

Performance Evaluation of Effluent Treatment Plant of Automobile Industry – A Case Study

Smita Singh¹, Dr S. V Ambekar²

¹M. Tech Scholar Department of Civil Engineering, Yeshwantrao Chavan College of engineering, Nagpur, MH, India

²Professor Department of Civil Engineering, Yeshwantrao Chavan College of engineering, Nagpur, MH, India

Abstract - In this study the physical and chemical parameters were studied from the inlet of effluent treatment plant of automobile wastewater before the treatment and from outlet of effluent treatment plant after the treatment. The various physical parameters such as pH, turbidity, total solids, suspended solids, volatile suspended solids, total dissolve solids and Chemical parameters like chlorides, sulfates, nitrates, D.O, B.O.D, C.O.D, iron, phosphorus and their removal efficiency were studied. The efficiency of various treatment units such as activated sludge process, and filtration were studied.

Key Words: Automobile industry, effluent treatment plant, B.O.D, C.O.D, efficiency

1. INTRODUCTION

India is a developing country and industries are the assets of a nation for its development. As industries play a very important role in the development of a nation, it can be of different types such as extractive industry, manufacturing, processing, construction industry etc. One such big industry in India is automobile industry where water plays a very important role, as it is the primary requirement for any industry. A huge amount of water is used and polluted during industrial process. Untreated wastewater from automobile industry has high levels of pH, turbidity, total solids, suspended solids, phosphorus. Despite its importance, water is the most poorly managed resource.

The water usages in different units of automobile industry are such as cooling, paint shops, welding, washing, condensing the steam and so on. A huge amount of water is consumed in paint shops and produces a large amount of wastewater. The major contaminants generated from the automobile wastewater are such as total solids, suspended solids, phosphate, chlorides, high B.O.D, C.O.D.

2. METHODOLOGY

The wastewater for analysis was collected from Mahindra tractor division Nagpur, Maharashtra and studied for treatment efficiency of various treatment units and removal of various physical and chemical parameters. The samples were studied for three different intervals of time i.e. morning sampling, afternoon sampling, evening sampling.

2.1 Sampling method

The analysis was done to understand the performance of effluent treatment plant (ETP) and removal efficiency of different treatment units. During the study the samples were collected from automobile industry near Hingna, Nagpur. The samples were studied for three different time intervals as industrial wastewater shows variation in its properties. The grab samples were collected in 1 litre PET bottles; the PET bottles were rinsed 3-4 times with distilled water before keeping the sample. Care was taken to avoid the entry of bubbles, and other solid debris into the bottle during sample collection.

2.2 Objective of the study

1. To evaluate the physical and chemical parameters viz., Turbidity, total solids, total suspended solids, total dissolve solids, volatile suspended solid, oil & grease, pH, chlorides, sulphates, nitrates, dissolve oxygen, iron, phosphate, biological oxygen demand & chemical oxygen demand and efficiency collected from automobile tractor industry.
2. To evaluate the efficiency of units such as activated sludge process & filtration.

2.3 Characterisation

The different physical parameters studied are:

1. pH
2. Turbidity
3. Total solids (T.S)
4. Suspended solids (S.S)
5. Volatile suspended solids (V.S.S)
6. Total dissolve solids (T.D.S)
7. Oil and grease

The different chemical parameters studied are:

1. Dissolve Oxygen (D.O)
2. Biological Oxygen Demand (B.O.D)
3. Chemical Oxygen Demand (C.O.D)
4. Chlorides
5. Sulphates
6. Nitrates
7. Iron
8. Phosphorus

The testing and sampling is carried out as per the standard methods given in APHA, AWWA (16th edition), all the testings were performed in college laboratory.

2.4 Steps involved in treatment process are

The techniques adopted for the treatment of automobile effluent are physical, chemical and biological methods.

The treatment process is followed by bar screen, skimming, equalization, flotation, clarification, neutralization, activated sludge process, disinfection followed by filtration.

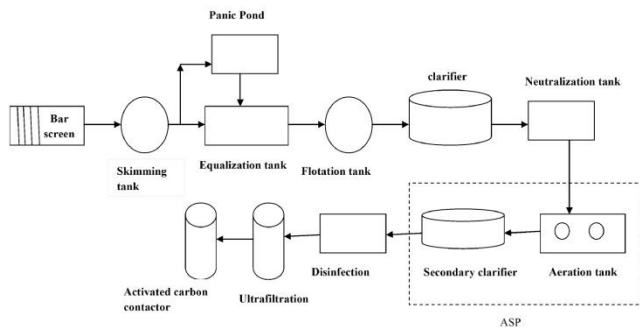


Fig.1: Flow diagram of effluent treatment plant

3. Results

In this study a significant difference was observed in the quality of morning, afternoon & evening samples of effluent before and after the treatment.

During the present study the samples were collected at an interval of morning, afternoon & evening sampling from an automobile industry located in Hingna, Nagpur. The results of various physical & Chemical parameters observed during the study are turbidity, total solids, total suspended solids, total dissolved solids, volatile suspended solids, oil and grease, pH, chlorides, dissolve oxygen, biological oxygen demand, chemical oxygen demand, sulphates, nitrates, iron and phosphorus are presented in table 1 & 2 while the efficiency was presented in table 3. The range value of physical and chemical parameters of effluent are described below.

The pH value ranges of inlet samples for morning is 4.8 to 6.1, for afternoon is 5.45 to 5.96 and for evening is 5.18 to 5.86 (Table 1) and pH range of outlet samples for morning is 6.8 to 7.3, for afternoon is 6.38 to 7.28 and for evening is 6.31 to 7.15 (Table 2). During this study the turbidity value ranges of inlet samples for morning is 260 to 490, for afternoon is 250 to 370 and for evening is 170 to 260 (Table 1) and turbidity value ranges of outlet samples for morning is 4 to 19, for afternoon is 10 to 15 and for evening is 6.31 to 7.15 (Table 2). The efficiency removal value observed ranges 92.69% to 99.18 % (Table 3). The term total solids can be defined as residue left in a beaker after drying the sample in an oven at a defined temperature. During this study total solids value ranges of inlet samples for morning is 1500 to 2150, for afternoon is 600 to 950 and for evening is 850 to 1050 (Table 1) and total solids value ranges of outlet samples for morning is 550 to 750, for afternoon is 650 to 900 and for evening is

600 to 950 (Table 2). The efficiency removal value observed ranges 19.04% to 66.66 % (Table 3).

Table-1: Showing minimum to maximum range of inlet sample (untreated) for physical and chemical parameters for ETP. All the parameters are in mg/l.

Parameters	Morning samples	Afternoon samples	Evening samples
pH	4.8 - 6.1	5.45 - 5.96	5.18 - 5.86
Turbidity (NTU)	260 - 490	250 - 370	170 - 260
Total solids	1500 - 2150	600 - 950	850 - 1050
Total suspended solids	300 - 500	150 - 350	100 - 300
volatile suspended solids	500 - 700	300 - 400	150 - 300
Total dissolve solids	1150 - 1850	400 - 600	550 - 850
Chlorides	225 - 530	140 - 165	95 - 150
D.O	0 - 0.8	0 - 1.2	0 - 0.2
B.O.D	300 - 735	450 - 690	312 - 810
C.O.D	1094 - 1146	1099 - 2578	1311 - 1885
Sulphates	114 - 188	110 - 246	115.50 - 168.80
Nitrates	10 - 43	16.70 - 25	1.67 - 9.22
Iron	4.37 - 8.26	2.80 - 3.56	1.49 - 4.70
Phosphorus	6.60 - 8.50	6.49 - 6.70	10.4 - 17.5
Oil & grease	250 - 400	200 - 400	200 - 300

During this study Total suspended solids value ranges of inlet samples for morning is 300 to 500, for afternoon is 150 to 350 and for evening is 100 to 300 (Table 1) and total suspended solids value ranges of outlet samples for morning is 50 to 150, for afternoon is 50 to 150 and for evening is 0 to 100 (Table 2). The efficiency removal value observed ranges 0 to 100 % (Table 3). During this study Volatile suspended solids value ranges of inlet samples for morning is 500 to 700, for afternoon is 300 to 400 and for evening is 150 to 300 (Table 1) and volatile suspended solids value ranges of outlet samples for morning is 200 to 250, for afternoon is 200 and for evening is 0 to 200 (Table 2). The efficiency removal value observed ranges 33.33% to 100% (Table 3). During this study total dissolve solids value ranges of inlet samples for morning is 1150 to 1850, for afternoon is 400 to 600 and for evening is 550 to 850 (Table 1) and total dissolve solids value ranges of outlet samples for morning is 400 to 700, for afternoon is 500 to 850 and for evening is 550 to 850 (Table 2). The efficiency removal value observed ranges 0 to 65.21 % (Table 3). During this study chlorides value ranges of inlet samples for morning is 225 to 530, for afternoon is 140 to 165 and for evening is 95 to 150 (Table 1) and chlorides value ranges of outlet samples for morning is 160 to 275, for afternoon is 180 to 350 and for evening is 165 to 570 (Table 2). The efficiency removal value observed ranges 28.88% to

48.11% (Table 3). During this study dissolve oxygen value ranges of inlet samples for morning is 0 to 0.80, for afternoon is 0 to 1.2 and for evening is 0 to 0.20 (Table 1) and dissolve oxygen value ranges of outlet samples for morning is 3.4 to 6, for afternoon is 5.4 to 7.4 and for evening is 3.6 to 8.4 (Table 2). The efficiency removal value observed ranges 77.77% to 100% (Table 3). During the course of treatment process the concentration of dissolved oxygen increases because of aeration. As the biomass present in the waste water uses the oxygen by aeration and increases their quantity and breakdown the organic matter, therefore in treated water we found less organic matter and more dissolve oxygen. The biological oxygen demand is an important parameter used in water pollution to determine the impact of wastewater on the receiving water bodies. During the study biological oxygen demand value ranges of inlet samples for morning is 300 to 735, for afternoon is 450 to 690 and for evening is 312 to 810 (Table 1) and biological oxygen demand value ranges of outlet samples for morning is 14 to 30, for afternoon is 23 to 30 and for evening is 12 to 66 (Table 2). The efficiency removal value observed ranges 91.85% to 96.66% (Table 3).

Table-2: Showing minimum to maximum range of outlet sample (treated) for physical and chemical parameters for ETP. All the parameters are in mg/l.

Parameters	Morning samples	Afternoon samples	Evening samples
pH	6.8 - 7.3	6.38 - 7.28	6.31 - 7.15
Turbidity (NTU)	4 - 19	10 - 15	3 - 10
Total solids	550 - 750	650 - 900	600 - 950
Total suspended solids	50 - 150	50 - 150	0 - 100
volatile suspended solids	200 - 250	200	0 - 200
Total dissolve solids	400 - 700	500 - 850	550 - 850
Chlorides	160 - 275	180 - 350	165 - 570
D.O	3.4 - 6	5.4 - 7.4	3.6 - 8.4
B.O.D	14 - 30	23 - 30	12 - 66
C.O.D	51 - 116	79 - 150	53 - 120
Sulphates	12 - 82	66 - 166	77 - 118
Nitrates	0.67 - 4.7	1.70 - 2.51	0.42 - 2.51
Iron	0.18 - 0.35	0.17 - 0.57	0.10 - 0.26
Phosphorus	2 - 3.6	2.62 - 3.3	6.74 - 8.65
Oil & grease	0	0	0

Chemical oxygen demand test is the best method for organic matter determination and rapid test for estimation of total oxygen demand by organic matter. During the study chemical oxygen demand value ranges of inlet samples for morning is 1094 to 1146, for afternoon is 1099 to 2578 and for evening is 1311 to 1885 (Table 1) and chemical oxygen demand value ranges of outlet samples for morning is 51 to 116, for afternoon is 79 to 150 and for evening is 53 to 120 (Table 2).

The efficiency removal value observed ranges 89.87% to 97.18% (Table 3).

During this study sulphates value ranges of inlet samples for morning is 114 to 188, for afternoon is 110 to 246 and for evening is 115.50 to 168.80 (Table 1) and sulphates value ranges of outlet samples for morning is 12 to 82, for afternoon is 66 to 166 and for evening is 77 to 118 (Table 2). The efficiency removal value observed ranges 32.52% to 56.38% (Table 3).

Table-3: Showing minimum to maximum range of removal efficiency for physical and chemical parameters for Effluent treatment plant.

Sr. no	Parameters	Efficiency %		CPCB standard (inland surface water)
		Min. Range	Max. Range	
1	Turbidity (NTU)	92.69	99.18	-
2	Total solids	19.04	66.66	-
3	Total suspended solids	0	100	100
4	volatile suspended solids	33.33	100	-
5	Total dissolve solids	0	65.21	-
6	Chlorides	28.88	48.11	600
7	D.O	77.77	100	-
8	B.O.D	91.85	96.66	30
9	C.O.D	89.87	97.18	250
10	Sulphates	32.52	56.38	1000
11	Nitrates	62.59	95.03	10
12	Iron	83.98	97.87	3
13	Phosphorus	16.82	69.18	5
14	Oil & grease	100	100	10

During this study nitrates value ranges of inlet samples for morning is 10 to 43, for afternoon is 16.70 to 25 and for evening is 1.67 to 9.22 (Table 1) and nitrates value ranges of outlet samples for morning is 0.67 to 4.7, for afternoon is 1.70 to 2.51 and for evening is 0.42 to 2.51 (Table 2). The efficiency removal value observed ranges 62.59% to 95.03% (Table 3). During this study iron value ranges of inlet samples for morning is 4.37 to 8.26, for afternoon is 2.80 - 3.56 and for evening is 1.49 - 4.70 (Table 1) and iron value ranges of outlet samples for morning is 0.18 to 0.35, for afternoon is 0.17 to 0.57 and for evening is 0.10 to 0.26 (Table 2). The efficiency removal value observed ranges 83.93% to 97.87% (Table 3). During this study phosphorus value ranges of inlet samples for morning is 6.60 to 8.50, for afternoon is 6.49 to 6.7 and for evening is 10.4 to 17.5 (Table 1) and phosphorus value ranges of outlet samples for morning is 2 to 3.6, for afternoon is 2.62 to 3.3 and for evening is 6.74 to 8.65 (Table 2). The efficiency removal value observed ranges 16.82% to 69.18% (Table 3).

During this study oil & grease value ranges of inlet samples for morning is 250 to 400, for afternoon is 200 to 400 and for evening is 200 to 300 (Table 1) and oil & grease value outlet samples for morning, afternoon and for evening is obtained as 0 (Table 2). The efficiency removal value observed is 100% (Table 3). During this study efficiency of treatment units such as activated sludge process and filtration were also determined the range value are given below.

Table-4: Showing minimum to maximum range of inlet sample (untreated) for physical and chemical parameters for activated sludge process. All the parameters are in mg/l.

Parameters	Morning samples	Afternoon samples	Evening samples
Chemical oxygen demand	1850 - 2150	1750 - 1850	1871 - 1950
Total solids	800 - 1200	1650 - 1800	900 - 1200
Total Suspended solids	95 - 100	100 - 150	65 - 100
Volatile suspended solids	100 - 150	50 - 65	50

Table-5: Showing minimum to maximum range of outlet sample (treated) for physical and chemical parameters for activated sludge process. All the parameters are in mg/l.

Parameters	Morning samples	Afternoon samples	Evening samples
Chemical oxygen demand	90 - 133	100 - 235	120 - 145
Total solids	800 - 1250	900 - 950	750 - 800
Total Suspended solids	0 - 10	50	40 - 42
Volatile suspended solids	0 - 150	0 - 50	0 - 50

The parameters which were studied for determining the efficiency of activated sludge process are chemical oxygen demand, total solids, suspended solids and volatile suspended solids. During this study the chemical oxygen demand value ranges of inlet sample for morning is 1850 to 2150, for afternoon 1750 to 1850, for evening 1871 to 1950 (table 4) and for outlet sample for morning is 90 to 133, for afternoon is 100 to 235, for evening 120 to 145 (table 5).

Table-6: Showing minimum to maximum range of removal efficiency for physical and chemical parameters for activated sludge process.

Parameters	Efficiency (%)	
	Minimum range	Maximum range
Chemical oxygen demand (C.O.D)	86.59	95.71
Total solids (T.S)	11.11	47.05
Total Suspended solids (T.S.S)	35.38	100
Volatile suspended solids (V.S.S)	0	100

The efficiency removal observed for chemical oxygen demand ranges from 86.59% to 95.71% (table 6). During this study the total solids value ranges of inlet sample for morning is 800 to 1200, for afternoon is 1650 to 1800, for evening 900 to 1200 (table 4) and for outlet sample for morning is 800 to 1250, for afternoon is 900 to 950, for evening is 750 to 800 (table 5). The efficiency removal for

total solids observed ranges 11.11% to 47.05% (table 6). During this study the total suspended solids value ranges of inlet sample for morning is 65 to 100, for afternoon is 100 to 150, for evening is 65 to 100 (table 4) and for outlet sample for morning is 0 to 10, for afternoon is 50, for evening is 40 to 42 (table 5). The efficiency removal observed for total suspended solids ranges 35.38% to 100% (table 6). During this study the volatile suspended solids value ranges of inlet sample for morning is 100 to 150, for afternoon is 50 to 65, for evening is 50 (table 4) and for outlet sample for morning is 0 to 150, for afternoon is 0 to 50, for evening is 0 to 50 (table 5). The efficiency removal observed for volatile suspended solids is 0 to 100% (table 6).

Table-7: Showing minimum to maximum range of inlet sample (untreated) for activated carbon filtration process. All the parameters are in mg/l.

Parameters	Morning sample	Afternoon sample	Evening sample
Total solids (T.S)	1005 - 1039	865 - 1079	869 - 1155
Total suspended solids (T.S.S)	33 - 57	36 - 54	39 - 60

Table-8: Showing minimum to maximum range of outlet sample (treated) for activated carbon filtration process. All the parameters are in mg/l.

Parameters	Morning sample	Afternoon sample	Evening sample
Total solids (T.S)	1019 - 1038	824 - 1063	847 - 1119
Total suspended solids (T.S.S)	28 - 38	27 - 53	35 - 59

The parameters which were studied for determining the efficiency of activated carbon filtration process are total solids and total suspended solids. The total solid value range of inlet sample for morning is 1005 to 1039, for afternoon is 865 to 1079, for evening is 869 to 1155 (table 7) and for outlet sample for morning is 1019 to 1038, for afternoon is 824 to 1063, for evening is 847 to 1119 (table 8). The efficiency removal observed for total solids ranges from 0.096% to 4.73% (table 9). During the study the total suspended solid value range of inlet sample for morning is 33 to 57, for afternoon is 36 to 54, for evening is 39 to 60 (table 7) and for outlet sample for morning is 28 to 38, for afternoon is 27 to 53, for evening is 35 to 59 (table 8). The efficiency removal observed for total suspended solids ranges from 0% to 34% (table 9).

Table-9: Showing minimum to maximum range of removal efficiency for physical and chemical parameters for activated carbon filtration process.

Parameters	Efficiency (%)	
	Minimum range	Maximum range
Total solids (T.S)	0.096	4.73
Total suspended solids (T.S.S)	0	34

The graphical representation of physical and chemical parameters of effluent treatment plant is shown below.

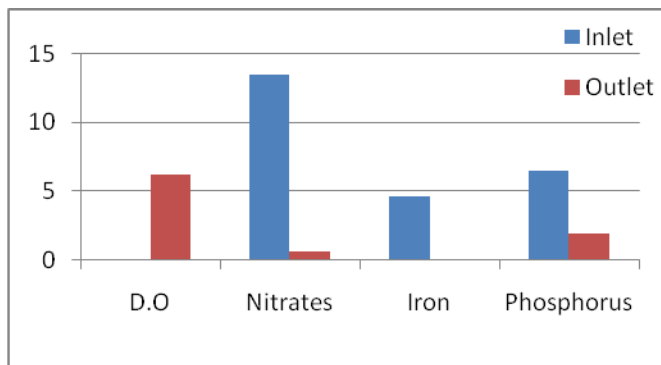


Chart 1: Graphical representation for maximum percentage removal observed for D.O, nitrates, iron & phosphorous in ETP. All the parameters are in mg/l.

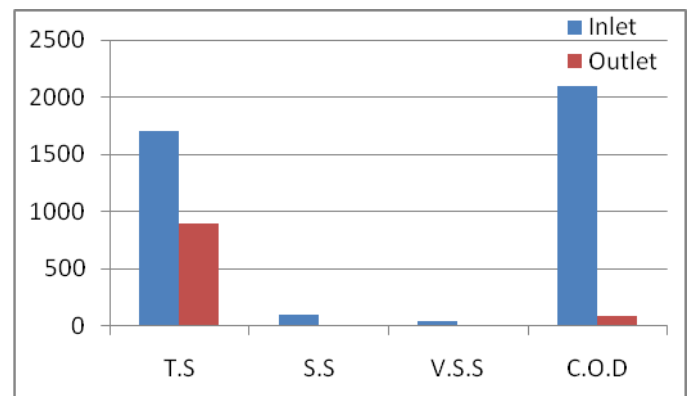


Chart 4: Graphical representation for maximum percentage removal observed for T.S, S.S, V.S.S & C.O.D in Activated sludge process. All the parameters are in mg/l.

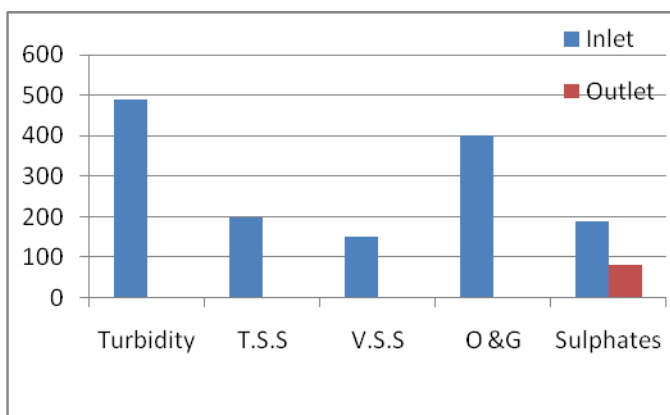


Chart 2: Graphical representation for maximum percentage removal observed for Turbidity, T.S.S, V.S.S, O&G & Sulphates ETP. All the parameters are in mg/l.

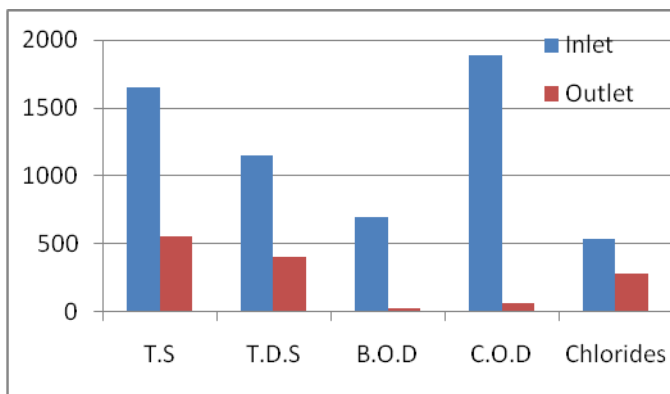


Chart 3: Graphical representation for maximum percentage removal observed for T.S, T.D.S, B.O.D, C.O.D & Chlorides ETP. All the parameters are in mg/l.

4. CONCLUSION

Results of existing effluent treatment plant are within limits with respect to the standard limits given by central pollution control board. A significant removal was found in all the parameters. The efficiency of activated sludge process observed is good. The efficiency observed in activated carbon filtration process is not satisfied.

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