Introduction:
The chief sources of Godavari river water pollution identified as sewage constitute 84-92% and industrial waste 8-16%. In a thermal power station, water plays an important role in generation of electricity. Raw water lifted from downstream of Godavari, is treated chemically and de-mineralised water is produced. It is used for generation of steam. Coal is pulverized and blown in the furnace with air and heat is liberated which is used for converting water (demineralised) into steam. This steam of high temperature and pressure is passing through turbine blades, which rotate the turbine. The turbine is coupled to a generator, which produces electricity. The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river i.e. after Gangawadi. For treatment of such contaminated water huge chemicals are required for production of filtered water (sump water), which leading to high chemical cost. To overcome from these difficulties due to polluted water, the quality assessment of intake water of Nashik Thermal Power Station is necessary for cost effective generation.

Study area:
Nashik Thermal Power Station (NTPS) is a unit of generation of electricity. It is located at Eklahare, which is 6 Km away from Nashik Road. NTPS is situated at Latitude 19.97 ° North with Longitude 73.89 ° East. Its total generation capacity is 630 mw through 3 sets of 210 mw. NTPS is situated on the bank of the Godavari river.

Methodology:
The six sampling stations were selected in order to get representative samples of natural and polluted water, covering 14.0 km. area approximately from Tapovan to Odha. Sampling stations have been referred as SN 1 - Tapovan before Sewage Treatment Plant, SN 2 - Tapovan after Sewage Plant, SN 3 - Dasak Bridge (Sant Janardan Swami Bridge), SN 4 - Gangawadi, SN 5 - Inlet to WTP-II of NTPS, SN 6 - Odha. Water samples from the sampling stations were collected monthly, during period March 08 – April 09 and physico-chemical and chemical parameters were analyzed by the standard methods. The pollution level over a period of time is increasing on the river water mainly due to sewage, industrial and other wastewaters are directly discharge in the river. The use of Godavari river water is, mainly for domestic, industrial, agricultural purpose and huge amount of water is also utilized by Nashik Thermal Power Station for electricity generation. Hence the present study is aimed to examine the water quality of the Godavari river and to evaluate the impact of such contaminated water.

Results AND Discussion
The analysis results of study sites with BIS limits are given in table 1, 2 and 3. Conductivity of the Godavari river ranged from 236 to 1438 µS/cm at various sampling sites. The conductivity values were higher at Dasak Bridge sampling station (SN-3) because Nasardi river contain domestic sewage as well as industrial effluents and joins the Godavari river. On other hand, the leaching of chemical fertilizers spread on agricultural lands by rainwater also causes high chemical oxygen demand (COD). The same was observed in this study. The TDS of the Godavari river ranged from 113 to 935 mg/l at various sampling sites. The higher value of TDS was observed at SN-3 due to mixing of sewerage, detergent and soaps required for cloth washing and mixing of industrial effluent in the Godavari river. The higher TDS values were observed for Noyyal river by Suthar, (2010). The concentration of total suspended solids was ranged from 24 to 225 mg/l at all sampling stations. The high total suspended solids are due to the direct input of massive local discharges of the Nashik city and industries, mixing of Nasardi river effluents in the Godavari river. The pH values were ranged 7.00 to 8.1. The higher pH at some sites could be due to bicarbonates and carbonates of calcium and magnesium in water. The concentration of dissolved oxygen in the Godavari river water ranged minimum 2.80 for sampling station no 2 and 3 for the month of June 08 and maximum 6.20 observed for sampling station no 4 for the month of March 08. The depletion of DO values indicates that the Godavari river was polluted. The low DO values were observed in the Godavari river in MERI report, (2001) and Chalakudy river by Chattopadhyay, (2005). Higher values of BOD and lower values of DO indicate more amount of organic matter present in sewage water (Wagh Vaishali, 2005). The concentration of BOD in the Godavari river water ranges for 5 to 69 mg/l at various sampling stations ranges, minimum ( sampling station no 5 in the month of May 08) and maximum 69 mg/l (sampling station no 4 in the month of July 08). The concentration of COD of the Godavari river water ranged from minimum 16.0 (sampling station no 5 in the month of May 08) and maximum 208 mg/l (sampling station no 4 in July 08). The high value of COD is due to mixing of domestic and industrial effluent in the river water. The concentration of hardness in the Godavari river water ranged minimum 96 mg/l (sampling station no1 and 2 in the month of December 08 and April 08) and maximum 324 (very hard) mg/l (sampling station no 5 in the month of Oct 08). The higher total hardness was due to mixing of domestic effluents in the river water and anthropogenic activities. The higher range of hardness for the Godavari river reported by Gaikwad, (2000) and for the Kanhan and Pench rivers reported by Khadse et al., (2008) due to mixing of urban runoff. The concentration of chloride in the Godavari river water ranged minimum 50 mg/l (sampling station no 1 in the month of December 08) and maximum 240 mg/l (sampling station no 4
in the month of July 08). The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin. The higher concentration of chloride observed for Kanhan and Pench by Khadse (2008). The concentration of sulphate in the Godavari river water ranges at all sampling stations ranged from minimum 7.13 mg/l (sampling station no 6 in the month of May 08) and maximum 66 mg/l (sampling station no 4 in the month of March 08). The increase in sulphate level at sampling station no may also due to human activities along the riverbank and leaching from fertilized and irrigated agricultural land. The higher sulphate values were observed for Hindon river by Suthar, (2010). The concentration of phosphate in the Godavari river water ranged from minimum 1.8 mg/l (sampling station no 1 in December 08) and maximum 4.95 mg/l (sampling station no 6 in Nov 08) at all sampling stations, the high value was due to constant contamination of domestic sewage, cloth washing, bathing, decay of aquatic organisms and mankind activities. Similar corroboration between amount of phosphate and human activities was observed by Welch (1952) and Hutchinson (1957), Cauvery river by Solaraj, (2009) and Chalakudy river by Chattopadhyay, (2005). The concentration of nitrate in the Godavari river water at all sampling stations ranged from minimum 1.40 mg/l (sampling station no2 in April 08) and maximum 4.95 mg/l (sampling station no 3 in October 08). Higher nitrate content was observed by Suthar, (2010) in Hindon river and Meeri report, (2001), it was due to mixing of sewage water in the river.

Difficulties in production of demineralized and soft water at Nashik TPS: The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river i.e. after Gangawadi. For treatment of such contaminated water huge chemicals are required for production of filtered water (sump water), which is being used for production of demineralized, domestic and soft water. The dematerialized water is used for production of steam in boiler and the soft water is used for cooling of steam in condensers. The dematerialized and softening plant of Nashik Thermal Power Station was designed for important water parameters total hardness 178-mg/l and chlorides 50 mg/l. The present study reveals that the water has high ionic loading i.e. maximum total hardness (324 mg/l), chlorides (240 mg/l) and high microbial contamination, hence it is a very difficult task to produce demineralized water having conductivity less than 1 µs/cm. Due to successive regenerations, chemicals, manpower and energy cost is high.

Nashik TPS incurs high (1.7 times) expenses on chemicals as compared to other TPS in Mahagenco. NTPS has installed separate domestic water pipeline for drinking purposes from Chehedi pumping station of Darana river which leads in cost.

### Table 1 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

| SN | Cond | TDS (mg/l) | TSS (mg/l) | pH | DO(mg/l) | BOD (mg/l) |
|---|---|---|---|---|---|---|
| **BIS limit** | - | 500 mg/l | - | - | - | - |
| Ranges | Avg | Ranges | Avg | Ranges | Avg | Ranges | Avg |
| SN 1 | 236-1352 | 568.67 | 113-880 | 365.67 | 28-216 | 74.83 | 7.7-7.6 | 7.31 | 3-6 | 5.1 | 8-40 | 18.5 |
| SN 2 | 240-1335 | 617.92 | 115-868 | 387.58 | 28-130 | 73.17 | 7-7.5 | 7.65 | 3-6 | 4.9 | 7-35 | 19.2 |
| SN 3 | 258-1438 | 656.58 | 134-935 | 410.75 | 30-225 | 71 | 7.15-7.7 | 7.46 | 2.8-6 | 4.52 | 8-41 | 24.92 |
| SN 4 | 323-1385 | 669.92 | 158-900 | 419.08 | 24-210 | 69.42 | 7.1-7.94 | 7.52 | 3-6.2 | 4.43 | 8.1-69 | 27.01 |
| SN 5 | 385-1369 | 701.67 | 219-890 | 429.17 | 26-160 | 67.25 | 7.05-8 | 7.54 | 3.5-6.1 | 4.76 | 5-35 | 19.44 |
| SN 6 | 415-1352 | 783 | 270-880 | 478.42 | 28-130 | 73.17 | 7-8.1 | 7.55 | 3.8-6 | 4.95 | 8-36 | 19.89 |

### Table 2 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

| SN | COD (mg/l) | TH (mg/l) | Ca H | MgH | Cl (mg/l) | SO₂ (mg/l) |
|---|---|---|---|---|---|---|
| **BIS limit** | 150 mg/l | 300 mg/l | 75 mg/l | 30 mg/l | 250 mg/l | 200 mg/l |
| Ranges | Avg | Ranges | Avg | Ranges | Avg | Ranges | Avg |
| SN 1 | 22-120 | 55.17 | 96-270 | 177.33 | 72-162 | 116.75 | 20-150 | 60.33 | 50-152 | 89.17 | 10.18-48.1 | 22.66 |
| SN 2 | 23-110 | 61.42 | 96-268 | 195.17 | 72-180 | 119.82 | 24-142 | 75.33 | 56-200 | 110 | 10- 48.31 | 22.47 |
| SN 3 | 24-128 | 75.70 | 120-290 | 205.25 | 72-175 | 119.08 | 48-160 | 86.17 | 63-150 | 108.33 | 11.45-50.14 | 24.53 |
| SN 4 | 25-208 | 80.58 | 140-260 | 206 | 86-170 | 130.75 | 40-135 | 76.08 | 56-240 | 112.08 | 15.46-65.99 | 31.06 |
| SN 5 | 16-110 | 58.17 | 128-324 | 216.33 | 80-180 | 132.92 | 47-172 | 83.42 | 56-220 | 122.33 | 8.17–51.99 | 27.83 |
| SN 6 | 26-108 | 61.33 | 130-275 | 209.42 | 82-182 | 131.92 | 48-124 | 77.5 | 58-185 | 121.83 | 7.13–47.6 | 25.47 |

### Table 3 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

| SN | PO₄ (mg/l) | NO₃ (mg/l) | Sio₂ | Zn | Fe |
|---|---|---|---|---|---|
| **BIS limit** | - | 45 mg/l | 5 mg/l | 0.3 mg/l |
| Ranges | Avg | Ranges | Avg | Ranges | Avg | Ranges | Avg | Ranges | Avg |
| SN 1 | 1.8 – 4.5 | 3.12 | 1.42 – 4.8 | 3.19 | 13.37 – 35.75 | 23.99 | 0.12 | 0.55 | 0.32-1.2 | 0.73 |
| SN 2 | 1.54-5.0 | 3.47 | 1.4 – 3.4 | 2.33 | 14.01 – 39.28 | 26.38 | 0 – 1.28 | 0.6 | 0.34-2.32 | 0.92 |
| SN 3 | 2.16-4.9 | 3.49 | 1.68 – 4.06 | 2.8 | 12.31 – 39.41 | 26.11 | 0 – 1.31 | 0.73 | 0.4-1.38 | 0.83 |
| SN 4 | 2.63-4.81 | 3.93 | 1.85 – 3.5 | 2.66 | 16.2 – 34.02 | 25.43 | 0 – 1.3 | 0.61 | 0.44– 1.4 | 0.79 |
| SN 5 | 2.3 – 4.5 | 3.44 | 1.90-4.20 | 2.92 | 16.6 – 34.56 | 26.83 | 0 – 1.35 | 0.64 | 0.33-1.36 | 0.77 |
| SN 6 | 2.34-4.95 | 3.88 | 1.82-3.9 | 2.74 | 21.87 –34.04 | 27.93 | 0 – 1.32 | 0.73 | 0.33-1.27 | 0.75 |
Table 3: Pearson correlation coefficients between the water quality parameters for the various sampling stations for March 08 - February 09.

|          | pH  | COND   | TDS | TSS | TH | Ca H | Mg H | CL | DO  | BOD | COD | SO4 | PO4 | NO3 | SIO2 | Zn | Fe  |
|----------|-----|--------|-----|-----|----|------|------|----|-----|-----|-----|-----|-----|-----|-----|----|-----|
| pH       | 1   |        |     |     |    |      |      |    |     |     |     |     |     |     |     |    |     |
| COND     | .962** | 1     |     |     |    |      |      |    |     |     |     |     |     |     |     |    |     |
| TDS      | .949** | .991** | 1   |     |    |      |      |    |     |     |     |     |     |     |     |    |     |
| TSS      | -.582 | -.392 | .310 | 1   |    |      |      |    |     |     |     |     |     |     |     |    |     |
| TH       | .899* | .843* | .778 | .800 | 1  |      |      |    |     |     |     |     |     |     |     |    |     |
| Ca H     | .317 | .167   | .232 | -.146 | .025 | 1   |      |    |     |     |     |     |     |     |     |    |     |
| Mg H     | .036 | .132   | .012 | -.286 | .380 | -.654 | 1   |    |     |     |     |     |     |     |     |    |     |
| CL       | .804 | .892* | .832 | .404 | .847* | -.200 | .547 | 1  |     |     |     |     |     |     |     |    |     |
| DO       | -.405 |-.273 | .247 | .691 | -.563 | -.136 | -.100 | -.167 | 1  |     |     |     |     |     |     |    |     |
| BOD      | .307 | .197   | .218 | -.424 | .335 | .299 | .180 | -.026 | -.930** | 1  |     |     |     |     |     |    |     |
| COD      | .299 | .216   | .232 | -.386 | .341 | .240 | -.084 | .030 | -.924** | .991** | 1  |     |     |     |     |    |     |
| SO4      | .669 | .470   | .460 | -.768 | .633 | .697 | -.175 | .231 | -.705 | .649 | .605 | 1   |     |     |    |     |
| PO4      | .877* | .771   | .802 | -.545 | .719 | .499 | -.343 | .455 | -.590 | .602 | .553 | .775 | 1   |    |    |     |
| NO3      | -.143 |-.274 | .213 | .064 | -.299 | .265 | -.745 | -.497 | .282 | -.200 | -.327 | -.033 | .124 | 1   |    |     |
| SIO2     | .765 | .889* | .844* | -.269 | .776 | -.223 | .521 | .981** | -.164 | .023 | .093 | .159 | .435 | -.572 | 1  |    |     |
| Zn       | .694 | .784   | .785 | -.206 | .667 | -.298 | .136 | .731 | -.328 | .277 | .295 | .097 | .625 | -.163 | .774 | 1  |    |
| Fe       | -.272 |-.150 | .229 | .005 | .038 | -.622 | .833* | .199 | -.227 | .101 | .216 | -.279 | -.473 | -.848* | .259 | .001 | 1  |

*Correlation is significant at the 0.05 level (2 tailed)  **Correlation is significant at the 0.01 level (2 tailed)

Conclusion:
From the investigation of downstream of the Godavari river at Nashik city, it was concluded that the quality of the Godavari river is deteriorating day by day. The domestic wastewater of the city was a major factor that is responsible for the contamination of the Godavari river and can be recognized by the key parameters like DO, BOD, COD. The wastewater of the city was a major factor that is responsible for the contamination of the Godavari river and can be recognized by the key parameters like DO, BOD, COD. At sampling stations no 1, 3 and 4 the water quality is highly polluted low DO and high BOD was observed. This is due to mixing of Nashik city effluents at sampling station no 1 and Nasardi effluents that contain high organic load before this sampling station no 3. The high BOD values observed at sampling stations no 4 (Gangawadi) indicates that more amount of organic matter is present in sewage at this site. After this sampling station no 4 (Gangawadi) Nashik Thermal Power Station lifts water for power station use.

Recommendations to control contamination in study area:
The proper treatment should be given to the sewage and industrial effluents of Nashik city properly before discharging it into the river so as to reduce pollution load of the Godavari river water. NMC should ensure the availability and efficiency of existing sewage treatment plants. Nashik TPS should get rebate in charges paid to Irrigation department and MPCB cess. The water quality monitoring station will be necessary besides the proper enforcement of the present rules and regulations.

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