International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 9, September- 2014

# Characterization and Design of Sewage Treatment Plant in Bidar City

Harsha Bemalgi
Student: Department of Civil Engineering
(M.Tech, Environmental Engineering)
P.D.A college of Engineering,
Gulbarga, India

Dr M. N. Dandigi
Professor: Department of Civil Engineering
P.D.A. College of Engineering
Gulbarga, India

*Abstract*— **A study was undertaken to assess the characteristics like physical and chemical analysis of the wastewater of Bidar city followed by the correlation analysis and design of sewage treatment plant. The characteristics involves the analysis of pH, total solids, suspended solids, dissolved solids, settleable solids, alkalinity, chlorides, hardness, iron, biological oxygen demand, chemical oxygen demand, sulphates, phosphates, ammonical nitrogen, nitrites, nitrates. Considering the peak and average flows and the peak results the sewage treatment plant has been designed. The different components are screens, grit chamber, primary sedimentation tank, aeration tank, secondary sedimentation tank, sludge digestion tank, sludge drying beds. By the execution of the project the entire sewage of Bidar city can be treated effectively and efficiently.**

***Keywords— domestic wastewater, activated sludge process, wastewater treatment plant.***

## I.INTRODUCTION

Characterization of wastewater is essential for an effective and economical waste management programme. It helps in the choice of treatment methods deciding the extent of treatment, assessing the beneficial uses of wastes and utilizing the waste purification capacity of natural bodies of water in a planned and controlled manner. Wastewater is the term for discarded or previously used water from a municipality or industry. The wastewater that is produced due to human activities in households is called domestic wastewater. Such water usually contains dissolved as well as suspended matter and must be treated prior to its discharge into natural water. To examine the quality of wastewater to be discharged into aquatic environment or to be treated and reused the characteristics of wastewater in question must be defined precisely

Domestic sewage is 99.9% water and 0.1% solids on evaporation. About two thirds of the solids are organic, comprising mainly of nitrogenous compounds Carbohydrates, Fats. The inorganic compounds include chlorides, metallic salts, ash, road grit etc. The main constituent of domestic sewage can be listed as solids, chlorides, alkalinity,biological oxygen demand, chemical oxygen demand, nitrogen, phosphates, sulphates etc [7].The organic matter present in the wastewater is described in terms of biological oxygen demand (B.O.D) and suspended solids (S.S). The B.O.D refers to the quantity of oxygen used in the biochemical oxidation of organic matter. The quantity of oxygen used is related to the duration and temperature of the process. Usually this is five days demand at $20^0$ C and is expressed as milligrams per litre (mg/L).

## II. LITRATURE REVIEW

*A.* Abdul-Talib et al (2003) advocated that sewer networks should be designed not only for convenience of water and pollutants but also for obtaining a wastewater quality that is suitable for the treatment process at the receiving wastewater treatment plant.

*B.* B. Boon (1995) further testified that septicity in sewerage system results from the activity of bacteria growing in sewage under aerobic conditions to reduce sulphur containing organic compounds, sulphates to form sulphides and other sulphur compounds. Lack of adequate ventilation, high temperature, of sewage will result in septicity.

*C.* Tanaka et al.(2000) reported that microbial transformation of organic matter in wastewater takes place during transport in sewers. These processes occur in the bulk water phase, in biofilms and in temporarily settled sediments under aerobic and anaerobic conditions. Under aerobic conditions in a gravity sewer, readily bio-degradable substrate directly discharged to the sewer and bio-mass is produced

## III.MATERIALS AND METHODOLOGY

*A.* During the period of study, Samples were collected on weekly basis around 8:.00 A.M to 9.00 A.M by grab sampling in five litres sterile dark colored containers. Sewage sample was collected at gornalli (b) because the maximum quantity of sewage of Bidar city is collected at this place. The sewage is collected at that point where the water depth is one third from the bottom and the container was immersed below the surface of the sewage and was transferred to the laboratory at the earliest and is stored in the deep freezer. Special preservations methods are necessary for portions that

are not to be analyzed immediately by adding special chemicals for certain tests.

*B* Analysis of physico-chemical characteristics of wastewater

The physicochemical characteristics analyzed are;

1. Temperature in °C.
2. pH
3. Total solids in mg/L
4. Dissolved solids in mg/L
5. Suspended solids in mg/L.
6. Settleable solids in ml/L
7. Alkalinity in mg/L
8. Chloride in mg/L
9. Total Hardness in mg/L
10. B.O.D. in mg/L
11. C.O.D. in mg/L.
12. Sulphates in mg/L
13. Phosphates in mg/L
14. Iron in mg/L
15. Ammonical Nitrogen in mg/L
16. Nitrites in mg/L
17. Nitrates in mg/L

*C.* Methods of examination

1. Temperature of sewage sample by Thermometer in°C.
2. pH of sewage sample by pH meter. Total solids in sewage sample by gravimetric method in mg/L.
3. Settleable solids in sewage sample by imhoff cone in ml/L.
4. Chloride in sewage sample by Titrimetric method in mg/L
5. Sulphate was determined by Turbidermetric method using spectrophotometer.
6. Nitrate of sewage sample by using Phenol Disulphonic Acid (PDA) method using Spectrophotometer in mg/L.
7. Nitrite in sewage sample by using Phenol Disulphonic Acid (PDA) method using Spectrophotometer in mg/L.
8. B.O.D. by wrinkler's method.
9. C.O.D. by Dichromate reflux method.
10. Phosphate and iron content in sewage sample by using spectrophotometer in mg/L.

## IV. RESULTS AND DISCUSSIONS

*A.* The physico-chemical characteristics of wastewater, number of samples and the corresponding dates on which the samples have been collected are given in Table 4.1. The results have also been represented in the form of graphs. Table 4.2 shows the coefficient correlations.

Table4.1Analysed Physico-Chemical Characteristics of Wastewater of Bidar City

| Sl.No | Date | Temp in °C | pH | Total Solids mg/L | Dissolved Solids mg/L | Suspended Solids mg/L | Settleable Solids ml/L | Alkalinity in mg/L | Chlorides in mg/L | Total Hardness mg/L | B.O.D mg/L | C.O.D mg/L | B.O.D/C.O.D | Sulphate mg/L | Phosphate mg/L | Iron mg/l | Ammonical mg/L | Nitrite mg/L | Nitrate mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 06-07-2013 | 22 | 7.3 | 1595 | 1243 | 350 | 3.2 | 155 | 86 | 382 | 495 | 857 | 0.65 | 96 | 2.15 | 2.1 | 22 | 3.82 | 10.62 |
| 2 | 14/6/2013 | 25 | 7.4 | 1612 | 1356 | 256 | 1.6 | 185 | 78 | 410 | 412 | 650 | 0.65 | 65 | 1.73 | 1.8 | 17 | 2.54 | 10.38 |
| 3 | 21/6/2013 | 21 | 7.1 | 1485 | 1372 | 113 | 2.8 | 118 | 95 | 322 | 432 | 675 | 0.64 | 48 | 1.62 | 2.3 | 29 | 2.67 | 11.48 |
| 4 | 28/6/2013 | 23 | 7.3 | 1495 | 1384 | 111 | 1.6 | 141 | 59 | 339 | 415 | 755 | 0.56 | 59 | 0.52 | 1.9 | 25 | 1.13 | 11.67 |
| 5 | 07-04-2013 | 21 | 7.3 | 1405 | 1231 | 174 | 2.9 | 179 | 65 | 350 | 452 | 678 | 0.51 | 43 | 0.64 | 1.8 | 21 | 1.34 | 10.45 |
| 6 | 07-11-2013 | 24 | 7.1 | 1592 | 1412 | 180 | 3.1 | 218 | 75 | 320 | 589 | 888 | 0.95 | 76 | 0.72 | 2.1 | 32 | 2.63 | 9.68 |
| 7 | 18/7/2013 | 22 | 7.4 | 1496 | 1386 | 110 | 2.8 | 241 | 61 | 312 | 412 | 857 | 0.49 | 94 | 0.86 | 2 | 26 | 1.48 | 11.43 |
| 8 | 25/7/2013 | 22 | 7.2 | 1445 | 1332 | 111 | 2.9 | 149 | 41 | 410 | 423 | 857 | 0.49 | 98 | 0.96 | 1.9 | 22 | 2.52 | 10.68 |
| 9 | 08-02-2013 | 21 | 7.1 | 1472 | 1326 | 96 | 2.6 | 158 | 110 | 391 | 435 | 768 | 0.56 | 83 | 1.12 | 1.8 | 24 | 2.41 | 11.43 |
| 10 | 08-09-2013 | 23 | 7.3 | 1485 | 1368 | 117 | 2.4 | 171 | 98 | 355 | 428 | 693 | 0.7 | 87 | 1.22 | 1.9 | 22 | 1.32 | 10.89 |
| 11 | 16/8/2013 | 22 | 7.2 | 1588 | 1392 | 196 | 2.5 | 111 | 43 | 453 | 453 | 834 | 0.54 | 91 | 0.98 | 2.2 | 23 | 1.98 | 9.55 |
| 12 | 23/8/2013 | 22 | 7.1 | 1552 | 1342 | 210 | 4 | 195 | 88 | 405 | 495 | 583 | 0.69 | 98 | 0.92 | 2.3 | 29 | 2.9 | 8.86 |
| 13 | 30/8/2013 | 24 | 7.3 | 1482 | 1302 | 180 | 2.5 | 108 | 101 | 428 | 428 | 769 | 0.55 | 63 | 1.23 | 2 | 25 | 2.64 | 10.53 |
| 14 | 08-08-2013 | 21 | 7.4 | 1473 | 1260 | 213 | 1.2 | 143 | 109 | 455 | 455 | 784 | 0.55 | 44 | 1.62 | 2.4 | 25 | 3.82 | 11.78 |
| 15 | 15/09/2013 | 23 | 7.2 | 1402 | 1232 | 170 | 1.6 | 192 | 121 | 407 | 407 | 757 | 0.53 | 78 | 1.52 | 2.5 | 23 | 4.16 | 7.42 |
| 16 | 22/9/2013 | 23 | 7.1 | 1501 | 1326 | 175 | 1.5 | 116 | 118 | 492 | 492 | 912 | 0.53 | 53 | 1.2 | 2 | 28 | 3.01 | 6.72 |
| 17 | 30/9/2013 | 23 | 7 | 1532 | 1240 | 292 | 1.7 | 164 | 99 | 415 | 415 | 865 | 0.48 | 42 | 1.3 | 1.9 | 24 | 1.62 | 8.43 |
| 18 | 10-09-2013 | 23 | 7 | 1405 | 1225 | 178 | 2 | 102 | 111 | 320 | 420 | 903 | 0.32 | 30 | 0.96 | 1.8 | 25 | 1.4 | 9.33 |
| 19 | 16/10/2013 | 23 | 7.4 | 1396 | 1256 | 140 | 4.5 | 155 | 65 | 412 | 412 | 862 | 0.47 | 38 | 0.84 | 1.7 | 29 | 0.92 | 10.68 |
| 20 | 23/10/2013 | 23 | 7.1 | 1596 | 1262 | 334 | 4.7 | 149 | 81 | 475 | 475 | 853 | 0.55 | 33 | 0.73 | 1.6 | 25 | 4.26 | 11.53 |
| 21 | 30/10/2013 | 24 | 7.4 | 1605 | 1272 | 333 | 4.8 | 180 | 82 | 462 | 462 | 904 | 0.46 | 60 | 2.15 | 1.8 | 19 | 3.43 | 11.63 |
| 22 | 11-01-2013 | 23 | 7 | 1622 | 1242 | 390 | 9 | 192 | 66 | 413 | 413 | 853 | 0.48 | 31 | 1.43 | 1.9 | 26 | 2.63 | 11.83 |
| 23 | 11-07-2013 | 23 | 7.1 | 1596 | 1256 | 313 | 8.5 | 155 | 85 | 532 | 532 | 702 | 0.68 | 88 | 0.18 | 2 | 24 | 1.43 | 8.83 |
| 24 | 14/11/2013 | 22 | 7.4 | 1485 | 1284 | 179 | 6.5 | 122 | 91 | 418 | 418 | 652 | 0.66 | 99 | 0.2 | 2.1 | 28 | 1.6 | 9.43 |
| 25 | 21/11/2013 | 24 | 7.4 | 1482 | 1342 | 140 | 3.5 | 167 | 109 | 441 | 441 | 612 | 0.72 | 42 | 1.63 | 2.2 | 27 | 2.43 | 10.85 |
| 26 | 28/11/2013 | 23 | 7.2 | 1495 | 1356 | 139 | 4.8 | 129 | 112 | 499 | 499 | 719 | 0.56 | 52 | 0.88 | 1.8 | 33 | 1.95 | 10.19 |
| 27 | 03-04-2013 | 23 | 7.1 | 1432 | 1284 | 148 | 6.5 | 184 | 106 | 415 | 415 | 682 | 0.59 | 49 | 0.43 | 1.9 | 28 | 3.01 | 9.98 |
| 28 | 12-11-2013 | 23 | 7.4 | 1582 | 1396 | 186 | 7.2 | 174 | 95 | 502 | 502 | 708 | 0.7 | 61 | 1.92 | 2.1 | 29 | 2.12 | 11.12 |
| 29 | 18/12/2013 | 22 | 7.2 | 1583 | 1348 | 235 | 3.7 | 195 | 90 | 439 | 439 | 901 | 0.48 | 65 | 1.82 | 2.2 | 30 | 2.56 | 11.09 |
| 30 | 25/12/2013 | 23 | 7.4 | 1432 | 1280 | 146 | 4.5 | 157 | 85 | 466 | 466 | 721 | 0.64 | 69 | 1.63 | 1.9 | 26 | 2.79 | 10.61 |
| Maximum | | 25 | 7.4 | 1632 | 1396 | 390 | 9 | 241 | 121 | 491 | 589 | 904 | 0.95 | 99 | 2.15 | 2.5 | 35 | 4.26 | 11.78 |
| Minimum | | 21 | 7 | 1396 | 1231 | 95 | 1.2 | 108 | 41 | 312 | 405 | 583 | 0.46 | 31 | 0.2 | 1.6 | 19 | 0.92 | 6.72 |
| Mean | | 22.7 | 7.23 | 1509.83 | 1310.63 | 196.63 | 3.66 | 159.5 | 87.5 | 369.2 | 452.66 | 777.08 | 0.594 | 64.33 | 1.16 | 1.99 | 26.13 | 2.49 | 9.63 |

Table 4.2 shows the coefficient correlations

| | Temp | pH | Total solids | Dissolved solids | Suspended solids | Settleable solics | alkalinity | chlorides | Total hardness | BOD | COD | BOD/COD | Sulphates | phosphates | Ammonical nitrogen | Nitrite | Nitrate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 0.274 | - | -0.22 | 0.026 | -0.201 | 0.088 | -0.068 | -0.097 | 0.117 | -0.18 | -0.2 | 0.139 | 0.329 | 0.053 | -0.001 | -0.082 | 0.184 |
| Total solics | 0.101 | | - | 0.252 | 0.711 | 0.308 | 0.29 | -0.255 | 0.308 | 0.484 | 0.116 | 0.225 | 0.134 | 0.266 | -0.042 | 0.29 | 0.152 |
| Dissolved solics | -0.043 | 0.026 | 0.252 | - | -0.49 | -0.162 | 0.161 | -0.219 | -0.155 | 0.078 | -0.276 | 0.457 | 0.358 | -0.003 | 0.355 | -0.217 | 0.184 |
| Suspended solids | 0.126 | -0.201 | 0.711 | -0.49 | - | 0.376 | 0.146 | -0.09 | 0.256 | 0.252 | 0.375 | -0.121 | -0.165 | 0.26 | -0.296 | -0.374 | -0.003 |
| Settleable solics | 0.465 | 0.088 | 0.308 | -0.162 | 0.376 | - | 0.15 | -0.112 | 0.438 | 0.256 | -0.055 | 0.117 | -0.028 | -0.209 | 0.114 | -0.067 | 0.184 |
| Alkalinity | -0.154 | -0.068 | 0.29 | 0.161 | 0.146 | 0.15 | - | -0.166 | -0.178 | 0 | -0.189 | 0.195 | 0.207 | 0.136 | -0.101 | 0.119 | 0.136 |
| Chlorides | -0.192 | -0.097 | -0.255 | -0.219 | -0.09 | -0.112 | -0.166 | - | 0.144 | -0.011 | -0.117 | 0.126 | -0.252 | 0.207 | 0.244 | 0.209 | -0.249 |
| Total hardness | 0.194 | -0.117 | 0.308 | -0.155 | 0.256 | 0.438 | -0.178 | 0.144 | - | 0.185 | 0.169 | -0.088 | -0.076 | 0.145 | -0.079 | 0.187 | -0.703 |
| BOD | -0.078 | -0.18 | 0.484 | 0.078 | 0.252 | 0.256 | 0 | -0.011 | 0.185 | - | 0.159 | 0.408 | 0.11 | 0.038 | -0.105 | 0.162 | -0.125 |
| COD | 0.078 | -0.2 | 0.116 | -0.276 | 0.375 | -0.055 | -0.189 | -0.117 | 0.169 | 0.159 | - | -0.614 | -0.253 | 0.188 | -0.284 | 0.125 | -0.027 |
| BOD/COD | 0.092 | 0.139 | 0.225 | 0.457 | -0.121 | 0.117 | 0.195 | 0.126 | -0.088 | 0.408 | -0.614 | - | 0.306 | -0.08 | 0.312 | 0.026 | -0.088 |
| Sulphates | 0.041 | 0.329 | 0.134 | 0.358 | -0.165 | -0.028 | 0.207 | -0.252 | -0.076 | 0.11 | -0.253 | 0.306 | - | -0.107 | -0.122 | -0.022 | -0.167 |
| Phosphates | -0.204 | 0.053 | 0.266 | -0.003 | 0.26 | -0.209 | 0.136 | 0.209 | 0.145 | 0.038 | 0.188 | -0.08 | -0.107 | - | -0.133 | 0.469 | 0.235 |
| Ammonical nitrogen | 0.315 | -0.001 | -0.042 | 0.355 | -0.296 | 0.114 | -0.101 | 0.244 | -0.079 | -0.105 | -0.284 | 0.312 | -0.122 | -0.133 | - | -0.105 | 0.078 |
| Nitrite | -0.218 | -0.082 | 0.29 | -0.217 | -0.374 | -0.067 | 0.11 | 0.209 | 0.187 | 0.162 | 0.125 | 0.026 | -0.023 | 0.469 | -0.105 | - | 0.02 |
| Nitrates | -0.134 | 0.184 | 0.152 | 0.184 | -0.003 | 0.184 | 0.136 | -0.249 | -0.703 | -0.125 | -0.027 | -0.088 | -0.167 | 0.235 | 0.078 | 0.02 | - |

*B.* Discussion

1. The hydrogen ion concentration expressed as pH is a valuable parameter in the operation of biological units. The observed average value of pH of the sewage is 7.23 which are slightly more than the water supplied to the community. The Composition of pH in domestic sewage is from 6.5 to 8.5.
2. In general, under Indian condition the temperature of the raw sewage was observed to be between 15 to 35$^{O}$C at various places in different seasons. Observed average temperature of sewage sample 22.7$^{o}$C which is near the ideal temperature for biological activities
3. The sewage solids may be classified into dissolved solids, suspended solids and settleable solids. In general the concentration of total solids in untreated wastewater as per Indian condition is from 350 to 1300mg/L. the average value of total solids as shown in table 4.1 of Bidar city is 1509.83 mg/L which is in the general concentration of Domestic sewage.
4. Nitrogen content in the untreated sewage is observed to be in the range of 20 to 50 mg/L. Nitrogen being an essential component of biological protoplasm, its concentration is important for proper functioning of biological treatment systems and disposal on land. The mean value of nitrogen content of Bidar city sewage is 26.13mg/L which indicates that the sewage is weak in its nitrogen content.
5. The observed mean value of chlorides 87.5mg/L shows that the Concentration of chlorides in sewage is very much greater than the normal chloride content of water supply. The typical range of chloride content in an untreated wastewater is from 30 to 100mg/L
6. The general range of BOD observed for raw sewage is 100 to 400 mg/L. the average value of five day BOD observed is 452.66mg/L The high values of BOD and zero DO in sewage indicates heavy organic load in sewage this may be due to discharge of wastes from several slaughter houses and meat shops in the town. The COD of raw sewage at various places in general is reported to be in the range 200 to 700 mg/L. the observed mean value is 777mg/L shows sewage is very strong in its COD content.
7. After a detailed study of the results obtained by analyzing the sewage we can conclude that the sewage from Bidar town has high organic loads and a high concentration of bicarbonates, chlorides and solids.
8. Hence the sewage cannot be left untreated as the organic load which is highly biodegradable will soon decompose causing evolution of foul gases thus polluting the environment and may create a great public health hazard in future. Therefore it is imperative that the sewage be treated suitably before it can be safely disposed.

The line of treatment suggested is primary treatment (involving screening & grit chamber) and secondary treatment (involving the activated sludge process).The sludge obtained may be digested an aerobically in sludge digesters and dried on sand drying beds. The dried sludge may be used as manure and the effluent may be utilized in several ways. Based on the results of the analysis of the sewage, a treatment plant is designed.

## V. CONCLUSION

A sanitary survey was taken up and it was observed that no industry existed in the area covered by the area under study. Hence no industrial effluent discharged conjoins the sewage system. Since the B.O.D/C.O.D ratio lies near the range of generally accepted ratio of 0.68. The BOD/COD value 0.74 which is slightly higher than 0.68 but still nearer to said value, it can be concluded from the study that the sewage is organic in nature. By analysis the wastewater is amenable for biological treatment

The values of BOD, COD, Total Solids, Dissolved Solids, and Suspended Solids etc in sewage sample indicate that the sewage sample of Bidar city is organic in nature. The treatment units designed are as follows

1. Bar **scr**eens are provided with steel bars 10 mm wide and placed at 20 mm clear spacing. Two screening units are provided to take care of the peak flow together.
2. Two horizontal flow type grit chambers are provided. Dimensions of grit chamber are 8.2 m (length) × 6 m (depth) ×3m (top width).
3. Two primary sedimentation tanks are provided to handle the average flow together and dimension of each tank are 35 m diameter and total depth of 2.9 m.
4. Four aeration tanks are provided each of dimensions 38m x 25m x 4.5m width 1350 diffuser plates standard size.
5. Two secondary sedimentation tanks are provided each of dimensions 50m diameter and a total depth of 3.5.
6. Two sludge digestion tanks are provided to digest sludge from primary and secondary settling tanks with a digestion period of 45 days each tanks has dimensions 15m diameter and depth 6m with and additional hoppered bottom for storing sludge.
7. Sludge drying beds 24 in number are provided each of dimensions 15 m x 30 and sludge is spread in 20 cm thick layer.

## REFERENCES

1. American Public Health Association (APHA), American Water Works Association(AWWA) & Water Environment Federation (WEF), Standard Methods for the Examination of Water and Wastewater, 21st Edition
2. American Society of Civil Engineers, Sulfide in Wastewater Collection and Treatment Central Public Health and Environment Engineering Organization, "Ministry of Working and Housing New Delhi"
3. Chang, N. B.; Chen, W. C.; Shieh, W. K. (2001) Optimal Control of Wastewater Treatment Plant via Integrated Neural Network and Genetic Algorithms. Civil Eng. Environ. Syst., 18 (1), 1–17.
4. Chen H. and Shonnard USA 1988 Systematic Framework for Environmentally Conscious Chemical Process Design; early and detailed design stages Ind; Eng, Chem., Res 2004
5. Douglas J.M. Conceptual Design of Chemical Processes, McGraw Hill, New York.
6. Gulyas, H. (1997) Discharge of organic contaminants to rivers with treated municipal wastewater. In: Water Pollution IV: Modeling, Measuring and Prediction, R. Rajar and C.A. Brebbia, eds. Computational Mechanics Publications Southampton (U.K.), Pp. 711-722.
7. Henze, M. and Ledin, A.(2001) Types, characteristics and quantities of domestic wastes In: Decentralized sanitation and reuse, concepts, systems and implementation (eds. Lens, P., Zeeman,G., Lettinga, G). IWA Publishing.
8. IS: 3025 (PART 15) – 1984, Methods of sampling and test (Physical and chemical) for Water and Waste Water, Part 15 - Total Residue (Total Solids-Dissolved and Suspended).