Water Quality Analysis of Waste Water: A Case Study of Khan Sarover Treatment Plant, Patan, Gujarat

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Abstract

The study carried out on Khan Sarovar treatment plant's water deals with the influence of environmental parameters on the ground water quality and water bodies. The waste water of approximately 60,00,000 liters' quantity is directly disposed into the canal, after treatment. The water which is chemically and biologically harmful should be treated or its assessment should be happens so as to cure it in better way. The assessment, analysis and periodical testing of the water samples for quality have been done. There are many modes and ways to assess the water quality. The water quality of drinking, washing, irrigation and industrial use may vary as per the minimum requirements of biological or physical parameters but the waste water and its spatial effect up to 5 kilometers have to be checked and assessed for direct use. Water Quality Index is a useful representation of overall quality of water for public or for any required use as well as in the pollution demolition programmes and in water quality management. This research paper presents with the study of physio-chemical and biologically important parameters such as pH, BOD, Colour, COD and Turbidity in water samples collected from Khan Sarovar Treatment plant after disposal. The study is intended to calculate Water Quality Index (WQI) of the Canal in order to ascertain the quality of water for public consumption, recreation and other purposes.
Keyword- Water Quality Index, ground water, pH, BOD, Artificial Recharge

I. INTRODUCTION

Water resource development has taken place all over the world. There is a tremendous amount of pressure in protecting the water resources available in the country. Protecting the surface water resources from wastewater pollution plays a vital role for the development. The disposal of wastewater into the surface water bodies leads to serious problems and affects the people in health aspects. Especially in the urban areas, the pollution of domestic effluent discharges into the nearby surface water bodies created problems for the public. There are many ways of safe disposal of wastewater. But improper management of wastewater generation in the urban areas find its own way of getting into the surface water. Hence, the effluent discharge affects the surface water bodies. The water quality changes in the surface water bodies created many health problems to the public. In present situation, the plant run off the waste water to canal approximately 60,00,000 litres /day without any use from it. The aim is to analysis the water quality and re-use the waste water in different purpose like irrigation, domestic use etc. by wastewater treatment processes. Wastewater treatment is a process to convert wastewater - which is water no longer needed or suitable for its most recent use - into an effluent that can be either returned to the water cycle with minimal environmental issues or reused. The latter is called water reclamation and implies avoidance of disposal by use of treated wastewater effluent for various purposes. Treatment means removing impurities from water being treated; and some methods of treatment are applicable to both water and wastewater. The physical infrastructure used for wastewater treatment is called a "wastewater treatment plant" (WWTP).

Water quality refers to the chemical, physical, biological, characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. Other natural resources, it should be assessed regularly and people should be made aware of the quality of drinking water. The present study is aimed at assessing the surface water quality index (WQI) for the Khan Sarovar Treatment Plant, Patan. This has been determined by collecting various groundwater samples from various distances such as 100 m, 500 m, 1000m, 2000m, 5000 m. The samples have been subjected to a comprehensive physiochemical analysis. For calculating the WQI, the following parameters have been considered: pH, BOD, Colour, COD, Turbidity.

In the setting of standards, agencies make political and technical/scientific decisions about how the water will be used. In the case of natural water bodies, they also make some reasonable estimate of pristine conditions. Different uses raise different concerns and therefore different standards are considered. Natural water bodies as well as ground water sources will vary in response to environmental conditions. Though ground water source may not contaminate much rapidly. Present study aims to ascertain and determine the minimum Water Quality Index (WQI) which will be sufficient and acceptable by the local community of Patan district, Gujarat within the surrounded area.

II. LITERATURE REVIEW

The objective of the present work is to discuss the suitability of groundwater for human consumption based on computed water quality index values. To study up to which extent the physical and biological parameters have been influenced and taking place from the fresh water line to groundwater aquifer of that vicinity. This study requires the drinking water parameter of groundwater for studying water quality index. A Review of Literature has been done before the start of work.

Tandel Bhavin N. et al assessed the Water Quality Index of Small Lake in South Gujarat Region, India by ascertaining various water quality parameters. Analysis of water quality using different approaches like statistical analyses of individual parameter, multi-stressors water quality indices, etc. have been considered by Venkatesharaju et al. 2010. Determination of water quality index and suitability of an urban water body in shimoga town, Karnataka was studied by K.Yogendara et al. Lakes and tanks are known to be ecological barometers of the health of a city as they regulate the micro-climate of any urban centre (Benjamin et al. 1996), thereby influ- encing the life of the people adjacent to it. The quality of surface water in an inland water bodies have a profound effect on the ground water table and ground water quality of the nearby aquifers due to existence of direct interaction between surface and ground water. Lakes have a great significance environmentally due to reasons such as (a) sources of water: surface and groundwater recharge and discharge, for drinking and irrigation, (b) supports liveli- hoods, lung space of clear and cool air, (c) food and nutrition, (d) act as flood control and stream flow maintenance, (e) recreation—education, boating, swimming, walking and jogging on the lake bund, (f) lakes are natural infrastructure for climate change adaptation and biogeo- logical cycles, (g) pisciculture, (h) wildlife habitat, especially fishes and birds, (i) rain water harvesting and, (j) emergency water supply for firefighting. For calculating the WQI, 14 parameters namely, pH, electrical conductivity, total dis- solved solids, total hardness, alkalinity, calcium, magne- sium, sodium, potassium, chloride, sulphate, nitrate, fluorides and iron were considered.

III. STUDY AREA

Khan sarovar located at Gujarat in Patan city. It Coordinate is 23˚50́3˝N 72˚65´5˝ E. The elevation of patan city 76m (249ft.). The population of Patan city as per 2011 calculation is around 133,737. Patan, an ancient fortified town, was founded in 745 AD by Vanraj Chavda, the most prominent king of the Chavda Kingdom. He named the city Anhilpur Patan or "Anhilwad Patan" after his close friend and Prime Minister Anhil shepherd. It is variously referred to any ocean.

Fig. 1: Khan Sarovar Patan, Gujarat

IV. WATER SAMPLING AND METHODOLOGY

In an effort to compare water quality, six locations were chosen for sampling purpose. These locations were 100m, 200m, 500m, 1000m, 2000m, 5000m away from the waste water disposal point at Khan Sarovar Treatment Plant. While sampling plastic bottle, BOD bottle, Solution of MnSo4 and KI was always kept. The analysis and lab testing of parameters were done subsequently after data collection. These parameters are explained as follows:

A. Biochemical Oxygen Demand

B.O.D. is a measure of the amount of food for bacteria that is found in water. Bacteria utilize organic matter in their respiration and remove oxygen from the water. The BOD test provides the rough idea of biological waste present in the water. Biodegradable waste is usually composed of organic wastes, including leaves, grass clippings and manure.

B. Dissolved Oxygen

DO test measure the amount of life sustaining oxygen dissolved in the water. This is the oxygen that is available ti fish, invertebrates, and all other animals living in the water. Low levels of dissolved oxygen in water is a sign of possible pollution.

C. pH

The pH level is a measure of acid content of the water. Water with a pH of 7 is considered neutral. If pH is below 7, it is classified as acidic, while the pH greater than 7 is said to be alkaline. The pH of tap water in India lies between 6.5 to 8.5.

D. Total Dissolved Solids

TDS is a measure of solid materials dissolved in the water. This includes salts, some organic matter and a wide range of other things from nutrients to toxic materials. Concentrations of TDS that are high or low may limit the growth and lead to death of many aquatic life forms.

E. Turbidity

Turbidity is a measure of dispersion of light in a column of water due to suspended matter. The higher the turbidity, the cloudier the water appears. If water becomes too turbid, it loses the ability to support a wide variety of plants and other aquatic organisms.

F. Colour

Colour would help us to identify the strength of pollution load. The colour also enforces us to think about the vegetation and aquatic life.

G. Chemical Oxygen Demand

The discharge of organic and inorganic loads and wastes may affect the contamination of ground water. This may affect even the purest form of water available i.e. ground water. The chemical load leads to increase the pollution of water bodies. Because of this reason only this parameter is determined.

H. Total Alkalinity

The household activities like cattle farming, bathing, washing etc. increase the carbonates and bi-carbonates content. This increases the inorganic load. Therefore, it is necessary to determine Total Alkalinity.

V. DETERMINATION OF WATER QUALITY INDEX FOR SURFACE WATER

The Water Quality Index uses a specific scale to rate the quality of the water. Once the Water Quality Index (WQI) score is determined, it can be compared against standard scale to determine how healthy water is available around us. Water Quality Index (WQI) is a unit less number that describes a quality value to an aggregated set of measure chemical, physical and microbiological parameters. Basically a WQI attempts to provide a mechanism for presenting a cumulatively derived numerical expression to define a certain level of water quality. WQI is a mechanism for presenting a cumulatively derived numerical expression defining ascertain level of water quality. Water quality indices aim at giving a single value to the water quality of a source reducing a great amount of parameters into simpler expression and enabling easy interpretation of monitoring data.

Water Quality Index is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality. In other words, WQI summarizes large amount of water quality data into simpler terms (e.g. good, bad) for reporting to public in consistent manner. Various researches have evolved which bought the changes to the methodology depending on the usage and parameters under consideration. Further development and calculation of WQI includes consideration of numerous parameters such as pH, BOS, COD, TDS, SS, Temperature, Chloride, Heavy metals, Sulphate etc. To analyse, determine and test all the parameters is very long and tedious process. So only few chosen parameters have been considered and these are pH, BOD, COD, Turbidity, Colour etc.

Sr. No.	*Test Description*	*Result: Sample 1**	*Result: Sample 2**	*Result: Sample 3**	*Result: Sample 4**	*IS:10500-1991 Limits*	
						Desirable	*Permissible*
1	*pH*	*7.03*	*7.47*	*4.70*	*8.93*	*6.5-8.5*	*No Relaxation*
2	*Suspended Solids*	*234*	*172*	*179*	*130*	*Max. 500 mg/l*	*Max. 2000 mg/l*
3	*Total Dissolved Solids*	*30*	*50*	*51*	*38*	*Max. 100 mg/l*	*Max. 250 mg/l*
4	*Alkalinity*	*193*	*182*	*163*	*172*	*Max. 200 mg/l*	*Max. 600 mg/l*
5	*Calcium as Ca*	*39.2*	*37.8*	*34.2*	*32.5*	*Max. 75 mg/l*	*Max. 200 mg/l*
6	*Magnesium as Mg*					*Max. 30 mg/l*	*Max. 100 mg/l*
7	*Sulphates as SO4*	*103*	*108*	*115*	*172*	*Max. 200 mg/l*	*Max. 400 mg/l*
8	*Chloride as Cl*					*Max. 250 mg/l*	*Max. 1000 mg/l*
9	*Nitrate as NO3*	*33.5*	*32.3*	*38*	*29*	*Max. 45 mg/l*	*Max. 100 mg/l*
10	*Total Hardness as CaCO3*	*123*	*142*	*133*	*110*	*Max. 300 mg/l*	*Max. 600 mg/l*
11	*Turbidity (NTU)*	*5*	*6*	*9*	*5*	*Max. 5 NTU*	*Max. 10 NTU*
12	*Fluoride as F*	*0.248*	*1.298*	*0.331*	*0.573*	*1.0 mg/l*	*3.0 mg/l*
13	*Electrical Conductivity*	*733*	*644*	*780*	*702*	*250 micro mho/cm*	*2000 micro mho/cm*

14	*Colour Hazen Units*	*Colourless*	*Colourless*	*Colourless*	*Colourless*	*Max. 5*	*Max. 10*
15	*Odour*	*Odourless*	*Odourless*	*Odourless*	*Odourless*	*Unobjectionable*	*-*

Table 1: Sample calculations and Parameter results of Testing

- Sample 1*: 5 km away from disposal point of Khan Sarovar treatment plant.
- Sample 2*: 2 km away from disposal point of Khan Sarovar treatment plant.
- Sample 3*: 1 km away from disposal point of Khan Sarovar treatment plant.
- Sample 4*: 500 m away from disposal point of Khan Sarovar treatment plant.

I. Remarks

1) The testing was done as per Relevant Parts of IS: 3025.
2) Water Confirms to IS: 10500 specifications and can be used for consumptive purposes.

Calculation of WQI: The Water Quality Index (WQI) has been calculated using Weighted Arithmetic Index method.

Weighing: The word weighing implies relative significance of each of the factor in the overall water quality and it depends on the permissible level of waste water discharge, as suggested by GPCB (Gujarat Pollution Control Board). Factors which have higher permissible limits are less harmful and have low weights while the factors having low permissible limits are more harmful. Therefore.

$$W_i = K/S_n \quad (1)$$

Where, W_i = Unit weight of chemical factor, K = constant of proportionality and is given by,

$$K = 1/ [(1/V_{s1})+(1/V_{s2})+(1/V_{s3})+….+(1/V_{sn}) \quad (2)$$

S_n = Standard value of i_{th} parameter.

Rating scale: Each chemical factor has been assigned a water quality rating to calculate WQI.

$$Q_i = 100[(V_a - V_i)/(V_s – V_i)] \quad (3)$$

Where V_a= average measured values in the water sampole for three months at a place

V_s = Standard value of i_{th} parameter (0 for all, exceptions: pH and DO)

$$\text{Water Quality Index (WQI)} = [\Sigma(Q_iW_i)/\Sigma W_i] \quad (4)$$

Where $\Sigma(Q_iW_i)$ = Summation of $(Q_i * W_i)$ of all the parameters considered.

ΣW_i = Total unit weights of all chemical factors.

Using the Water Quality Index, all the samples were categorized into the following five classes.

J. WQI Scale

Excellent	*0-25*
Good	*26-50*
Moderately polluted	*51-75*
Severely polluted	*76-100*
Unfit for human consumption	*>100*

Generally, WQI are considered for a specific use of water. In this study the WQI for human consumption is considered and permissible WQI for the waste water is taken as 100. A water supply with a poor quality rating would not normally be considered acceptable for activities involving direct contact with the water.

VI. RESULTS AND DISCUSSION

The disposed water from Khan Sarovar Treatment Plant, Patan has been assessed for periodical 15-day) Water Quality Index (WQI) for all spatial locations under study area. Table 2, Table 3, Table 4 and Table 5 summarises the WQI calculations for disposed waste water for four samples taken at different time interval. Fig. 2 shows the variation of parameters with respect to location.

Sr. No.	*Distance from Disposal Point*	*Average WQI over temporal variation*	*Predominance in parameter*	*Remarks*
1	*100 m*	*60.2*	*pH, Turbidity, BOD*	*Not fit for Irrigation, Drinking, Industrial purpose*
2	*200 m*	*54.3*	*Turbidity, BOD*	*Not fit for Drinking purpose*
3	*500 m*	*53.6*	*BOD, COD*	*Not fit for Drinking*
4	*1000 m*	*48.2*	*BOD*	*Fit for use*
5	*2000 m*	*42.1*	*-*	*Fit for use*
6	*5000 m*	*39.2*	*-*	*Fit for use*

Table 2: Spatial Variations of Average WQI over temporal measurement

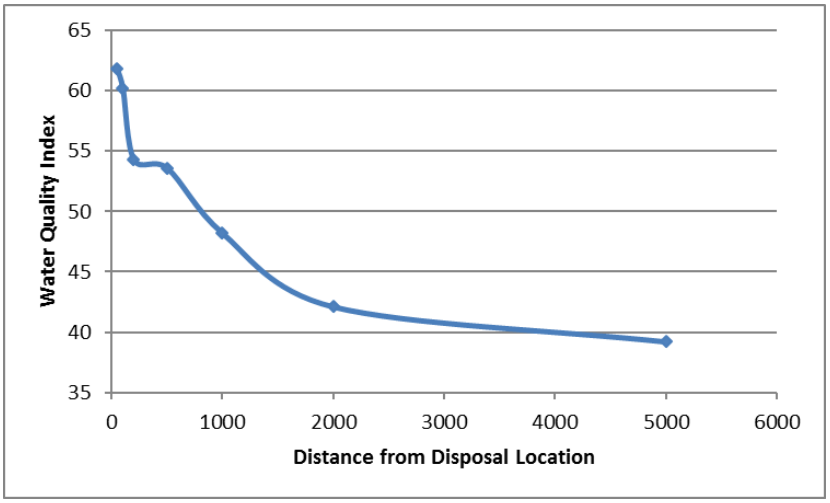

Fig. 1: Spatial Variation of WQI

VII. CONCLUSIONS

Following mentioned points can be summarized as an outcome and conclusion of the present study.

The waste water of approximately 60,00,000 litres quantity is directly disposed into the canal, after treatment. The water has to be treated well before disposal because the water of the canal is used directly for multi purposes such as irrigation, industries requirement etc. The water which is chemically and biologically harmful should be treated or its assessment should be happens so as to cure it in better way. The assessment, analysis and periodical testing of the water samples for quality have been done.

Surface water resources are the most prominent, clean and direct source of water which is oftenly used for disposing treated water from treatment units. The disposed treated water needs to be assessed at different location after discharge point so as ensure the quality characteristics of canal. In the present study, testing of physiological parameters has been done to assess the surface water quality index of the disposed treated water into the canal. Various literature reviews have been carried out to fix the methodology and testing procedure.

The analysis of different chemical and physical parameters reveals that the water is fit for drinking as per calculated Water Quality Index Scale. The values are compared with standards. The predominance of certain parameter has been found and actions may be taken to mitigate the problem. Research paper summarises the study done for assessing the Water Quality of surface water which has been assessed.

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