treatment processes and to determine if a particular treatment plant is accomplishing the purpose for which it was designed (Hurst *et al.,* 1997).

For analysis of physicochemical parameter, waste water samples were collected from two sites:

Site I- Untreated effluent (ETP Inlet)

Site II- Treated Effluent (ETP Outlet)

Objectives of the study

The aims and objectives of the study are given below.

1. To assess the physical parameters viz., Temperature, Total Solids, Total Suspended Solids, Total Dissolved Solids and Oil & Grease of waste water samples collected from automobile industry Sidcul Haridwar.
2. To assess the chemical parameters like pH, DO, BOD, COD of waste water samples collected from automobile industry Sidcul Haridwar.

Plate-1: Google map showing Neel Metal production limited Sidcul, Haridwar

Results and Discussion

During the present study the samples were collected at an interval of 10 days from an automobile industry located in IIE, SIDCUL Haridwar. Results of various physico-chemical parameters observed under the present study i.e. water temperature, total dissolve solids (TDS), total solids(TS), total suspended solids (TSS), pH, dissolved oxygen (DO) , biochemical oxygen demand (BOD), chemical oxygen demand (COD) and Oil & Grease are presented in table 1 and 2 while the precentage reduction was presented in table 3 and graph 1 and 2. Water temperature affects different Physico-chemical characteristics of water and waste water. The rate of differernt biochemical reactions depends on the temperature. Atmospheric temperature affects the water and waste water temperature. During the present Study minimum temperature in the inlet was found 20^0C and maximum temperature was found 28.2^0C with an average value 22.7^0C ±2.79 (Table 1) and in outlet minimum temperature was found 17.3^0C and maximum temperature was found 21.8 ^{0}C with an average value 19.3^0C ±1.71(Table 2). In case of the temperature the percentage reduction (%Reduction) was found 14.98% (Table 3). Similar trend of temperature in waste water was obtained by Singh *et al.,* 2016 and Bhutiani *et al.*, 2015. Cooling of water depends on the retention time. The effluent cools down automatically as it passes through the diffferent phases of treatment. Total solid is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids includes total suspended solids, the portion of total solids retained by a filter, and total dissolved solids, the portion that passes through the filter. During the present Study minimum TS in the inlet was found 1979mg/l and maximum TS was found 2403mg/l with an average value 2182.8mg/l ±135.32 (Table 1) and in outlet minimum TS was found 837mg/l and maximum TS was found 995mg/l with an average value 912.1mg/l±42.12 (Table 2). In case of the TS the percentage reduction (%Reduction) was found 58.21% (Table 3). Similar trend in TS reduction was found by Chinnasamy *et al.,* 2010. Grit and Pebbles was removed by screens and in settling chambers. Microbes present in the waste water degrade and eatup the dissolved and suspended solids and thus reduced the total solids. Dissolved solids are those that pass through a filter. They include some organic materials, as well as salts, inorganic nutrients, and toxins. Total dissolved solids are mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen, calcium, sodium, potassium and iron (Kannan *et*

al., 2009). Noorjahan (2014) reported TDS value as 5758 - 6672 mg/L.The presence of high level of TSS and TDS may be due to the insoluble organic and in organic present in the effluent (Nagarajan *et al.,* 2005). During the present Study minimum TDS in the inlet was found 1375mg/l and maximum TDS was found 1763mg/l with an average value 1544.8mg/l ±127.81 (Table 1) and in outlet minimum TDS was found 758mg/l and maximum TDS was found 910mg/l with an averge value 829.1mg/l± 40.88 (Table 2) . In case of the TDS the percentage reduction (%Reduction) was found 46.33% (Table 3) . Similar results in effluent was obtained by singh *et al.,* 2016 and Ajim *et al.,* 2015. High levels of TDS are aesthetically unsatisfactory and may also produce distress in human and livestock (Patel *et al.,* 2009).

Table1- Showing variation in different physico- chemical parameters of untreated effluent

Date / Parameter	Temp ^{0}C.	TS (mg/l)	TDS (mg/l)	TSS (mg/l)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Oil &Grease (mg/l)
10.1.16	20	2195	1695	500	7.1	2.4	205	2500	23
20.1.16	20.5	2393	1763	630	7.89	2.1	210	2600	28
30.1.16	20.5	2403	1703	700	7.56	2.3	200	2670	25
10.2.16	20.8	2305	1655	650	8.32	1.8	212	2300	21
20.2.16	20.7	1979	1389	590	8.17	2.1	212	2345	27
02.3.16	20.6	2262	1612	650	7.98	2.6	185	2390	26
12.3.16	21.1	2111	1481	630	7.85	1.9	210	2460	20
22.3.16	21.1	2120	1380	740	8.26	2.4	190	2500	24
1.4.16	22	1981	1422	559	7.76	2.3	190	2480	23
11.4.16	21.8	2033	1375	658	8.04	2.2	195	2650	21
21.4.16	22.6	2272	1650	622	8.32	2.4	187	2610	19
2.5.16	23.2	2107	1457	650	7.92	1.9	207	2540	22.4
12.5.16	25.5	2305	1605	700	8.1	1.7	207	2500	24.6
22.5.16	27.1	2251	1581	670	8.26	1.5	212	2600	25.3
1.6.16	27.6	2128	1478	650	7.3	1.5	215	2700	27
11.6.16	28.2	2080	1470	610	8.42	1.4	218	2540	24.6
Average±SD	22.7± 2.79	2182.8± 135.32	1544.8± 127.81	638.1± 57.07	8.0± 0.38	2.0± 0.37	203.4± 10.75	2524.1± 114.8	23.8± 2.64

Suspended solids are those that can be retained on a water filter and are capable of settling out of the water column onto the stream bottom when stream velocities are low. They include silt, clay, plankton, organic wastes, and inorganic precipitates such as those from acid mine drainage.During the present Study minimum TSS in the inlet was found 500mg/l and maximum TSS was found 740mg/l with an average value 638.1mg/l ±57.07 (Table 1) and in outlet minimum TSS was found 67mg/l and maximum TSS was found 92mg/l with an average value 83.0mg/l±7.60 (Table 2). In case of the TSS the percentage reduction (%Reduction) was found 86.99% (Table 3). Similar trend of TSS in untreated effluent and treated effluent was found by Pramod *et al.,* 2010, Wahaab 2001 and Khanna *et al.,* 2014. TSS imparts turbidity to the water and waste water. More the TSS, more will be the turbidity. As the waste water discharged in the nearby water bodies therefore it is very important to reduce the TSS. Because due to this TSS the penetration power of sunlight decreases and therefore photosynthesis activity decreases, thus pollution level increases. pH is the measurement of

intensity of acidity and alkalinity and measures the concentration of hydrogen ion in water. The pH determination is an important objective in the treatment of waste water. Variation in pH values of effluent can affect the rate of biological reactions and survival of various micro-organisms. During the present Study minimum pH in the inlet was found 7.1 and maximum pH was found 8.42 with an average value 8.0±0.38 (Table 1) and in outlet minimum pH was found 6.72 and maximum pH was found 8.32 with an average value 7.7±0.50 (Table 2). In case of the pH the percentage reduction (%Reduction) was found 3.75% (Table 3). Similar results in untreated and treated efffluent were obtained by Bhutiani *et al.*, 2016 ,Negi and Sahu, 2015.

Table2- Showing Variation in different Physico- Chemical Parameters of Treated effluent.

Date/ Parameter	Temp ^{0}C.	TS (mg/l)	TDS (mg/)	TSS (mg/l)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Oil &Grease (mg/l)
10.1.16	17.4	908	838	70	6.72	6.8	15	39	2.6
20.1.16	17.6	995	910	85	7.3	6.2	17	42	2.1
30.1.16	17.3	944	856	88	7.56	6.2	18	40	2.9
10.2.16	17.9	944	860	84	8.12	5.9	20	45	1.8
20.2.16	18	837	758	79	8.17	5.5	21	41	3
02.3.16	18.3	879	789	90	7	5.4	23	38	2.5
12.3.16	18.5	898	812	86	7.39	5.4	23	43	2.3
22.3.16	18.6	902	810	92	8.26	5.1	24	40	4.1
1.4.16	19	942	852	90	7.76	5	26	41	3.6
11.4.16	19.4	934	845	89	8.04	5	25	49	4.3
21.4.16	19.3	936	857	79	8.32	4.6	26	57	3.9
2.5.16	21.8	962	882	80	7.92	4.5	26	53	4.1
12.5.16	22	907	832	75	8.1	4.3	26	49	3.6
22.5.16	21.5	872	790	82	8.26	5	24	45	3.9
1.6.16	21.4	881	789	92	7.3	4.8	24	41	3.3
11.6.16	21.5	852	785	67	7.25	5.3	22	44	2.7
Average±SD	19.3± 1.71	912.1± 42.12	829.1± 40.88	83.0± 7.60	7.7± 0.50	5.3± 0.68	22.5± 3.44	44.2± 5.33	3.2± 0.79

Oxygen is dissolved in most waters in varying concentration. Solubility of oxygen depends on temperature, pressure and salinity of water. During the present Study minimum DO in the inlet was found 1.4mg/l and maximum DO was found 2.4mg/l with an average value 2.0 mg/l±0.37 (Table 1) and in outlet minimum DO was found 4.3mg/l and maximum DO was found 6.8mg/l with an averge value 5.3mg/l±0.68 (Table 2) . In case of the DO the percentage reduction was found 62.26% (Table 3). During the course of treatment process the concentration of dissolved oxygen increases because of aeration. Micro-organism present in the waste water uses the oxygen provided by the aeration and multiply their numbers and degrade the organic matter, therefore in treated water we found less organic matter and more dissolved oxygen. Determination of Biological Oxygen Demand (BOD) is one of the important parameters used in water pollution to evaluate the impact of waste water on receiving water bodies. Increase in BOD which is a reflection of microbial oxygen demand leads to depletion of Dissolved Oxygen (DO) which may cause hypoxia conditions with consequent adverse effects on aquatic biota. During the present Study minimum BOD in the inlet was found 185mg/l and maximum BOD was found 218mg/l with an average value

203.4mg/l±10.75 (Table 1) and in outlet minimum BOD was found 15mg/l and maximum BOD was found 26mg/l with an average value 22.5mg/l±3.44 (Table 2). In case of the BOD the percentage reduction (%Reduction) was found 88.93% (Table 3). Similar trend of BOD (%Reduction) reduction was obtained by Sumit *et al.,* 2013. As DO and BOD are inversely propotional to each other. As DO increases, so likewise BOD decresaes. Similar trend of DO and BOD was found in our study.

Table 3- Showing percentage removal of the studied physico-Chemical parameters

SN	Parameter	Untreated	Treated	Percentage Removal	CPCB STANDARDS	
					Inland surface water	Land for irrigation
1	Temp (^{O}C)	22.7	19.3	14.98	Shall not exceed 5^{0}C above the receiving water temperature	-
2	TS(mg/l)	2182	912.1	58.21	-	-
3	TDS(mg/l)	1544.8	829.1	46.33	-	-
4	TSS(mg/l)	638.1	83	86.99	100	200
5	pH	8	7.7	3.75	5.5-9.0	5.5-9.0
6	DO(mg/l)	2	5.3	62.26(GAIN)		
7	BOD(mg/l)	203.4	22.5	88.93	30	100
8	COD(mg/l)	2524.1	44.2	98.25	250	-
9	Oil &Grease (mg/l)	23.8	3.2	86.56	10	10

❖ **All the values of parameters in this table are the averages values during the study**

Chemical Oxygen Demand (COD) test is the best method for organic matter estimation and rapid test for the determination of total oxygen demand by organic matter present in the sample. Increased amount of COD may be due to high amount of organic compounds which are not affected by the bacterial decomposition (Nagarajan and Ramachandra moorthy, 2002). During the present Study minimum COD in the inlet was found 2300 mg/l and maximum COD was found 2700 mg/l with an average value 2524.1 mg/l±114.18 (Table 1) and in outlet minimum COD was found 38mg/l and maximum COD was found 57mg/l with an average value 44.2mg/l ± 5.33 (Table 2) . In case of the COD the percentage reduction was found 98.25% (Table 3) . Similar trend of COD in untreated effluent was found by Pramod *et al.,* 2010. Similar trend of COD reduction was obtained by Kharat and Akolkar (2014). Because of aeration, the micro-organism get favourable conditions and they multiplied rapidly and eatup the organic matter, therefore COD decreases to a great extent. Oil and grease if present in excess amount it interfere with aerobic and anaerobic biological process. The all samples contain high quantity of oil and grease which causes serious problems. The presence of oil and grease in an effluent was mainly due to the processing operations. It should be removed since they usually float and affect the oxygen transfer to the water and also objectionable from an aesthetic point of view. Before the treatment process, the oil & grease was removed by different methods. During the present Study minimum Oil and Grease in the inlet was found 19mg/l and maximum Oil and Grease was found 28mg/l with an average value 23.8mg/l±2.64 (Table 1) and in outlet minimum Oil and Grease was found 1.8mg/l and maximum Oil and Grease was found 4.1mg/l with an average value 3.2mg/l±0.79 (Table 2) . In case of the Oil and Grease the precentage reduction was found 86.56% (Table 3) . Similar results of oil and grease in effluent was obtained by Singh *et al.,* 2016 and Singh *et al.,* 2016.

Conclusion

Present study concerned with performance evaluation of ETP of an automobile industry. All the parameters studied during the study were found under the prescribed limit. A significant percentage removal was found in all the parameters.

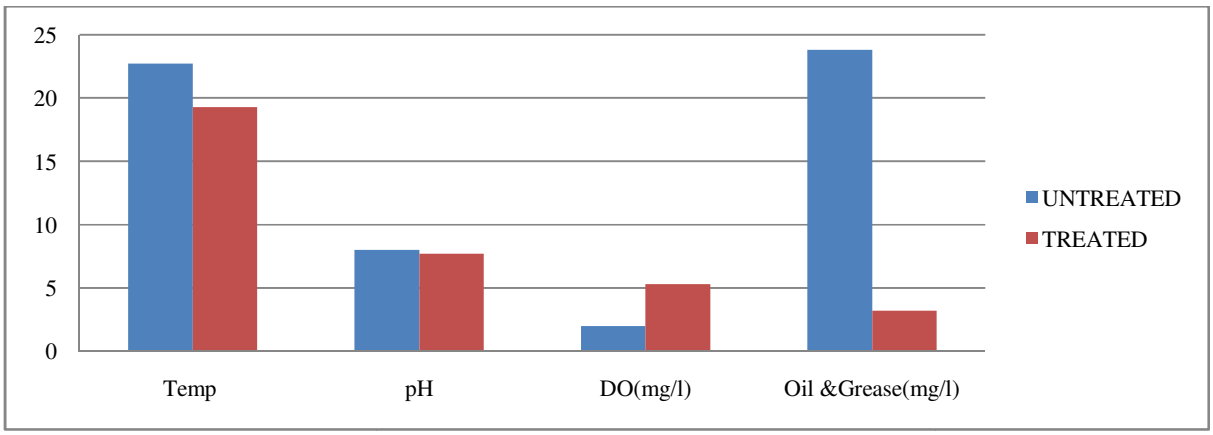

Fig 1- Graphical representation of percentage removal of the some studied physico- chemical parameters

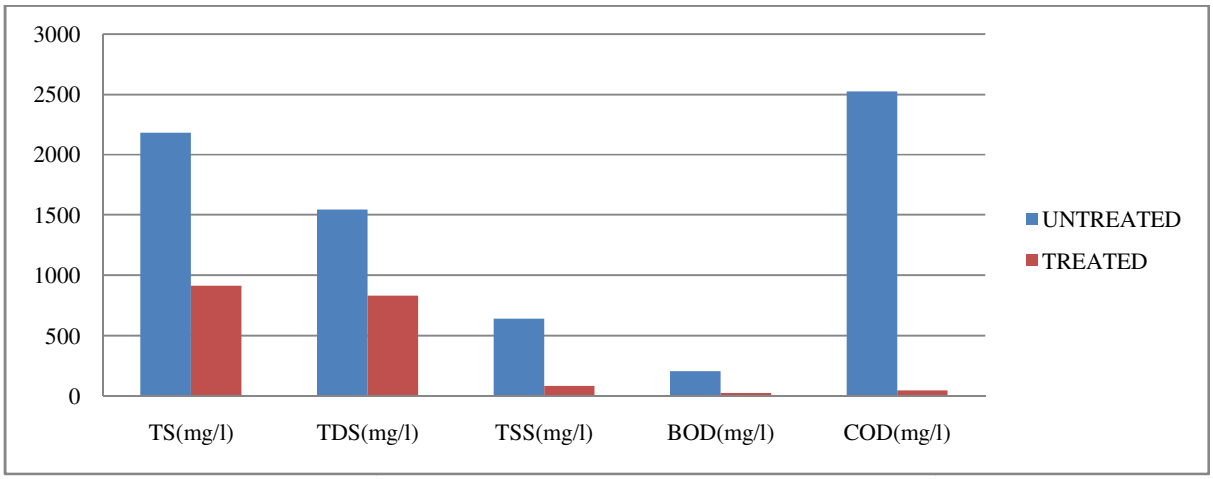

Fig 2- Graphical representation of percentage removal of the some studied physico- chemical parameters

Although in case of DO a significant percentage gain was found. During the study the overall performance of the treatment plant was satisfactory. The findings of this study prove that if the untreated effluent of automobile industry is discharged to the environment, it creates a potential public and environmental health hazard.. The treated effluent meets the CPCB standard for discharge in inland surface water hence it can be said that the plant is working efficiently. This treatment plant shows high reduction potential for TSS, COD, BOD and Oil & Grease.

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