



Review Paper

Physico-Chemical Parameters for Testing of Present Water Quality of Khan River at Indore, India

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Abstract

Water is a scarce and valuable resource for the survival of mankind. Man-made activities change the morphology of the areas the river regimes causing problems of water pollution. Fast industrialization for sustainable development is causing major concern to the pollution of surface water because most of the industries are disposing off their waste directly to the nearby stream without making any treatment and violating the provisions for standard laid out for the same. Through the bodies like state pollution control board try to tackle the problem of pollution but the net result indicate that the pollution is increasing due to enormous population growth as such the available water in various surface sources must be preserved. The Khan River is of E Quality River from origin to confluence. Major part of the untreated domestic waste of Indore city flows into Khan River. The River water, at downstream, used for growing vegetables by the Farmers, posses the risk of contaminating food chain. Khan River becomes dry before confluence into Kshipra. But during monsoon season its water reaches up to Kshipra and affects the quality of Kshipra river water in Ujjain city. The present study was done in the as per the grab sample theory at mid stream of river. After collecting the required samples from desired sites, the samples were brought to laboratory within three hours and analysed as per I.S. 3025. On the following day we, all the experiment part was done. pH, EC, TDS, turbidity, DO, BOD, COD, TA, TH, Ca H, Mg H, Na⁺, K⁺, Cl⁻, F⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, SAR, % Na and boron parameters were determined for the testing of water quality. The temperature, colour and pH were observed at the site itself.

Keywords: pH, sodium absorption ratio, percentage of sodium (%Na).

Introduction

Water is life. No life can exist without water. Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living beings. It has many beneficial uses such as drinking, irrigation, navigation, propagation of wild life, fisheries, recreation; aesthetics etc. water is one of the most valuable natural resources. It is the basic element of social and economic infrastructure and is essential for healthy society and sustainable development. Water, the matrix of life is exposed to pollution, unhealthy environment, resulting in human affliction and diseases transmission due to rapid industrialization and population¹.

Water is scarce and valuable resource and it is highly essential for the survival of mankind. Man made activities are changing the morphology of the area of the river regimes and causing problem of pollution of water. Khan River is the main water body of the study area; Khan River is polluted due to discharge of domestic waste water and industrial waste water. During summer sediment depositions containing many harmful organic and inorganic matters are observed which get carried along with initial monsoon flows of river khan to Kshipra River².

River khan the tributary of river Kshipra originates from

Nimboli tank (Latitude 22°37' N and Longitude 75°54' E) near Indore meets Kshipra at Triveni located about 6 km. Up stream of Ujjain town. It flows for a length of about 6 km. before meeting Kshipra having a heavy catchment area of about 712 Sq km. This is also a non perennial river and on it two barrages viz. Kayastha Khedi and Rambasa have been constructed to store the water which is mainly utilized for Irrigation purpose. River Khan is highly polluted due to the discharge of domestic waste and Industrial waste from various Industries (Located within the catchment area of the river) like textile, mills, chemical, pharmaceuticals, electroplating, paper mill, food processing etc. Located in different industrial estate of Indore city. In monsoon, these deposits along with the agricultural runoff pollutes river Khan and Kshipra, also endanger the aquatic life.

General Physico-Chemical aspects and considerations

Assessment of water quality can be defined as the analysis of physical, chemical and biological characteristics of water. Water quality indices used for assessing surface water quality³. The selection of determinants was done on the basis of the main pollutants discharge by the industries of Indore city as well as the industries situated at Dewas and city of Ujjain in Khan and

Kshipra river respectively.

pH: pH can be viewed as an abbreviation for power of hydrogen or more completely, power of the concentration of hydrogen ion. Most natural water is alkaline in nature due to presence of bicarbonates and carbonates formed due to dissolution of atmospheric Carbon dioxide. pH can be drastically change due to prevailing biochemical activities undergoing in water. Photosynthetic activity increases the pH due to consumption of free CO₂ and dissociation of bicarbonates into carbonates. The carbonate are much stronger alkalise than the bicarbonates⁴.

Electrical Conductivity: The electrical conductivity is the capacity of waters to conduct current, and is caused by the present salt, acids and bases, called electrolytes, capable of producing cations and anions. As the conductivity is directly related to the presence of dissolve salts, its magnitude can give the fair idea of the level of dissolved solids. A factor of 0.65 can be employed to convert the conductivity values in $\mu\text{mho/cm}$ at 25°C into dissolve solids⁴.

Dissolve Solids: The composition of solids present in a natural body of water mainly depends upon the nature of the bedrocks and the soil developed from it. The physico-chemical factors, which govern the chemistry of salts in water, may also influence the composition⁴. The high salt content of the bodies of water is responsible for increasing the soil salinity in several parts of the world, especially in arid condition⁵.

Total Hardness: Hardness is caused by divalent metallic ions that are capable of reacting with sops to form ppt. And with certain anions present in the water to form scale. There are two types of hardness-temporary hardness is also known as carbonate hardness and it is mainly due to presence of carbonate and bicarbonates of Ca and Mg which is removed by boiling or by adding Ca(OH)₂ to it. The permanent hardness is also known as non-carbonate hardness and is due to the sulphate, chlorides and nitrates of calcium and magnesium.

Dissolve oxygen and Biological Oxygen Demand

Adequate dissolve oxygen is necessary for the life of fish and other aquatic organism. The D.O concentration may also be associated with corrosives of water, photosynthetic activity simplicity. The D.O test used in the biological oxygen demand determination as carried out by the dilution method. The amount of oxygen required to carry out biological decomposition solids in sewage under aerobic condition at standard temperature is known as B.O.D. The test for B.O.D is very important. As the river water under normal condition will not contain much amount of dissolve solids. Direct method can safely be used.

Chemical Oxygen Demand: Chemical Oxygen Demand (COD) test determined the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The test can be employed for the same purpose as the

BOD test taking into accounts its limitations. COD determination has an advantage over BOD determination in that the result can be obtained in about 5 hour as compared to 5 days required for BOD test. Further, the test is relatively easy, gives reproducible result and is not affected by interference as the BOD test⁶.

Alkalinity: Alkalinity is measure of solution's capacity to react with a strong acid (H₂SO₄) to a predetermined pH. Alkalinity of water is due to the presence of hydroxides, carbonates and bicarbonates. Higher alkalinity, more neutralized agent needed to counteract it.

Chloride and sulphate: Almost all natural water contains chloride and sulphate ions. Their concentrations vary considerably according to the mineral content of the Earth in any given area. In small amount they are not significant. In large concentrations they present problem. Usually chloride concentration is low. Sulphates can be more troublesome because they generally occur in great concentrations. Low to moderate concentrations of both chloride and sulphate ions add palatability to water. In fact, they are desirable for this reason. Excessive concentrations of either, of course, can make water unpleasant to drink.

Fluoride: Fluoride with lower concentrations at an average of 1mg/L is regarded as an essential constituent of drinking water mainly because of its role in prevention of dental carries⁷.

Phosphorous: Phosphorous in water occurs mainly in orthophosphate, condensed phosphate and organically bound phosphate. The microbial detraction of organic matter releases the phosphorous in phosphate form. The significance of phosphorous lies in its ability to cause eutrophication water in presence of other nutrients, especially nitrogen. The quality criteria of phosphorous in waters in only to check the unwanted algal growth⁴.

Ammonium Nitrogen: Ammonia in water can be present either in ammonium ion or in gaseous form. The gaseous form is much more toxic than its ionic form. pH work for the toxicity of ammonia as it governs proportion of the two form. At higher pH much of the ammonia is present in the toxic gaseous form. A reduction in pH converts the gaseous form into the less toxic ionic form⁴.

Sodium and Potassium: Sodium and potassium are important cat ions occurring naturally in waters. Their major sources in water are the weathering of rocks. Bothe the sodium and potassium are highly soluble in nature and do not form any precipitating salts. They have a strongly tendency to remain absorbed on soil particles, but can be easily exchanged by divalent cat ions like calcium and magnesium⁴. In humans, a higher concentration of sodium can lead to the cardiovascular disorder: and in women, toxemia can be associated with pregnancy⁸.

Nitrate: Most natural water are deficient in nitrate having a concentration usually below 5 mg/L, but certain polluted surface water and ground water may have substantially higher quantities. The nitrate has gained major significance because of its implication in infant methaemoglobinaemia, a diseases characterized by bluish colouration of skin. In these diseases, the normal haemoglobin is converted into met haemoglobin due to formation of ferric ions in the harem, and loses its capacity to carry oxygen⁴.

Sodium Absorption Ratio and % Sodium (Na): These two parameters can be calculated by the following formulae

$$\% \text{ Na} = \frac{\text{Na}}{\text{Ca} + \text{Mg} + \text{K} + \text{Na}} \times 100 \text{ all in meqs/L}$$

$$\text{SAR} = \frac{\text{Na}}{\sqrt{\frac{\text{Ca} + \text{Mg}}{2}}} \text{ in meq/L}$$

Some Physico-Chemical water pollution study

Due to increasing urbanization, surface water is getting over contaminated and more stringent treatment would be required to make surface water potable. Therefore, it is required to carry out the study of physico chemical characteristics of surface water to find out whether it is fit for drinking or some other beneficial uses. Murhekar had worked out the Physico-Chemical parameters and analysis for various water qualities. The water samples from different site showed very poor water quality, it was probably due to domestic waste discharge in river. High amount of total sissolve solids, total alkalinity and sodium content indicated the need of some treatment for minimization of the parameters. Some of The sampling sites showed some physico-chemical parameters within the water quality standards and the quality of water is good⁹.

Dubey had been studied physico-chemical studies of Wastewater disposed off in the river and outlet of ponds of entire Ujjain city. The Ujjain district is one of the main tributaries of the holy river Kshipra. Several types of industries exist in the nearby city and the domestic and industrial waste of this major city is responsible for degrading the quality of river Kshipra. In the present study sample of river water were collected during the year. Physico-chemical parameters namely pH, turbidity, TS, TDS, TSS, CaH, MgH, Cl, SO₄, NO₃, BOD, COD were analyzed using standard methods. The result indicated that the water is unsuitable for both domestic and portable use as there exist possibility of corrosion in boilers¹⁰.

Tripathi and Misra this study assessed the qualities of contaminated soils of the municipal waste dumpsites in Allahabad and Uttar Pradesh. The study evidently indicated that the level of heavy metal contamination is higher at dumpsites which may be a cause of concern for their surrounding environment and organisms. This work proved valuable in providing baseline information for further soil quality monitoring studies in study area. This study indicated the level

of contamination at the municipal waste dumpsites and explored the relationship between ranges of quantitative variables. All the studied dumpsites were contaminated with heavy metals with the maximum being at Daraganj dumpsite. Thus the open dumping of waste should be discouraged and a proper monitoring and remediation plan is needed to reduce the chances of ground water pollution by leaching of these contaminants. Further in-situ and in-vitro bioaccumulation studies can also be performed by using the information in this study. Such studies are useful in providing indicators of contamination at such open dumpsites. Artificial reclamation with mature soil is recommended for these sites¹¹.

Soni et al. the studies were carried out to ascertain the quality of water at western zone of Narmada River of Madhya Pradesh (India). Due to heavy discharge of harmful and deleterious substances in river, the biological, chemical and physical characteristics of water have changed to a considerable extent. The objectives of this study were to find out the changes in physico-chemical nature as well as biological health of Narmada River. A thorough study was done on the basis of prevailing seasons. The deterioration of water quality was noticed at lower site of water body in a particular season as low temperature, dissolved oxygen and higher concentration of content of chlorine, etc., Water quality index of all sites of Narmada River was calculated for three seasons, viz. summer, monsoon and winter and it was found to be highest at Koteswar dam site of river in monsoon season and the lowest (70) was observed in water of upstream of Omkareshwar dam during winter. The suitable correlation coefficients were calculated for 7 pairs of variables and correlation matrices were then established seasonally¹².

Janjala and Vaishnav carried out experimental work on physico-chemical monitoring and statistical evaluation of surface water in Korba District, C.G. India. In these studied analytical data were obtained for temperature, pH, EC, TDS, TS, hardness, Alkalinity, fluoride, chloride, nitrate, sulphate, phosphate, DO, BOD, COD, Fe, Al, Hg and Zn. Korba district is one of the most polluted place in India. Day by day pollution level are alarming ,so the present study is very much significant in the current times. Analytical procedure is that the field parameter like temperature, pH, EC, turbidity, DO and TDS were measures at the sampling site by nine parameter analyzer kit whereas other such as total solid by gravimetric method, COD and BOD by open reflux and incubators method, chlorides by titrating with AgNO₃, fluoride by an ion meter, nitrite by phenol disulphuric acid method and phosphate and sulphate by stannous chloride and spectrometric method. The obtained results were compared with std. values for drinking water set by WHO and IS. The data obtained was interpreted using statistical tools like mean, standard deviation, standard error, % CV and correlation of coefficient and arrived at a conclusion. The obtained values were discussed as negative and positive relation with various parameters across the study area¹³.

Verma et al studied some physico-chemical water pollution indicators of River Yobe-Nigeria and analysis was carried out to establish interrelationships where reliable correlations were established using regression analysis. This indicates the reliability of the relationships which suggests that it can be used to predict the levels of pollution by the parameters investigated and possibly offering a preventive measure prior in pollution monitoring system. The high to moderate correlation coefficient observed, R^2 ranged from 0.68 to 0.15 between these parameters¹⁴.

Hossain et al studied surface water Pollution in Eastern Part of Peninsular Malaysia. Industrial and municipal wastes were mixing with river flow and surrounding water body thereby deteriorating the quality. To assess the Water Quality Index in order to evaluate the water quality of the area for public use, irrigation and other purposes. The study also showed that, application of Water Quality Index as a tool of assessing the overall surface water pollution was helpful and easily understandable. Although, all parameters were not considered, method of water quality index assessment is seems to be more systematic and it is easy for understanding about the water pollution as well as a useful tool for water quality management in many ways¹⁵.

Patil et al studied different physical, chemical and heavy metal parameters for testing of water quality. The availability of good quality water is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases¹⁶.

Murhekar studied the trace metals contamination of water samples from various samples surface water in and around Akot city. The sampling points were selected on the basis of their importance. The heavy metals like Cd, Cr, Pb, Cu, Ni and Zn were analyzed in surface water samples of rivers lake and field water pond. The results were compared with standards prescribed by WHO and ISI. It was found that the surface water was contaminated. Some sampling sites showed trace elements contamination above the water quality standards and the quality of water is very bad and it is unfit for drinking purpose¹⁷.

Parihar et al studied the physico-chemical and microbiological characteristics of the drinking water, were determined in July 2009 from different location in Gwalior region, M.P., India. Total 16 water samples were collected from different locations in and around Gwalior city. The physico-chemical and microbiological characteristics of different water samples showed that maximum samples were not suitable for drinking purpose. The observation of study strongly suggest that water of Gwalior region is of very high TDS and needs to be lowered down within prescribed limits before using it for drinking purposes. Also, the water samples were showing microbial content beyond the portability range, which needs to be disinfected before consumption to avoid water-borne diseases¹⁸.

Kushwah et al carried out an experimental work on water quality of raw sewage and final treated water to waste water treatment plant Bhopal. Parameters were analyzed by using waste stabilization technique. it was observed that high concentration of electrical conductivity, hardness and chemical oxygen demand (COD) was present in the raw sewage however better water quality was found after treatment in final treated water. Treated water discharge onto the nearby water bodies, it is proposed that it pass through the waste water treatment plant which would reduce most of the pollutants¹⁶.

Sohani and Iqbal has been work out the Microbiological studies involved presumptive, confirm and completed test. Result shows that the numbers of microbial organisms released into distribution systems, due to discharge of sewage water into drinking water. The distribution system of water in Indore city is not perfect and should be monitored time to time for reducing disease and other health hazards²⁰.

Thoker et al in this study the wastewater has greatest potential for polluting the receiving water. Kshipra River is one of the sacred Indian rivers is being polluted by effluents discharged of industries. The study was an attempt for analysis of water quality being polluted by effluents. The study revealed that there was an adverse impact on physico-chemical characteristics of river Kshipra as a result of directly discharge of untreated effluents from industries. This poses a health risk to several rural communities which rely on the receiving water bodies primarily as their source of domestic water. The results indicate that the effluents affects the water quality which lead to significant environmental and health risk to the rural communities who rely on the receiving water as their source of domestic water purpose without treatment. The study showed a need for a continuous pollution monitoring programme for the river Kshipra²¹.

Preserving river for better future and bringing awareness – Role of technical bodies

MPPCB is a statutory organization which was first constituted in 1974 and was entrusted with responsibility to implement the water (prevention and control of pollution) Act 1974. This board has been rested with considerable authority and responsibility to control and prevent the pollution by various effluent and emission under the water and air pollution control law, laid down from time to time. In reality MPPCB is the real machinery for implementing and enforcing the provisions on various pollution control acts. MPPCB's main objective is to maintain water, air and soil is healthy and unstable stable condition of various purposes. For this adequate monitoring network under Board's own scheme and national and international programmed are being implemented in the state through four zone offices, 14 regional offices and two is monitoring station. Inland surface water may be classified into different categories which shown below.

Table-1
Classification of inland surface water

Characteristics	Drinking Water Source without conventional treatment but after disinfection	Outdoor bathing (Organised)	Drinking water source after conventional treatment and disinfection	Propagation of Wild life and Fisheries	Irrigation, Industrial Cooling, Controlled Waste disposal
Dissolve Oxygen, mg/L, Min	6	5	4	4	00
Biological Oxygen Demand, mg/L, Max	2	3	3	00	00
Total Coliform Organism, MPN/100 ml, Max	50	500	5000	00	00
Total Dissolve Solids, mg/L, Max	500	00	1500	00	2100
Chlorides, mg/L, Max	250	00	600	00	600
Colour, Hazen units, Max	10	300	300	00	00
Sodium Absorption Ratio, Max	00	00	00	00	26
Boron, mg/L, Max	00	00	00	00	2
Sulphate, mg/L, Max	400	00	400	00	1000

Objectives of study for river Khan

To study some physico-chemical water pollution indicator in Khan River for post monsoon and winter season. And access the quality of Khan River by calculating water quality index and its comparison with the relevant IS standard.

Study Area: Indore city 22°02'-23°05' North latitude and 75°25'-76°16' East Longitude. Several types of industries exist in the nearby city and the domestic and industrial waste of this major city is responsible for degrading the quality of river Khan.

Experimental part – How to do

The physico-chemical parameters of surface water of Khan river studied in the month of November 2013-April 2014 (post monsoon and winter) for a period of six months from four different sites. Water samples were analyzed for some physico-chemical parameters. The results obtained were compared with Class-E River standard IS 2296-1982.

For the study, Grab sample theory was selected as the base and so the study was done at mid stream of river. After collecting the samples from the sites, it was brought to the laboratory within three hours to ensure the character of the parameters are same as it was found at the time of collection and after that it was preserved. On the following day, all the experiments were done.

Sampling sites for the study

The following pictures show the study area selected for the project. Pictures below depict the condition of pollution of Khan river and the volume and physical appearance of the river water. It was observed that from Krishnapura bridge to Khatipura bridge, the river is almost in septic condition throughout. The river is used as Nallah and only domestic as well as industrial waste flows through the Nallah and there is no other flow. Therefore maximum depth of water is more or less 1 foot and breadth is not more than 10 feet but there are number of stop dams, regulating flow of Khan, so water depth is

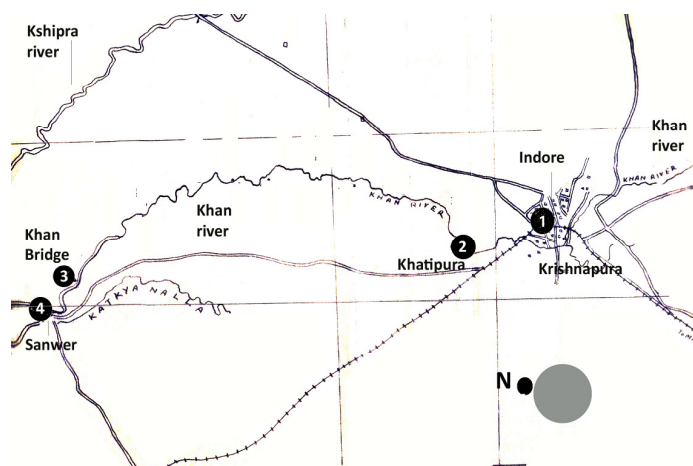


Figure-1
Map of study area

increases as well as breadth of river is increases near the stop dams of wherever flow is obstructed.

After sanwer and up to confluence there is sufficient flow and river water is comparatively of better quality, but there is high

algal growth from Baman piplya to point of confluence. The domestic sewage of city flows through sedimentation tanks at Kabit khedi, resulting is in very bad condition therein. The extent of pollution can be easily seen in photograph below.



Figure-2

View of Khan River in the heart of the city i.e. at Krishnapura Bridge, Here the river is like an open drain and creates foul smell in the nearby areas



Figure-3

View of Khan River Khatipura Bridge. Photograph shows increased flow of river water due to discharge of industrial and domestic wastes



Figure-4

View of Khan River at Khan Bridge near sanwer bypass road, The flow is variable; here there is a high algal bloom in water



Figure-5

View of Khan River at Sanwer, This water is generally used for irrigation purpose

Conclusion

The study shows the various pollutants of river Khan and their physical and chemical properties as well as the reason of pollution and the remedial measures. The method has been shown to study to behaviour of various parameters which can help in policy making and preparation of a study model to counteract the problem of Khan river pollution and the harmful effects of the pollutants on the environment. From the study, it is clear that Khan River is polluted due to discharge of domestic and industrial waste. Due to sedimentation of such harmful organic and inorganic matter from the industries and surroundings, the river water gets contaminated and full of harmful pollutants. These pollutants, along with initial monsoon, flows through river Khan to the Kshipra river. Though there are many studies done in history in this context but it is clear that the study is complex and confined to a limited area of the river from where the sampling is done, as a result, such studies cannot be generalized for whole river but it may just show the trends. The studies done so far are generally limited to one season only for which the sample have been taken and may vary for other seasons and also same seasons of each forthcoming years because there may be chemical, physical, natural or intentional changes with respect to site. Sometimes many studies are done for a single project but still the data may vary as a result of environmental changes, so the study could not be generalized. It shows the deviating tendency of the studied model.

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