# Physico Chemical Parameters and Water Quality Index in Coastal waters of Vamsadhara Estuary, Srikakulam District, Andhra Pradesh, India

**Bhargavi K, Priyanka parameswari K, Shyamala P, Nageswara Rao G**

**ABSTRACT:** The physicochemical characterization of coastal waters from Vamsadhara estuary along Srikakulam coast, Andhra Pradesh was carried out during monsoon and post monsoon seasons. Physicochemical parameters like temperature, pH, salinity, total alkalinity, Dissolved Oxygen(DO), nutrients (phosphate, silicate, nitrite, nitrate), total dissolved solids (TDS), petroleum hydrocarbons (PHC) and $Ca^{+2}, Mg^{+2}$ were analyzed. It was observed there is no significant variation in the parameters during the two seasons and the results were found to be within the limits prescribed by Bureau of Indian standards (BIS). Pearson correlation analysis (r) has been used to determine the relationship between various parameters. It was found that a moderately high positive correlation was observed between salinity and two parameters, CDOM and pH during monsoon. Moderately high negative correlation was observed between CDOM and two parameters, DO and phosphate during monsoon. During post monsoon, moderate correlation was found between CDOM and DO and between salinity and pHin post monsoon. Water quality index calculated based on the physicochemical parameters indicates that the quality of water is good and free from pollution.

**Key words:**Vamsadhara, Characterization, Correlation Analysis, BIS (Bureau of Indian standards), Water quality index (WQI)

## I. INTRODUCTION:

The coastal environments in India are under continuous stress due to discharge and disposal of domestic and industrial wastes both from point and non-point sources as a result of population growth, rapid industrial discharge, economic activities, lack of proper sewage systems and discharge of untreated /semi-treated sewage and effluents from coastal towns/cities. The government of India under the ministry of earth sciences(MOES) has been monitoring the levels of pollution in sea water at several locations along the east and west coast in the country. As a part of this study, under a project called "Sea water quality" funded by NCCR, Chennai the present study has been carried out along Srikakulam coast. Andhra Pradesh has a coastal line of around 974km forming around 16% of the total coastal line of India and Srikakulam district has the longest coastal line in Andhra Pradesh. Srikakulamisbordered

In the present study Vamsadhara estuary has been selected for the assessment of quality of water. Water quality is determined in terms of the physicochemical land biological contents in it. This quality of water varieswithseasonsand geographic areas[1,2,3]. The various parameters used in assessment of water quality are pH, temperature, salinity, DO, alkalinity, phosphate ,silicate, nitrite , nitrate, total suspended matter (TSM),$Ca^{+2}, Mg^{+2}$ , petroleum hydro carbons (PHC) etc. The present paper reports the result of the various water quality parameters determined at three fixed locations near Vamsadhara estuary. Pearson correlation analysis was carried out to explain interdependence of various parameters, and water quality index was calculated based on the physicochemical parameters. The water quality is classified into four types based on the Water Quality index, WQI range(Table1).

## II. MATERIAL AND METHODS:

### A) Study area and sampling:

The VamsadharaRiver runs for a distance of about 250 km before joining the Bay of Bengal. The water monitoring studies was carried out inthe coastal waters of Vamsadhara (18°19'53.40"N latitudes, 84°08'47.70"E longitude), Station names are represented as 0.5 km (shore, Station 1 at 0m V1S1 and 10m V1S2 depth respectively), 2 km( Near shore ,Station 2 at 0m V2S1, 10m V2S2 and 20m V2S3 depth respectively), 5 km (Off shore, Station 3 at 0mV3S1, and 10mV3S1, depth respectively). The details of study area as shown in the Figure -1.Thewatersampleswerecollected from these stations during monsoon and post monsoon using Niskin water sampler [4].The collected samples were stored in pre cleaned polythene bottles [5] All chemicals used in analysis are of analytical grade and purchased from sigma –Aldrich.

Double distilled water was used for preparing standard solutions. Analysis of all physicochemical parameters and nutrient analysis was done by using standard methods [1]as given in table 2. Parameters such as temperature, pH and DO were carried out onboard. Temperature and pHwere measured at the time of sampling using a centigrade thermometer, digital pH meter respectively. DO was measured by Winkler's method. Alkalinity and salinity by titration method, Calcium and Magnesium by EDTA titration method. Nutrients (nitrates, nitrites, phosphates, silicates),CDOMweremeasured by spectrophotometric method andPHC by spectrofluorometer[6]. Pearson's correlation analysis was carried out todeterminethe correlation between different parameters.

## III. RESULTSAND DISSCUSION:

During the study period, a total of thirteen parameters have been determined and the results are shown in figure 2 and discussed below.

TEMPERATURE: Temperature is an important parameter for chemical and biological reactions taking place in water and aquatic organisms [7]. In this study the values varied from 31.0 – 33.6°Cduring monsoon and during post monsoon 23.6 to 25.2

similar results are reported earlier The water temperature varies between 24 -30°C during this seasons.

pH:In this study during monsoon the pH values varied from 7.27 to 8.24 whereas in post monsoon the minimum value observed is 5.25 and the maximum value is 8.23 [8]. According to water index and BIS (Bureau Of Indian Standards) these values were found to be in the range given by BIS. Within this pH range the biological activities of aquatic organisms is possible and also help sin the solubility of nutrients [9].

Salinity: The Salinity value were found to be between a minimumof17.5PSUtoamaximumvalue32.36PSUand during post monsoon the values were found to vary between 23.96 to 31.02PSU [10]. Lower salinity values observed,17.5 PSU, during the monsoon can be attributed to heavy rainfall and the entry of fresh water all the observed values found within the values of BIS.

Total alkalinity: This parameter is used to assess the ability of marine environmentto neutralizeacidic pollutants. During monsoon it variedbetween 1.989 - 2.064 (mEq/L) and in post monsoon the values are found to vary from a minimum of 1.9 – 2.0 (mEq/L) to be within the limits of BIS (Bureau of Indian Standards). There is no significant changeobserved between the monsoon and post monsoon.

Dissolved Oxygen: DO values play an important role in maintaining the aerobic condition [11]. In monsoon the valueschange from 4.074 – 5.796 (μM/l) and in post monsoon the DO values varied from a minimum of 5.6 to 8.8 (μM/l).DO of the collected water samples is quite close to the limits of BIS (Bureau of Indian Standards).

Nutrients: According to BIS and water index values the optimum values of nitrate are (0.3 – 8.7 μM/L), Phosphate in the range of (0.1 – 4.3 μM/L), silicate was in the range of (10 - 300 μM/L) Nitrate values varied from a minimum of 0.67 to 1.8713 (μM/L) during monsoon and during post monsoon, nitrate concentrations were found to be in the range (0.23 μM/L) - (2.02 μM/L). The values are higher than values given by BIS This increase in nitrate levels during post monsoon is due to freshwater inflow from river, agriculture waste and terrestrial runoff and due tohalogenicandantigenic sources [12,13].

The nitrite values were found to be range026-1.871(μM/L) during monsoon season, and during post-monsoon it varied from (0.7μM/L)- (3.7μM/L). The nitrite values were found to be higher during post-monsoon compared to monsoon. Denitrification increases with salinity of water and since salinity values are more in post monsoon compared to monsoon, nitrite valuesare also higher. Totalnitrogenwasfoundtofluctuatebetween1.525- 11.921(μM/L) during monsoon; during post-monsoon fluctuates between a minimum of (1.61 μM/L)– (5.35 μM/L). During monsoon the concentration of inorganic phosphate was found to be in the range 0.628 -3.3255(μM/L) while during post monsoon inorganic phosphate fluctuated between (0.89 μM/L) - (4.4 μM/L). The higher phosphate values in post monsoon season are due to input of domestic sewage and terrestrial agricultural runoff. Silicate varies from10.69 to 165.91(μM/L) during monsoon and varies from a minimum of (82.5μM/L) to a

maximum of (190.9 μM/0L) during post monsoon. The main source of silicate into coastal water can be a result of weathering of rocks and land run off[14].

Total Suspended Matter: The values of TSM ranged from a minimum of 95(mg/L) to a maximum of 216 (mg/L) in monsoon and it ranged from a minimum of 28(mg/L) to a maximum of 180 (mg/L).these values were found to be within the limits of BIS (Bureau of Indian Standards).The slightly higher values in monsoon are due to more suspended matter accumulated in these stations. The suspended matter might be to weathering of rocks and land run off[14].

Colored Dissolving Organic Matter (CDOM): Thevalues of CDOM ranged between 0.921-1.7296 during the monsoon and during post monsoon it ranged from 0.02-0.23 in Vamsadhara indicating the values within the limits of BIS (Bureau of Indian Standards). High values of CDOM are observed in monsoon which indicates mixing of low saline river water.

Ca and Mg values: The values of magnesium ranged from 0.327 -0.07 (mg/L) nd calcium ranges from 0.43- 1.13 (mg/L) in monsoon. During post monsoon magnesium varies from 0.24 - 0.49 (mg/L) whereas calcium varies from 0.24 -0.49 (mg/L). These valuesare within range prescribed by BIS (Bureau of Indian Standards).

Petroleum Hydro Carbons: pollution of the sea by petroleum hydrocarbons occurs from multiple anthropogenic activity, leakage from drilling discharges and urban and sea run off. The PHC values ranged from a minimum of 3.32 to a maximum value of 5.32 ppb during monsoon and in post monsoon 4.29 – 5.871ppbfound to be in range given BIS (Bureau of Indian Standards).

**PEARSON'S Correlation analysis during Monsoon season and Post Monsoon season:**

Pearson's correlation coefficients were determined by using MS-Excel and the relationship between different variables is given in tables (3&4) for both seasons.

- ➢ During monsoon it was found that a moderate positive correlation was observed between CDOM and salinity (0.63362), and a moderate positive correlation (0.426856) exists between pH and salinity which might be due to intrusion of more fresh water. The correlation between CDOM and DO was found to be negative (-0.76735)as bacterial growth require oxygen the value of DO decreases and correspondingly CDOM value which is because of the plankton increases. This implies that CDOM is not from anthropogenic activity[15].

- ➢ During post monsoon amoderate negative correlation is observed between CDOM and phosphate (-0.58994) and also between CDOM and DO. As phosphate and DO decrease (since these are required for plankton growth), the value of CDOM increases. This again implies that CDOM is not from multiple sources and human activities.

**Water quality index**: Water quality index was calculated by the method described by Manoj Kumar et.al., as follows [16,17] in three steps: In the first step assigning of weight (Wi) to the selected

parameters like pH, TSM, $ca^{+2}$, $mg^{+2}$, nutrients according to their relative importance in overall quality of water is carried out. In the second Step, relative weight of the chemical parameters will be calculated using the following equation(Wi) Wi =wi \ ∑wi (i=1 to n) where n is the number of parameters. In step three, quality rating scale (qi) for each parameter is assigned, qi=(Ci\Si) × 100; where Ci is the concentration of each chemical parameter in each water sample in (mg\l) and Si is the standard values of all the parameters given by BIS. SIi, sub index of a parameter is given as SIi =Wi× qi and WQI =∑SIi 1to n. Table 5 gives the WQI values for all the stations of the present study in both the seasons. Based on the results obtained, the water quality can classified as "good".

## IV CONCLUSIONS:

The water quality parameters like temperature, pH,alkalinity, salinity, dissolved Oxygen, nitrates, phosphates, silicates, petroleum hydrocarbons, $Ca^{+2}$, $Mg^{+2}$ values were found to be within the limits of pollution level and under permissible levels given by BIS. Therefore, the quality of sea water at Vamsadhara estuary is suitable for marine life. Physico-chemical analysis shows that the water is pollution free and balanced ecologically. Based on the water quality index, the water can be characterized as good.

## V ACKNOWLEDGEMENTS:

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**Table-1:** *Water quality index specified by BIS*

| Water quality | WQI range |
|---|---|
| Excellent water | $\leq 50$ |
| Good water | 50 – 100 |
| Poor water | 100 – 200 |
| Very poor water | 200 -300 |

**Table 2 :** *Methods adopted for determination of physico chemical perameters.*

| S .No | Parameters | Methodology |
|---|---|---|
| 1. | Temperature | Thermometry |
| 2. | pH | pH Meter |
| 3. | Alkalinity | Titration |
| 4. | Salinity | Titration |
| 5. | Ca& Mg | EDTA titration |
| 6. | Dissolved oxygen | Winkler |
| 7. | Nutrients | Spectrophotometer |
| 8. | Petroleum hydrocarbons &CDOM | Spectro flourometer |
| 9. | Total suspended matter | Filtrations method |

**Table-3: Correlation analysis of parametric values duringMonsoon**

|  | temp | pH | TSM | CDOM | Ca$^{+2}$ | Mg$^{+2}$ | Nitrite | Nitrate | silicate | phosphate | DO | salinity | TA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| temp °C | 1 | | | | | | | | | | | | |
| pH | 0.511 | 1 | | | | | | | | | | | |
| TSM(mg/l) | 0.340 | -0.081 | 1 | | | | | | | | | | |
| CDOM | 0.342 | -0.200 | -0.116 | 1 | | | | | | | | | |
| ca+2(g/l) | 0.487 | -0.395 | 0.656 | 0.484 | 1 | | | | | | | | |
| Mg+2 (g/l) | -0.371 | 0.121 | 0.314 | -0.895 | -0.249 | 1 | | | | | | | |
| Nitrite(μm) | -0.518 | -0.892 | -0.100 | 0.127 | 0.164 | -0.199 | 1 | | | | | | |
| nitrate (μm) | -0.547 | 0.163 | -0.379 | -0.511 | -0.865 | 0.243 | 0.144 | 1 | | | | | |
| silicate (μm) | 0.447 | -0.099 | -0.185 | 0.948 | 0.391 | -0.966 | 0.159 | -0.370 | 1 | | | | |
| phosphate (μm) | 0.678 | 0.702 | 0.524 | -0.077 | 0.114 | 0.068 | -0.584 | 0.002 | 0.047 | 1 | | | |
| DO (μm/l) | -0.175 | 0.529 | -0.111 | -0.767 | -0.769 | 0.516 | -0.371 | 0.753 | -0.652 | 0.263 | 1 | | |
| salinity (PSU) | 0.149 | 0.426 | 0.523 | -0.288 | 0.149 | 0.597 | -0.544 | -0.193 | -0.394 | 0.555 | 0.044 | 1 | |
| TA (mEq/l) | -0.510 | -0.077 | 0.195 | -0.479 | -0.072 | 0.794 | -0.160 | -0.053 | -0.704 | -0.210 | 0.067 | 0.660 | 1 |

**Table-4: Correlation analysis of parametric values during Post -Monsoon**

|  | temp | pH | TSM | CDOM | ca$^{+2}$ | Mg$^{+2}$ | Nitrite | nitrate | silicate | phosphate | DO | salinity | TA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| temp °C | 1 | | | | | | | | | | | | |
| pH | -0.02 | 1 | | | | | | | | | | | |
| TSM(mg/l) | -0.17 | 0.111 | 1 | | | | | | | | | | |
| CDOM | 0.416 | 0.233 | 0.298 | 1 | | | | | | | | | |
| ca+2(g/l) | 0.618 | 0.475 | -0.641 | 0.157 | 1 | | | | | | | | |
| Mg+2 (g/l) | 0.466 | 0.363 | -0.194 | 0.854 | 0.542 | 1 | | | | | | | |
| Nitrite(μm) | 0.2 | 0.154 | -0.159 | -0.332 | 0.267 | -0.231 | 1 | | | | | | |
| nitrate (μm) | 0.241 | -0.187 | -0.417 | -0.320 | 0.402 | -0.228 | 0.182 | 1 | | | | | |
| silicate (μm) | 0.007 | 0.294 | -0.558 | -0.476 | 0.537 | -0.162 | 0.788 | 0.500 | 1 | | | | |
| Phosphate(μm) | 0.303 | -0.196 | -0.271 | -0.589 | 0.185 | -0.434 | 0.094 | 0.169 | 0.066 | 1 | | | |
| DO (μm/l) | -0.69 | -0.367 | 0.308 | -0.403 | -0.830 | -0.543 | -0.198 | -0.592 | -0.380 | 0.112 | 1 | | |
| salinity (PSU) | 0.102 | 0.729 | 0.353 | 0.633 | 0.285 | 0.526 | 0.108 | -0.033 | 0.123 | -0.690 | -0.553 | 1 | |
| TA (mEq/l) | -0.04 | -0.521 | 0.544 | 0.292 | -0.616 | -0.132 | 0.056 | -0.022 | -0.311 | -0.515 | 0.162 | 0.123 | 1 |

**Table- 5:** *Range of water quality index for Vamsadharaestuary*

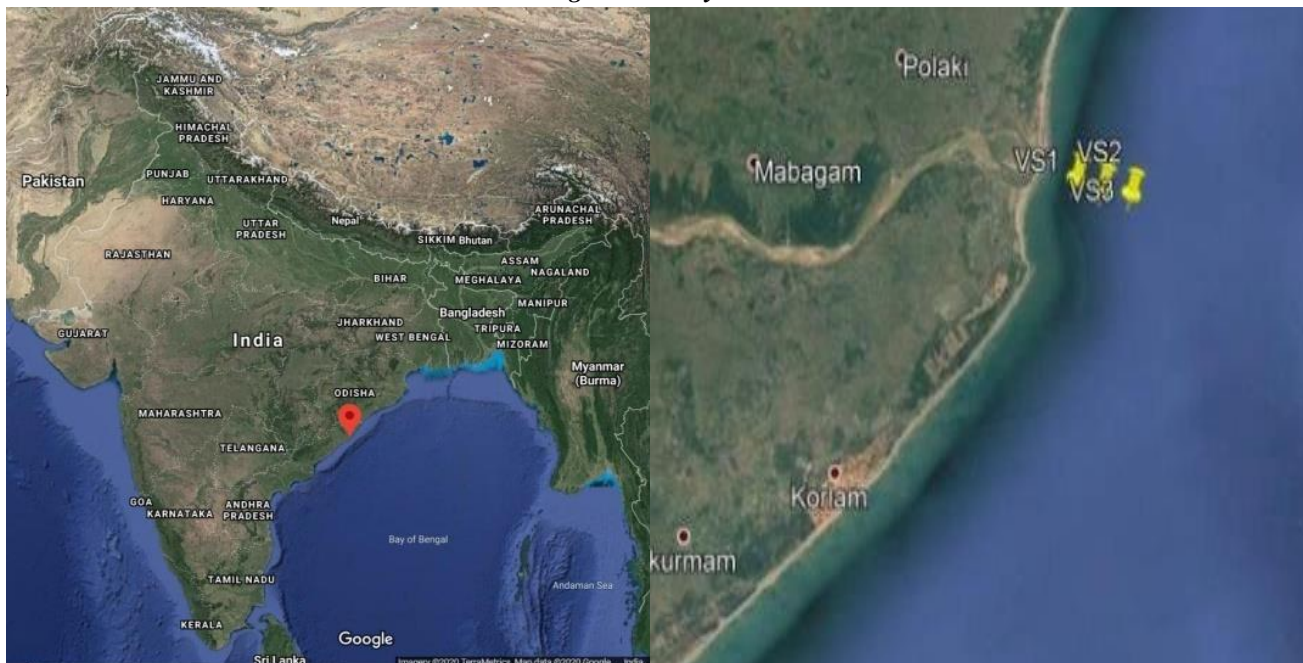| STATIONS | WQI | |
|---|---|---|
| | **MONSOON** | **POST MONSOON** |
| V$_1$S$_1$ | 54.84 | 63.59 |
| V$_1$S$_2$ | 16.93 | 47.33 |
| V$_2$S$_1$ | 17.84 | 55.56 |
| V$_2$S$_2$ | 26.81 | 59.99 |
| V$_2$S$_3$ | 31.18 | 52.15 |
| V$_3$S$_1$ | 26.31 | 44.52 |
| V$_3$S$_2$ | 41.95 | 43.71 |

*Figure 1: Study area*



*Figure 2: Graphical representation of parametric values during Monsoon and Post Monsoon*
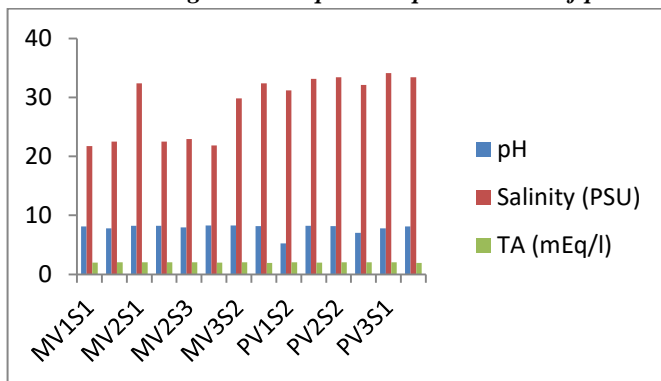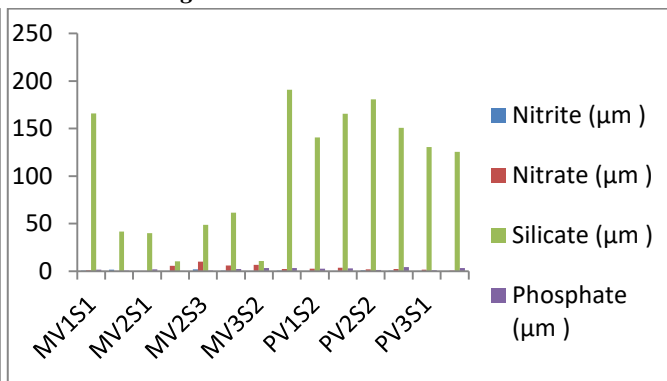


Fig-2[a]: pH, Salinity   Total alkalinity



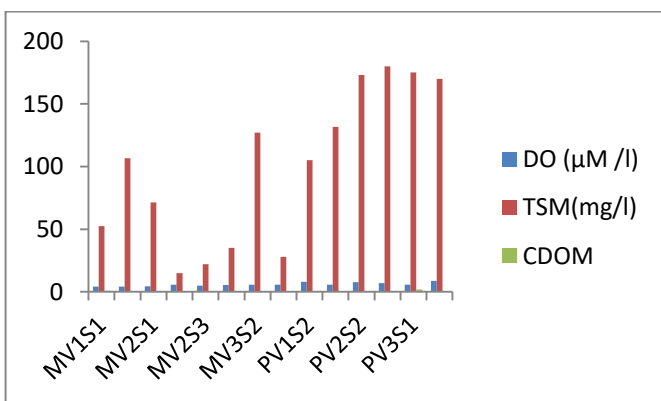Fig-2[b]: Nitrate, Silicate and Phosphate



Fig-2[c]: DO, TSM , CDOM



Fig-2[d]: $Ca^{2+}$, $Mg^{2+}$, PHC
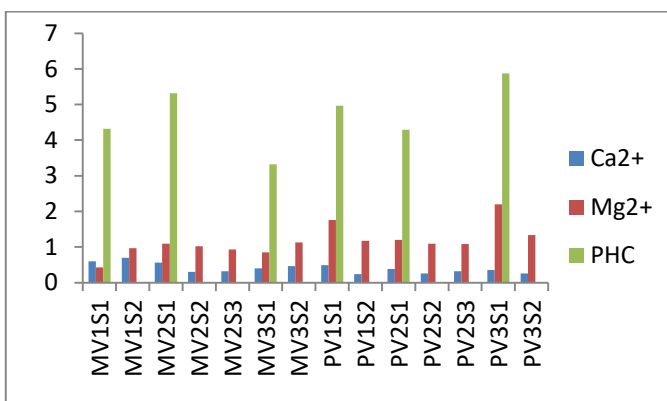
\***NOTE:**Station names of **Monsoon** are represented as MV1S1, MV1S2 (Station 1 at 0m and 10m depth respectively), MV2S1, MV2S2, MV2S3 (Station 2 at 0m, 10m and 20m depth respectively), MV3S1, MV3S2 (Station 3 at 0m and 10m depth respectively) and of **Post monsoon** are PV1S1, PV1S2 (Station 1 at 0m and 10m depth respectively), PV2S1, PV2S2, PV2S3 (Station 2 at 0m, 10m and 20m depth respectively), PV3S1, PV3S2 (Station 3 at 0m and 10m depth respectively).

**Bhargavi K,** Department of Physical and Nuclear Chemistry & Chemical Oceanography, School of Chemistry, Andhra University, Visakhapatnam-530 003.

**Priyankaparameswari K,** Department of Inorganic and Analytical chemistry, School of Chemistry, Andhra University,Visakhapatnam-530 003. India.

**Shyamala P,** Department of Physical and Nuclear Chemistry & Chemical Oceanography, School of Chemistry, Andhra University, Visakhapatnam-530 003.

**Nageswara Rao G,** Department of Inorganic and Analytical chemistry, School of Chemistry, Andhra University, Visakhapatnam-530 003, Andhra Pradesh, India.