Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 11, pp.22508-22513, November, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

PHYSICO-CHEMICAL ANALYSIS ON WATER PUMPED OUT FROM COAL MINE AQUIFER

*,[1]Selvaraju, R., [2]Oumabady Alias Cannane, N., [3]Renukadevi, K. B. and [1]Meenambigai, K.

[1]Department of Engineering Physics, Annamalai University, Annamalai Nagar, Tamil Nadu, India
[2]Depatrment of Physics, Bharathiyar College of Engineering and Technology Karaikal, India
[3]Depatrment of Physics, Rajiv Gandhi College of Engineering and Technology Puducherry, India

ARTICLE INFO

Article History:
Received 29th August, 2015
Received in revised form
06th September, 2015
Accepted 19th October, 2015
Published online 30th November, 2015

Key words:
Mine water, Physico-chemical parameters, Chlorides and sulphates.

ABSTRACT

A study has been carried out to explore the Physico-chemical characteristics of mine water pumped out from coal mine located at Neyveli, South India. Water samples, from five different sites through a canal were collected and analyzed for physico-chemical parameters, like; pH value, electrical conductivity, total hardness, total alkalinity, total dissolved solids, chlorides and sulphates. Results were compared with water standards and discussed.

Citation: Selvaraju, R., Oumabady Alias Cannane, N., Renukadevi, K. B. and Meenambigai, K. 2015. "Physico-chemical analysis on water pumped out from coal mine aquifer", *International Journal of Current Research*, 7, (11), 22508-22513.

INTRODUCTION

Entry of Pollutants causes disturbances in an ecosystem, which manifest themselves into a chain of adverse reactions often very complex in nature. Based on the nature, the pollution may be of the following three types; Air Pollution, Water Pollution and Soil Pollution (Asthana and Asthana, 1998). Water is super abundant on the planet as whole, but, fresh potable water is not always available at the right time or the right place for human or ecosystem use. Water covers 71% of the earth's surface and makes up 65% of human bodies. If water becomes polluted it loses its value and becomes a threat to health and to the survival of the living being (Cheremisinoff and Angelo, 1977). When the untreated effluents are discharged into the environment, they disrupt the ecological aura of living organisms (Behera and Mishra, 1985). Wastes running through the water are hazardous and infectious (Jameel, 1998). Mine water discharge from the abandoned and current mining activities polluted Bolivia's Desaguadero River, its dozen main tributary rivers and other smaller rivers by carrying heavy metals, dissolved and suspended solids which in turn polluted the Poopó Lake which is considered as an important lake (Navarro Torres *et al*., 2012). In the mining environment, pollution may occur from entry of mine water. The contaminants include heavy metals, cyanide, phosphate, carbonates, sulphides, sulphates, arsenic and its complexes, nitrogen and its compounds (Economopoulos, 1993).

***Corresponding author: Selvaraju, R.**
Department of Engg. Physics, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Location of Study Area

Neyveli is a mining and power generation Township in Cuddalore District, Tamil Nadu, India. It is located at 11.30^0 N-79.29^0E. The lignite-rank of coal is estimated with a deposit of 3,300 million in Neyveli region. To excavate the reserves, very large quantities of groundwater is pumped out from underlying aquifer so as to keep piezometric water level below lignite seam. During this, water is extracted from the confined and unconfined aquifers of the Cuddalore formation (Chidambaram *et al*., 2012). A lake, by name, Walaja Tank, with area of 191.6 sq.km and volume of 2.57 MCM receives water, which is pumped round the year from the mine through Vellar Rajan Canal. In the neibouring Kurinjipadi Panchayat, nearly 20,000 acres of land is cultivated throughout the year with this water resource.

MATERIALS AND METHODS

In the present study, mine water samples were collected for physico-chemical analysis from Sengalodai using standard procedures (APHA, 1985). Water samples were subjected to physical tests such as colour, odour, taste, electrical conductivity and pH and to chemical analyses, like; total dissolved solids (TDS), total hardness, total alkalinity, chlorides and sulphates. The above tests were performed in Environmental Laboratory, Department of Civil Engineering, Annamalai University, India. Borosilicate glassware, distilled water and E-Merk reagents were used throughout the testing. Total alkalinities of the water samples were determined by titrating with N/50 H_2SO_4 using phenolphthalein and methyl orange as indicators. The chloride ions were generally determined by titrating the water samples against a standard solution of $AgNo_3$ using potassium chromate as an indicator. The total hardness of the water samples was determined by complexometric titration EDTA using Eriochrome balck-T as an indicator. Sulphate and fluoride of the water samples were estimated by UV-visible spectrophotometer. TDS of water sample were measured using gravimetric method.

RESULTS AND DISCUSSION

The study about mine water aims to assess the mine water quality at Sengalodai in Kurinjipadi Panchayat. The values of the measured parameters of water samples collected from various distances (WS_1, WS_2, WS_3, WS_4 and WS_5) are tabulated in Table 2 in reference with Bureau of Indian Standards for water and graphically displayed in Figs. 3 - 9.

Taste

Palatable taste was observed for all the five samples.

pH Value

pH is a critical water quality parameter. Normal value of pH is 6.5 to 8.5. Adverse effects of pH result from solubilization of toxic heavy metals and protonation or deprotonation of other ions. At pH 6.5 - 8.0, there will be likely strong influences, like, corrosion and scaling processes which may cause considerable damage to industrial equipment and structures (Anane-Acheampong-Osisiadan *et al.*, 2013). Maximum pH value is observed in Sample WS_3 and the minimum in WS_5. High pH induces formation of trihalomethanes which are toxic in nature. pH values below 6.5 initiate corrosion in pipes and metal components and this results in release of toxic metals. In the present study, pH ranged from 7.29 to 7.69. The variation of pH with distance is shown in. Fig.3. Even when marginal change in pH does not have any adverse in health, it alters the water taste (Mustafa *et al.*, 1998). Elevated pH values can be caused by increased biological activity in eutrophic systems.

Table 1. Water sample collection and details

No	Label	Site	Distance from Mines-I	Sample depth(cm)
1.	WS_1	Near Mines – I	½ Km	28
2.	WS_2	SIPCOT	1 Km	40
3.	WS_3	Parvathipuram	2 Km	45
4.	WS_4	Karunkuzhi	3 Km	30
5.	WS_5	Maruvai	7 Km	25

Table 2. Physico-chemical parameters of mine water

Physico chemical parameters	WS_1	WS_2	WS_3	WS_4	WS_5	BIS Desirable Limit	BIS Permissible Limit
Temperature	31^0C	31^0C	31^0C	31^0C	31^0C	31^0C	31^0C
pH	7.37	7.41	7.69	7.32	7.29	6.5	8.5
Colour	Colourless	Light yellow	Light yellow	Light yellow	Light yellow	5 Hazen units	25 Hazen units
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
Taste	Palatable	Palatable	Palatable	Palatable	Palatable	Agreeable	Agreeable
Electrical Conductivity (mV)	2.30	2.90	3.20	2.68	2.60	0.75 mS/cm	2.25 mS/cm
Hardness (mg/l)	182	210	264	167	163	300 mg/l	600 mg/l
Chlorides (mg/l)	1464.6	1857.3	1459.3	1034.3	1466.7	250 mg/l	1000 mg/l
TDS (mg/l)	420	486	396	364	371	500 mg/l	2000 mg/L
Alkalinity (mg/L)	313	342	276	294	324	200 mg/l	600 mg/l
Sulphate (mg/l)	185	152	145	123	121	150 mg/l	400 mg/l

Colour

The true colour of water is the one that results due to balanced combination of constituents. Colourless water is witnessed in WS_1 and water was slightly yellowish in samples WS_2, WS_3, WS_4 and WS_4 respectively.

Odour

Odour of all the water samples was within the discernible limit.

The pH may also affect the availability and toxicity of constituents such as trace metals, non-metallic ions, and essential elements. Small changes in pH often cause large changes in the concentration of available metallic complexes and can lead to significant increases in the availability and toxicity of most metals (DWAF, 1996).

Electrical Conductivity (EC)

Disposal of mine drainage effluent into surface water or ground-water can cause serious impacts on water quality for all uses. Although effluents from the plant were treated before discharged into the canal, the treatment processes might not be effective. Increased mineral salts cause increase in salinity (Chapman, 1996). Electrical conductivity ranges from 2.3 to 3.2mS/cm and is given in Fig.4. Maximum value (3.2mS/cm) is observed in WS_3 and minimum value (2.3 mS/cm) in WS_1. However, with the exception of WS_3 which recorded higher conductivity value (3.20 mS/m) exceeding for drinking water, the levels in the canals were within the acceptable limit suggesting no health threats. Electrical conductivity (EC) values are useful as an indication of the dissolved solids or as a base for extrapolating other chemical data when only partial chemical analysis is known (Raju, 2007).

Total Dissolved Solids

The desirable limit of total dissolved solids is 500 mg/L. Water with high dissolved solids generally is of inferior palatability and may induce an unfavorable physiological reaction in consumers (Bhanja *et al*., 2000). Higher TDS levels cause changes in ecosystem structure and function. TDS less than 600 mg/l is generally described as good (McCutcheon *et al*., 1993). In the present study, the maximum value of total dissolved solid is 486 mg/L sample WS_2 and minimum is 364 mg/Lin WS_4. The variation of total dissolved solids with distance is shown in Fig. 5.

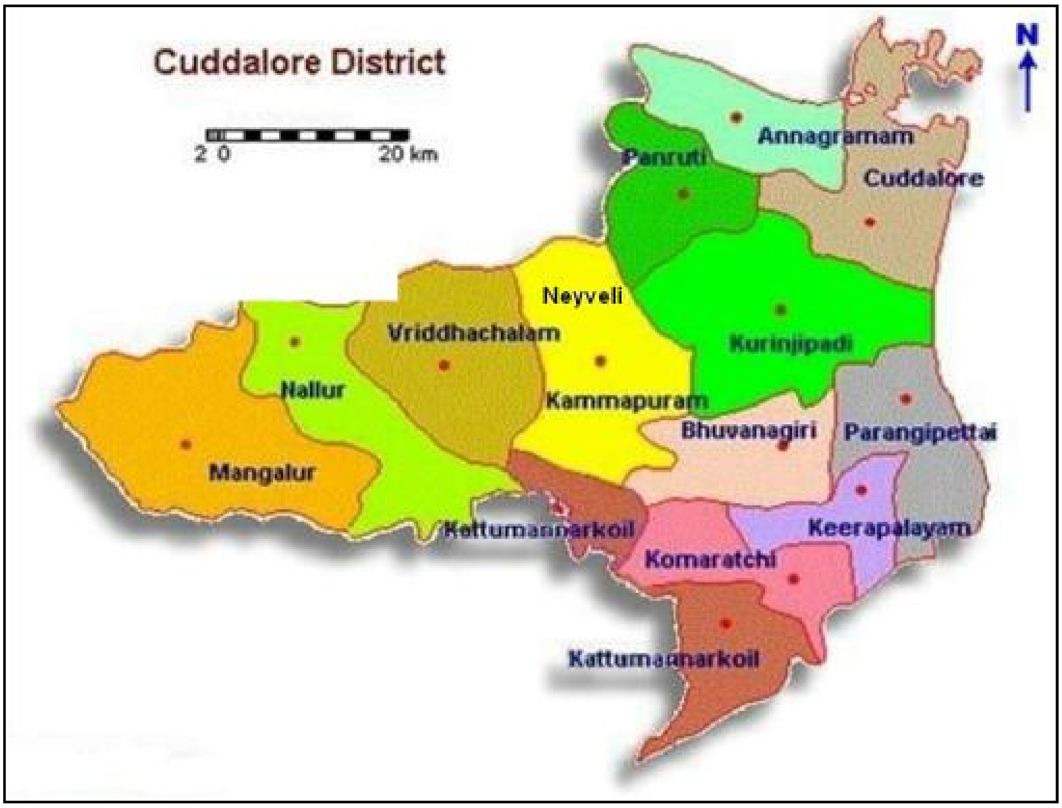

Fig.1. Map of Cuddalore District

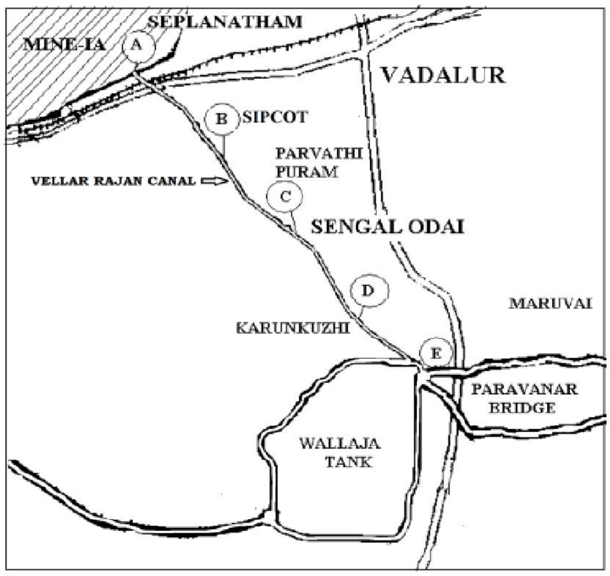

Fig. 2. Location Map of the sample collection at Sengalodai

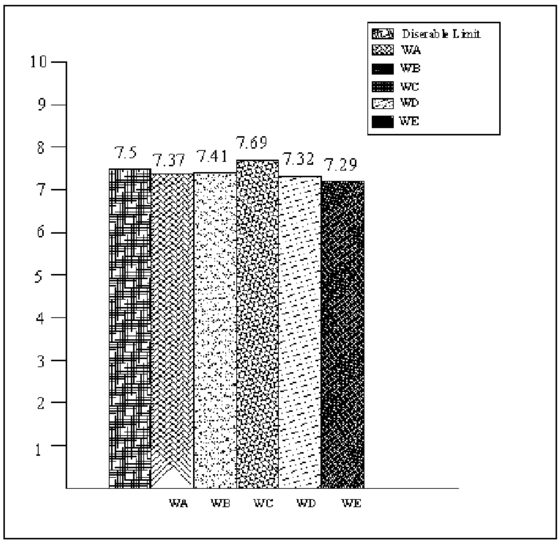

Fig. 3. Variation of pH

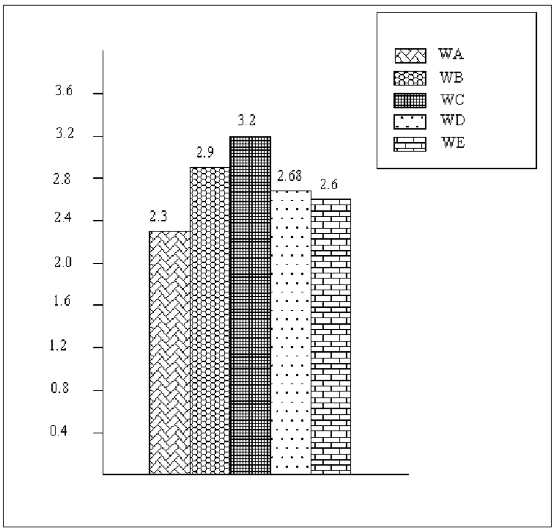

Fig. 4. Variation of Electrical Conductivity

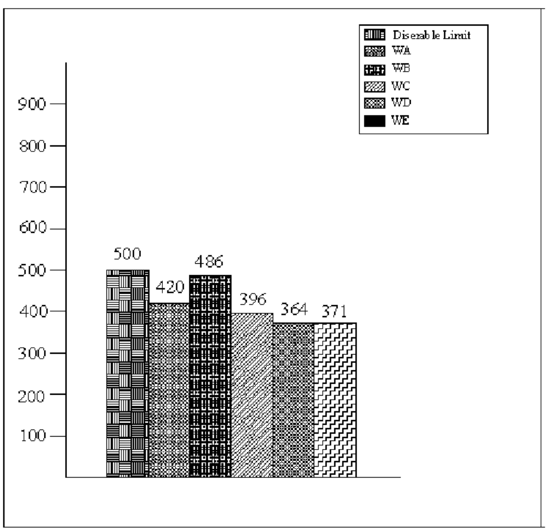

Fig. 5. Variation of Total Dissolved Solids

Total Hardness

The hardness of water may be rated according to the content of combined compounds of Ca and Mg as $CaCO_3$ in mg/L. The normal value of hardness is 300 mg/L. Hardness of water in the study area ranges from 163 to 264 mg/L. The variation of total hardness with distance is shown in Fig. 6. Values of total hardness are within the prescribed limits (600 mg/L) of WHO (WHO, 1984).

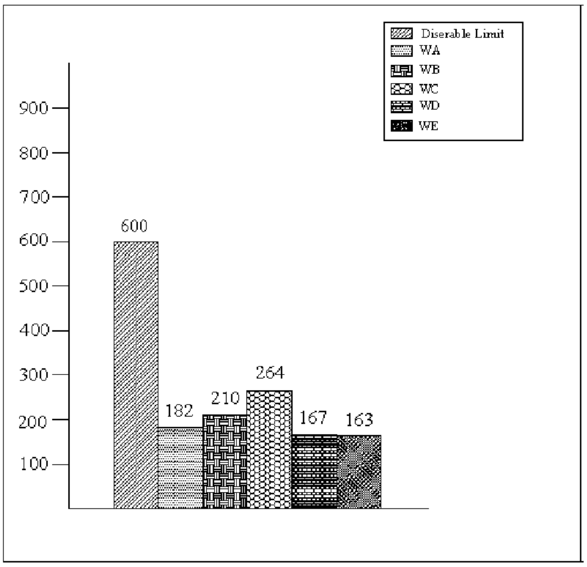

Fig. 6. Variation of Total Hardness

Total Alkalinity

Bicarbonates and carbonates cause total alkalinity. The high concentration of sewage may be the cause of high alkalinity. Alkalinity in water samples had a range of 276 mg/L (at WS_3) to 342 mg/L (WS_2). The variation of total alkalinity with distance is shown in Fig. 7. Values of alkalinity are within prescribed limit.

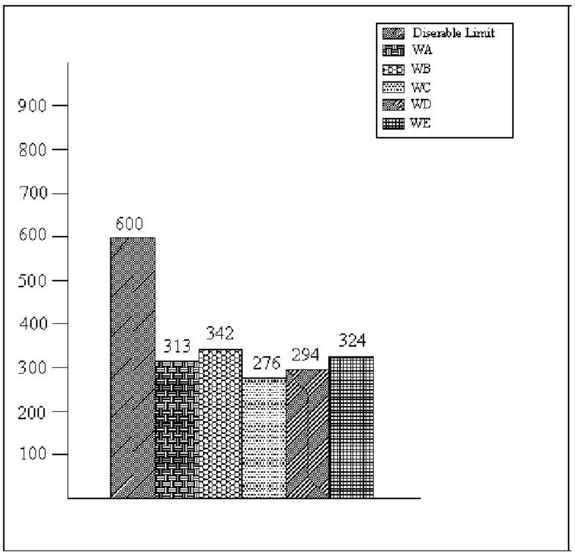

Fig. 7. Variation of Total Alkalinity

Chloride

Chloride is the best indicator of pollution. A high concentration of chloride content gives a salty taste to water. Higher intake of compound chloride may result cardiac diseases. Indian Standard gives the range of chloride in water as 1000 mg/l. In the present study, it varies from a minimum value 1034.3 mg/l (WS_4) to a maximum 1857.3mg/l (WS_2). It exceeds the permissible limit. High chloride concentration in water indicates the presence of large amount of organic matter. The higher concentration of chloride in water is an index of pollution of animal origin and there is a direct correlation between chloride concentration and pollution levels (Ranjana *et al*., 2013). The variation of total chlorides with distance is shown in Fig. 8.

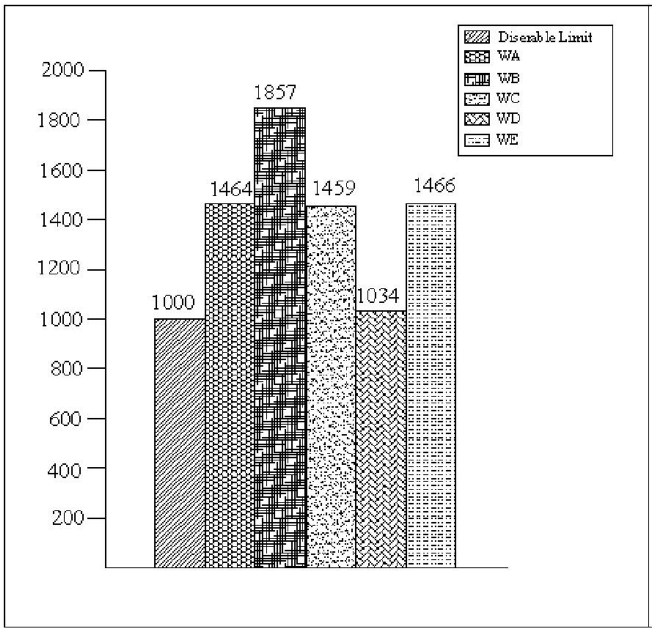

Fig. 8. Variation of Chlorides

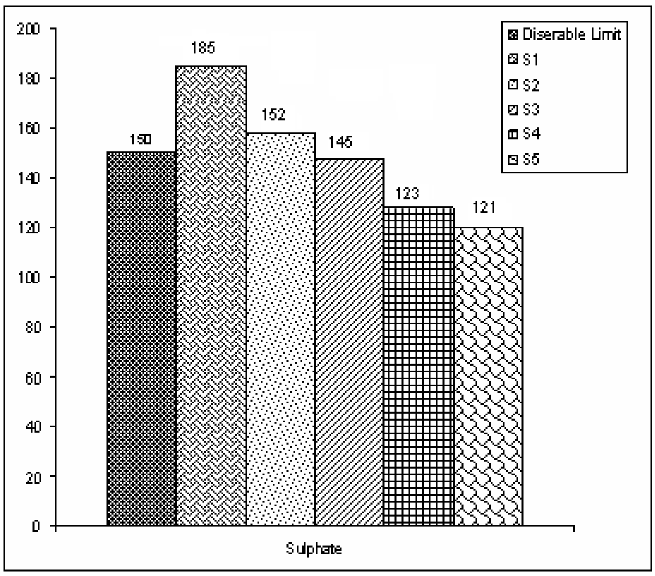

Fig. 9. Variation of Sulphates at different

Sulphate

Discharge of sewage and industrial waste into water tends to increase the sulphate concentration. Sulfides formed as a result of acid mine runoff from coal or other mineral extraction and from industrial sources may be oxidized to form sulfates, which are less toxic (k*y.gov/nrepc/water/ramp/rmso4.htm*). The permissible limit for sulphate in drinking water is 200 - 400 mg/L, according to Indian Standard, IS 10500 - 1991. In the present study, sulphate is present in the range of 121-187 mg/l. The variation of total sulphates with distance is shown in Fig. 9.

Conclusion

pH values, Total dissolved solids, Total hardness and Total alkalinity of various water samples are within the standard limits. Contents of chloride of all the samples are higher than the permissible limits. Higher concentration of chloride in water is an index of pollution of animal origin and there is a direct correlation between chloride concentration and pollution levels. Sulphate values of samples WS_1 and WS_2 are higher than the permissible limit and lower than desirable limits in samples; WS_3, WS_4 and WS_5.

REFERENCES

Anane-Acheampong.-Osisiadan, P, Darkwah, L and Owusu-Boateng, G. 2013. Mine water and the environment: a case study at Central African Gold Bibiani Limited, *Ghana Global Advanced Research Journal of Physical and Applied Sciences*, vol. 2, no. 2, pp. 039-046.

APHA (American Public Health Association), 1985. 16th edition, Washington.

Asthana, D.K and Asthana, M., 1998. *Environment: Problems and solutions, vol.2*, S. Chand & Company Ltd., New Delhi.

Behera, B.K and Mishra B.N., 1985, The effect of sugar mill effluent on enzyme activities of rice seedlings, *Environmental Research*, vol.37, no.2, pp.390-398

Bhanja, Mohanta, K and Patra, K.U.A. 2000.Studies on the water quality index of River Sanamachhakandana at Koenjhar Garh, Orissa, India, *Pollution Research*. Vol.19, no.3, pp. 377-385.

Chapman, D.V. 1996. Water Quality Assessments: *A guide to the use of biota, sediments and water in environmental monitoring*, 2nd edition, F & FN Spon, London

Cheremisinoff, P.N and Angelo M.C., 1977. *Environmental Assessment and Impact Statement Handbook, 2nd Edition*, Ann Arbor Science Publications, Ann Arbor

Chidambaram, P, Anandhan, M.V, Prasanna, A.L, Ramanathan, K, Srinivasamoorthy, G and Senthil Kumar., 2012. Hydrogeochemical Modelling for Groundwater in Neyveli Aquifer, Tamil Nadu, India, Using PHREEQC: A Case Study, *Natural Resources Research*, vol. 21, no. 3, pp.311-324.

DWAF (Department of Water Affair and Forestry), 1996. *South African Water Quality Guidelines, Second edition*, vol.1, Domestic Use.

Economopoulos, A.P. 1993. Assessment of Sources of Air, Water, and Land Pollution: A guide to rapid source inventory techniques and their use in formulating environmental control strategies. *Environmental Technology Series*, vol.2, WHO/PEP/GETNET/93.1-A, World Health Organization, Geneva.

Jameel, A.A. 1998. Physico-chemical studies in Uyyakondan channel water of river Cauvery: Pollution Research, *Journal of Current Science*, vol. 17, no.2, pp. 111-114. 334.

McCutcheon S.C, Martin J.L and Barnwell T.O,J., 1993, Water quality, Maidment D.R. (ed.), *Handbook of Hydrology*, McGraw Hill Inc., New York, pp.11.1–11.73.

Mustafa, W, Somasundaram, S.S.N, Hameed, P.S and Palaniappan, R. 1998. Evaluation of ground water quality in Tiruchirappalli City, *Indian Journal of Environmental Protection*, vol. 19, no. 4, pp. 284-289.

Navarro Torres, V.F, Echenique Z.G and Singh R.N. 2012. Environmental Hazards associated with Mining Activities in the Vicinity of Bolivian Poopó Lake, *Journal of Mining & Environment*, vol.3, no.1, pp. 15 – 26

Raju. N.J. 2007. A seasonal wise estimation of TDS from EC and SiO2 in ground waters of upper Gunjanaeruriver basin, Cuddapah district, Andhra Pradesh. *Current Science*, vol. 92, no.3, pp. 371-376.

Ranjana, S, Mohini, G and Ekhalak, A. 2013. Assessment of Physico-Chemical Characteristics and Pollution Status of Tapi Estuary at Dumas Jetty, Surat, *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 2, no.10, pp. 5531-5537.

Sulfate and water quality - Kentucky.gov, k*y.gov/nrepc/water/ramp/rmso4.htm*

WHO - World Health Organization, 1984, *International Standards for Drinking Water*, 3rd edition.

****