Research Article

# Water Quality Status of Denkada Anicut in Vizianagaram District of Andra Pradesh

G V S R Pavan Kumar *[1], K Narayana Rao[2], B Sreerama Murty [1]

[1]Department of Chemistry, Maharaj Vijayaram Gajapathiraj College of Engineering, Vizianagaram-535005, Andhra Pradesh
[2]Department of Chemistry, Maharajah's post graduate college, Vizianagaram-535002

**Abstract**

The present work aimed at the physico-chemical characterization and assessment of water quality in the reservoir of a dam, Denkada anicut, situated in Saripalli, Vizianagaram district of Andhra Pradesh. A study of water quality of the dam water was carried out to analyze various parameters, to determine the quality of the water of the dam and to assess whether the water is suitable for irrigation purpose as well for drinking purpose. Measurement of various parameters like pH, EC, TDS, DO, Ca, Mg, Na, K, chloride, phosphate, nitrite etc, by the authors gave information about the viable quality of the water of the dam. Also contents of chlorides, TDS, SAR, Na% and RSC are within the limits accepted for irrigation, WQI of the dam found to be <50 indicating the water portability. It was found that the surface waters of the dam are not contaminated by effluents such as sewage and etc. Therefore, the authors conclude that the water can be classified as fit for irrigation purpose, in view of the reported data.

***Correspondence**
G V S R Pavan Kumar
prs_ganti@yahoo.co.in

**Keywords**: Dams, Denkada Anicut, water quality, physico-chemical characters.

## Introduction

A dam is a man made barrier that impounds surface flow water or underground streams. Dams generally serve the primary purpose of retaining water, while other structures such as floodgates or levees (dikes) are used to manage or prevent water flow into specific land regions. A dam can also be used for collection and storage of water, which can be evenly distributed between the adjoining locations.

Reservoirs are man-made lakes with vital aquatic ecosystems that serve important environmental and economic purposes, mainly potable water supply through ground percolation, hydel power, irrigation and fisheries. Expanding human population brought about by the opportunities of good water supply, irrigation, fish production recreation and navigation offered by reservoirs have put enormous stress on the quality of water impounded by the reservoir. The impact of human activities in and around the reservoir leaves mark on the changing physical and chemical properties of water on which the sustenance of fish that inhabit the reservoir. Water quality is determined by the physical and chemical limnology of a reservoir and includes all physical, chemical and biological factors of water that influence the beneficial use of the water. Water quality is important in drinking water supply, irrigation, fish production, recreation and other purposes to which the water must have been impounded.

Water quality deterioration in reservoirs usually comes from excessive nutrient inputs from the catchment area, eutrophication, acidification, organic pollution and obnoxious fishing practices. The effects of these "import" into the reservoir do not only affect the socio-economic functions of the reservoir negatively, but also bring loss of structural biodiversity of the reservoir. Djukic *et al.* (1994) have used the physico-chemical properties of water to assess the water quality of a reservoir. The use of the physico-chemical properties of water to assess water quality gives a good impression of its status, productivity and sustainability of such water body. The changes in physical characteristics like temperature, transparency and chemical elements of water, such as dissolved oxygen, chemical oxygen demand, nitrate and phosphate, provide valuable information on the quality of the water, the source(s) of the variations and their impacts on the functions and biodiversity of the reservoir.

Present study is aimed at assessing the water quality of Denkada anicut of Vizianagaram district of Andhra Pradesh for drinking and irrigation, using some selected physico-chemical properties. The results form the baseline for monitoring and tracking changes in the water quality as a result of the reservoir's natural dynamics over time or impact of human activities on the reservoir and its water shed.

Water quality monitoring of aquatic systems like dam or reservoir serves as a fundamental tool for planning and management of the river basin. The physical, chemical and biological characteristics of lakes vary widely. The impact of human activities directly influences lake habit and can alter the lake's environment. Water quality index is one of the most effective tools [1-4] to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment of water quality. Based on the WQI values the water was graded as excellent water quality and etc.

| WQI level | Water quality status |
|---|---|
| 0-25 | Excellent water quality |
| 26-50 | Good water quality |
| 51-75 | Poor water quality |
| 76-100 | Very poor water quality |
| >100 | Unsuitable for drinking |

The water quality index calculations are as follows

$W_i = k/S_i$

Where $W_i$ is the unit weight of and Si is the standard for $i^{th}$ parameter

K is the proportionality constant

$Q = 100V_i / S_i$

Where Qi is the sub index of the $i^{th}$ parameter, Vi is the monitored value of $i^{th}$ parameter and WQI is calculated as follows

$WQI = \sum Q_i W_i / \sum W_i$

A survey of literature [5-8] revealed that several researchers have studied water quality of lakes at global levels. Considering the impacts of industrialization on water quality of many dams and rivers as reported in literature, a study of water quality of Denkada anicut from December 2010 to April 2011, was carried out

(i) To evaluate the physical and chemical parameters of water of the reservoir
(ii) To see its suitability form drinking and irrigation.

## Experimental

### *Area under Study*

The Denkada Aniuct [9] (**Figure 1**) was constructed on the Champavathi River during 1965-68. The project is located near Saripalli1 [10] village, Nellimarla [11] (**Figure 3**) Mandal of Vizianagaram District (**Figure 2**), to benefit a total ayacut area of 5,153 acres in the District. Nellimarla is a Mandal and town ship located in Vizianagaram district of Andhra Pradesh in India. Nellimarla is located on the banks of Champavathi River at $18^0$16.67"N $83^0$.43'33"E. It has an average elevation of 190 meters (626 ft). The project utilizes 0.640 TMC of the available water. The dam is located at Saripalli village, close to Nellimarla by 1-2km.


**Figure 1** Denkada anicut through Google


**Figure 2** Vizianagaram district mandal wise map, nellimarla mandal (24)


**Figure 3** Nellimarla mandal and saripalli village through Google

### Sampling

In the present study, integrated sampling procedures were adopted, in order to get water samples that truly represent the water quality of the entire anicut. Five different sampling stations were identified and samples were collected and mixed to get an integrated sample. The samples were collected from December 2010 to April 2011 on fortnightly basis, to ensure any significant changes in the quality of the water.

## Materials and Methods

For the physico-chemical characterization, the water samples were collected in PVC bottles and samples for DO in BOD bottles. All the spectrophotometric measurements were made by using scanning visible spectrophotometer SL-177. Sodium and potassium in the samples were determined by using microprocessor based flamephotometer CL-361. All the chemicals used were of AR grade. Standard methods of APHA [12] were used for the analysis of water samples.
Suitability of water for irrigation [13] is evaluated by % Na given by

$$Na\% = 100 \times Na^{+} / (Na^{+} + Ca^{+2} + Mg^{+2} + K^{+})$$

Bicarbonate is expressed as residual sodium carbonate (RSC) given by the equation

$$RSC = (CO_3^{2-} + HCO_3^{-}) - (Ca^{+2} + Mg^{+2})$$

Sodium absorption ratio (SAR) used to evaluate alkali hazards is calculated as

$$SAR = Na^{+} / \sqrt{(Ca^{+2} + Mg^{+2})/2}$$

Magnesium hazard ratio [13] is calculated as Mg Hazard

$$= 100 \times Mg^{+2} / (Ca^{+2} + Mg^{+2})$$

## Results and Discussion

The water quality data of the samples analyzed at Denkada anicut were reported in **Table 1**. The following are the conclusions of the study.

DO play a vital role in assessing the water quality and to study the physical and biological processes prevailing in water. Good water should have 14.6, 7.6 and 7.0 mg/L of DO at 0, 30 and 35 $^{o}$C respectively. DO in Denkada anicut was found in between 6.5-8.2 mg/L and temperature ranged from 23-30 $^{o}$C. This value of DO is in good agreement with the prescribed standard value indicating the absence of any organic pollutants in the waters.

The pH of most of the natural waters falls into the range of 5.5 to 8.5. In general, most of the waters are slightly alkaline, due to the presence of dissolved carbonates and bicarbonates. Acidic contamination was not found in the water samples analyzed at Denkada anicut, as the pH of the samples was found to vary from 7.2 to 8.8. This value of pH is in accordance with the prescribed standard value.

**Table 1** seasonal variation in the parameters analyzed

| Date | 5 Dec 2010 | 19 Dec 2010 | 2 Jan 2011 | 16 Jan 2011 | 31 Jan 2011 | 13Feb 2011 | 20Feb 2011 | 13 Mar 2011 | Standards IS:10500 |
|---|---|---|---|---|---|---|---|---|---|
| DO | 6.5 | 6.9 | 7.2 | 7.3 | 7.4 | 8.1 | 7.8 | 7.9 | 14.6 |
| Temp | 21 | 25 | 27 | 30 | 27 | 25 | 27 | 30 | |
| pH | 8.8 | 7.4 | 8.1 | 8.3 | 7.6 | 8.1 | 7.9 | 8.6 | 6.5-8.5 |
| EC | 390 | 330 | 360 | 360 | 420 | 360 | 410 | 420 | |
| Turbidity | 1 | 2 | 1 | 3 | 1 | 2 | 3 | 1 | 5NTU |
| Nitrite | ND | 0.01 | 0.08 | 0.3 | 0.1 | 0.09 | 0.1 | 0.2 | <1ppm |
| Phosphate | ND | ND | ND | ND | ND | ND | ND | ND | 10ppm |
| BOD | 1.4 | 1.5 | 1.4 | 1.4 | 1.5 | 1.6 | 1.5 | 1.4 | |
| COD | 7.2 | 8.4 | 9.1 | 6.9 | 6.2 | 7.5 | 8.8 | 9.2 | |
| TDS | 100 | 280 | 250 | 210 | 260 | 160 | 210 | 280 | 500ppm |
| Carbonate | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | |
| Bicarbonate | 183.6 | 183.6 | 183.6 | 235.5 | 183.6 | 220.3 | 234.8 | 183.6 | |
| THW | 201 | 201 | 151 | 201 | 151 | 201 | 201 | 201 | 300ppm |
| Ca | 40.3 | 40.3 | 40.3 | 40.3 | 40.3 | 40.3 | 40.3 | 40.3 | 70ppm |
| Mg | 24.2 | 24.2 | 12.2 | 24.1 | 12.2 | 24.2 | 24.2 | 24.2 | 30ppm |
| Na | 9.8 | 4.2 | 10.5 | 16.2 | 10.4 | 11.2 | 12.6 | 16.2 | 100ppm |
| K | 2.5 | 2.2 | 6.2 | 2.5 | 6.4 | 6.6 | 6.8 | 2.6 | 10ppm |
| Cl | 51.7 | 69.1 | 51.7 | 51.7 | 62.3 | 52.2 | 51.7 | 62.4 | 250ppm |
| Boron | ND | ND | ND | ND | ND | ND | ND | ND | 1ppm |
| **Parameters for irrigation** | | | | | | | | | |
| SAR | 0.007 | 0.01 | 0.02 | 0.03 | 0.03 | 0.04 | 0.05 | 0.06 | <10 |
| Na% | 1.1 | 2.1 | 4.1 | 4.1 | 5.1 | 6.1 | 7 | 7.9 | <60 |
| Mg hazard | 50 | 50 | 33.5 | 49.9 | 50 | 50 | 50 | 50 | |
| RSC | 0.22 | 0.22 | 1.2 | 1.08 | 0.22 | 0.79 | 1.07 | 0.22 | <1.25 |

Turbidity of water is the other important parameter in monitoring proper filtration and to determine the treatment procedures with different dosages of chemicals at water works. A survey of literature indicated that, the values of turbidity for the samples collected from Chatri Lake situated about 3km away from Amaravathi city were found to be as 49.5-84.5 NTU during Feb-May 1997 [14]. At Denkada anicut the turbidity of water samples was found ranging from 1.0-3.0 NTU. These values are well within the limits of IS: 10500, indicating that the water is free from suspended contaminants.

Water samples analyzed at Denkada anicut were found to have a zero concentration of total phosphates. The nitrite in the present investigation was found to vary from 0.01-0.3 mg/L, which is well within the limit prescribed. BOD of water samples collected from Denkada anicut ranged from 1.4-1.6 mg/L, the water was found to be safe and clean with respect to BOD according to the classification of Royal Commission [13]. The COD values in the present investigation were found to be in the range of 6.2-9.1 mg/L, which are well within the limits prescribed.

The water samples collected from Denkada anicut in the present work were found to have electrical conductivity values from 330-420 µmho/cm. The water samples analyzed showed TDS=100-280 mg/L, alkalinity =223.7mg/L, total hardness =151-201 mg/L, calcium= 40.3 mg/L and magnesium = 12.2-24.2 mg/L. These values are in the prescribed limits. Thus, the water is safe for drinking with respect to TDS, alkalinity, hardness, calcium and magnesium.

Na ion is a highly significant constituent with respect to irrigation waters, when compared to drinking and industrial purposes. $Na^+$ when present as NaCl in concentration more than 500 mg/L makes the water unpalatable and causes appetite disturbances [13]. The permeability of the soil will also be affected by the increased concentration of Na ion. In the present study, the values of $Na^+$ were found to be in the range 4.2-6.2 mg/L and which make the water potable. The other important parameter with respect to irrigation is chlorides. When the chloride in irrigation water is high (>10epm or 354.5ppm), it is likely to pose severe problems and affect the crop production adversely. In the present study, $Cl^-$ ranged from 21.7-69.1 mg/L and is in the prescribed limits [15].

The other parameters which play an important role in assessing the quality of the water for irrigation studied are, SAR, Na%, Mg hazard and RSC. In the present study, the water samples analyzed at Denkada anicut were found to have all these parameters well within the prescribed limits and are displayed in **Table 1**. And it was found by the authors that the water samples analyzed are free from boron contamination.

Water quality index (WQI) calculations were reported in **Tables 2, 3, 4** and **5**. From such calculations it was found that the values of WQI are found to be 22.6 in December, 34.0 in January, 26.5 in February and 38.5 in March in and are presented in **Figure 4** and **Figure 5**. It was found that WQI values of the dam in different seasons are in the range of 25-50 and rated as having a good water quality. From the reports obtained from the analysis of the water samples collected from the dam, it was found that all the parameters analyzed such as pH, EC, TDS, DO, Ca, Mg, Na, K, chloride, phosphate, nitrite etc are in well agreement with the prescribed standard limit values prescribed by IS: 10500. And from the report it was found that the surface waters of the dam are free from adulteration of any effluents. And thus the water from the dam is suitable for irrigation as well as drinking purpose.

**Table 2** WQI in the month of December 2010

| | Vi | Si | Qi | Wi | WIQi |
|---|---|---|---|---|---|
| pH | 8.1 | 8.5 | 97.8 | 0.085285 | 8.340878 |
| DO | 6.7 | 7 | 95.71429 | 0.10356 | 9.912211 |
| EC | 360 | 500 | 72 | 0.00145 | 0.104389 |
| TDS | 190 | 500 | 38 | 0.00145 | 0.055094 |
| THW | 201 | 300 | 67 | 0.002416 | 0.161899 |
| Ca | 40.3 | 70 | 57.57143 | 0.010356 | 0.596212 |
| Mg | 24.2 | 30 | 80.66667 | 0.024164 | 1.949237 |
| Na | 7 | 200 | 3.5 | 0.003625 | 0.012686 |
| K | 2.35 | 20 | 11.75 | 0.036246 | 0.425892 |
| nitrite | 0.01 | 1 | 1 | 0.724923 | 0.724923 |
| Cl | 60.4 | 250 | 24.16 | 0.0029 | 0.070057 |
| bicarbonate | 183.6 | 200 | 91.8 | 0.003625 | 0.33274 |
| | | | | WQI | 22.68622 |

**Table 3** WQI in the month of January 2011

| | Vi | Si | Qi | Wi | Wi Qi |
|---|---|---|---|---|---|
| pH | 8 | 8.5 | 94.11765 | 0.085285 | 8.026828 |
| DO | 7.3 | 7 | 104.2857 | 0.10356 | 10.79987 |
| EC | 380 | 500 | 76 | 0.00145 | 0.110188 |
| TDS | 240 | 500 | 48 | 0.00145 | 0.069593 |
| THW | 167.6667 | 300 | 55.88889 | 0.002416 | 0.13505 |
| Ca | 40.3 | 70 | 57.57143 | 0.010356 | 0.596212 |
| Mg | 16.16667 | 30 | 53.88889 | 0.024164 | 1.302176 |
| Na | 12.36667 | 200 | 6.183333 | 0.003625 | 0.022412 |
| K | 5.033333 | 20 | 25.16667 | 0.036246 | 0.912195 |
| nitrite | 0.16 | 1 | 16 | 0.724923 | 11.59877 |
| Cl | 55.23333 | 250 | 22.09333 | 0.0029 | 0.064064 |
| bicarbonate | 200.9 | 200 | 100.45 | 0.003625 | 0.364093 |
| | | | | WQI | 34.00145 |

**Table 4** WQI in the month of February 2011

| | Vi | Si | Qi | Wi | WIQi |
|---|---|---|---|---|---|
| pH | 8 | 8.5 | 94.11765 | 0.085285 | 8.026828 |
| DO | 6.7 | 7 | 95.71429 | 0.10356 | 9.912211 |
| EC | 385 | 500 | 77 | 0.00145 | 0.111638 |
| TDS | 185 | 500 | 37 | 0.00145 | 0.053644 |
| THW | 201 | 300 | 67 | 0.002416 | 0.161899 |
| Ca | 40.3 | 70 | 57.57143 | 0.010356 | 0.596212 |
| Mg | 24.2 | 30 | 80.66667 | 0.024164 | 1.949237 |
| Na | 11.9 | 200 | 5.95 | 0.003625 | 0.021566 |
| K | 6.7 | 20 | 33.5 | 0.036246 | 1.214246 |
| nitrite | 0.055 | 1 | 5.5 | 0.724923 | 3.987076 |
| Cl | 51.95 | 250 | 20.78 | 0.0029 | 0.060256 |
| bicarbonate | 227.55 | 200 | 113.775 | 0.003625 | 0.412391 |
| | | | | WQI | 26.50721 |

**Table 5** WQI in the month of March 2011

| | Vi | Si | Qi | Wi | WiQi |
|---|---|---|---|---|---|
| pH | 8.6 | 8.5 | 99.9 | 0.085285 | 8.519976 |
| DO | 7.9 | 7 | 112.8571 | 0.10356 | 11.68753 |
| EC | 420 | 500 | 84 | 0.00145 | 0.121787 |
| TDS | 280 | 500 | 56 | 0.00145 | 0.081191 |
| THW | 201 | 300 | 67 | 0.002416 | 0.161899 |
| Ca | 40.3 | 70 | 57.57143 | 0.010356 | 0.596212 |
| Mg | 24.2 | 30 | 80.66667 | 0.024164 | 1.949237 |
| Na | 16.2 | 200 | 8.1 | 0.003625 | 0.029359 |
| K | 2.6 | 20 | 13 | 0.036246 | 0.4712 |
| nitrite | 0.2 | 1 | 20 | 0.724923 | 14.49846 |
| Cl | 62.4 | 250 | 24.96 | 0.0029 | 0.072376 |
| bicarbonate | 183.6 | 200 | 91.8 | 0.003625 | 0.33274 |
| | | | | WQI | 38.52197 |

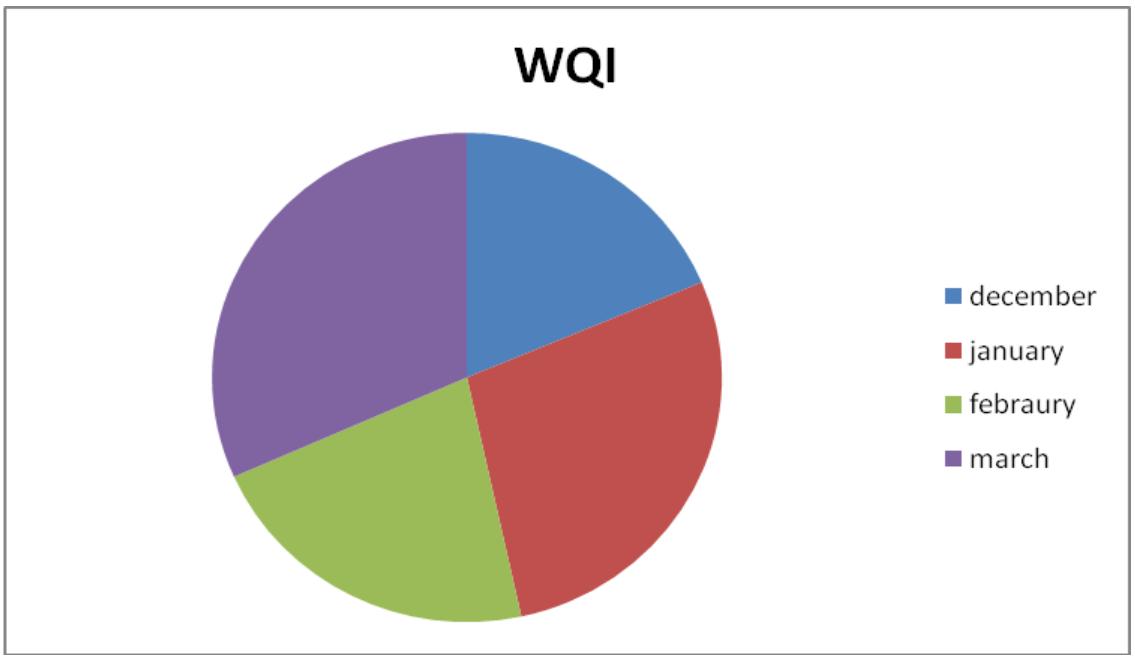


**Figure 4** WQI values in different months

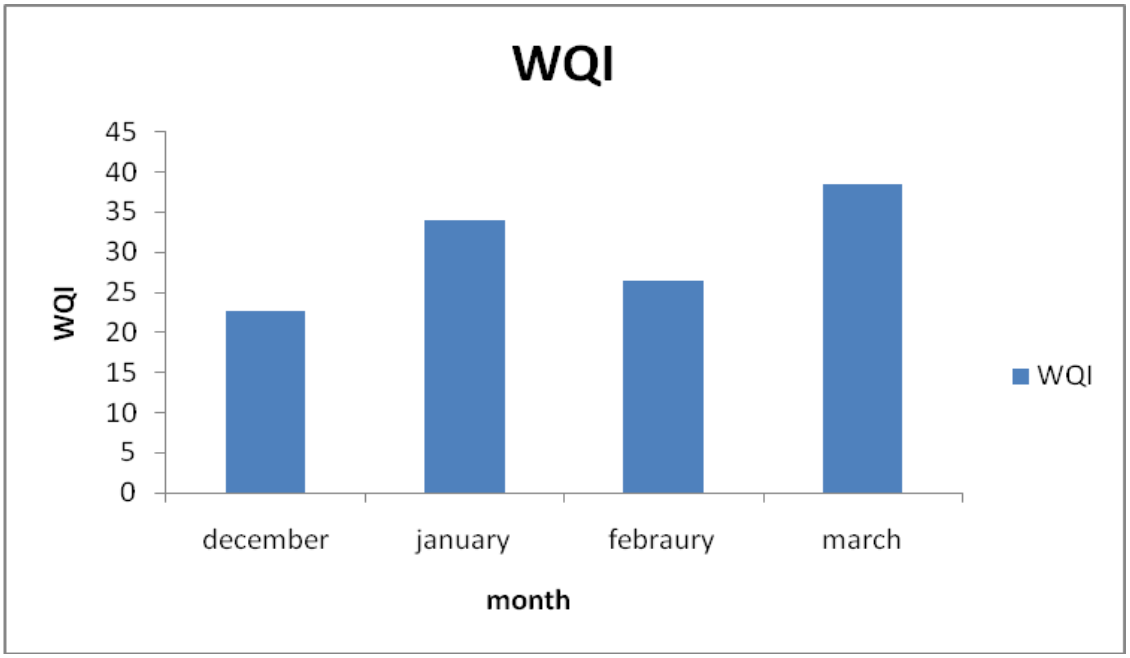


**Figure 5** WQI values in different months

## Conclusions

From the parameters studied, it is concluded that the water in the Denkada anicut reservoir is safe for drinking. The values of TDS, chloride, SAR, RSC, Mg hazard and Na % observed and reported are well within the limits. WQI of the water samples analyzed also found to be of excellent in their rating. Hence, it is concluded that the water is fit for irrigation purpose.

## Acknowledgements

The authors thank the management of Maharajah's Post Graduate College, Phool Baugh, Vizianagaram-535002 (India), for the facilities provided, support and encouragement.

## References

[1] Kuyucak, N., 2002. Acid mine drainage prevention and control options. CIM Bulletin 95 (1060): 96–102.
[2] Filipek, L.H., Hatton, C., Gusek, J. and T. Tsukamoto, 2003. Passive treatment of acid rock drainage (ARD): state of the practice. In: Proceedings of the Tenth International Conference on Tailings and Mine Waste, October, 2003, Colorado, USA, pp. 293–303.
[3] Modis, K., Adam, K., Panagopoulos, K. and A. Komtopoulos, 1998. Development and Validation of a geostatistical model for prediction of acid mine drainage in underground sulphide mines. J. Trans. Instn. Min. Metall. (Sect A: Min. Industry), A102–A107.
[4] Fiset, J.F., Zinck, J.M. and P.C. Nkinamubanzi, 2003. Chemical stabilization of metal hydroxide sludge. In: Proceedings of the X International Conference on Tailings and Mine Waste, October 2003, Vail, CO, USA, AA Balkema, pp. 329–332.
[5] Biswas A K and Tortajada C, Development of large dams: A global perceptive, *Inernat J Water Resources Devel*, **17**, 2001, pp 9-21.
[6] Ganesan M, jayabalan N and Jegatheesan K, Environmental status and Seasonal variation in the water quality studies of Pilavakka reservoir at Western Ghats in India, *J Plant Archieves*, **4**, 2004, pp195-201.
[7] Hatim E and Ozlem G, Influences of waste water discharges on the water quality of Mamasm dam watershed in Aksaray, Central Anatolian part of Turkey, *J.Environ Geology*, **48,** 2005, pp 829-834.
[8] Singh A K, Mondal G C, Singh P K, Singh S, Singh T B and Tewary B K, Hydrochemistry of reservoirs of Damodar river basin, India: weathering process and water quality assessment, *J. Environ Geology*, **48,** 2005, pp 1014-1028.
[9] http://wikimapia.org/18556282/Denkada-Anicut
[10] http://en.wikipedia.org/wiki/saripalli
[11] http://en.wikipedia.org/wiki/Nellimarla
[12] Lenore S C, Arnold E G and Trussel R R, Standard methods for the Examination of Water

and Waste water, 17th Edn (American Public Health Association, USA) 1989, 2.35-4.133
[13] Manivasakam N, Physicochemical Examination of Water, Sewage and Industrial effluents, 4th Edn (Pragathi Prakashan, Meerut) 2002, pp 232-234.
[14] Chaudhri U S, Johari S and Chaudhari P R, Tropic status of Chatri lake in the vicinity of Amaravathi city, *Ind J Environ Health*, **43**, 2001, pp 135-137.
[15] WHO, Guidelines for Drinking Water Quality, 2nd Edn, 1996.



Received : 15th March 2013
Revised : 22nd March 2013
Accepted : 30th March 2013
Online : 18th May 2013