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RIVER BANK FILTRATION - A NATURAL AND ECONOMICAL WATER TREATMENT TECHNOLOGY

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Abstract - River Bank Filtration is a water treatment technique that consists of bring out water from river by pumping wells located in the nearby aquifer. It is the technique of Aquifer Recharge in which the surface water treated through the aquifer medium. In present study an attempt is made to understand the impact of River Bank Filtration on surface water, in Jabalpur city in Madhya Pradesh. The geological conditions, well types, cost saving on coagulant and the physical, chemical and biological effect of RBF were discussed in this study. Chemical coagulants are costly because of this it is becoming difficult day by day to run the treatment plant by using chemical coagulant, so RBF can be a good alternative pretreatment idea in the long run. It has been found that bank filtration works effectively as a natural treatment as well as alternative solution of pre-treatment. Turbidity removal efficiency of RBF was 94.22% in this study. Due to its efficiency, easiness and low-cost process River Bank Filtration will be a better and sustainable solution to partly fulfill the present water demand in India.

Key Words: river bank filtration, cost of coagulant, pretreatment technique.

1.INTRODUCTION

Groundwater is the major source of water in the India, which is under stress due to the excessive use of water. Over dependency on groundwater to fulfill the requirement of increasing population, industrialization and agricultural activities has also decreased its quality. More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater in India. Day by day population is increasing in India, so demand of water has also increased. For this demand, other than groundwater we also depend on the surface water such as river water, in India major area of villages is depend on river water for drinking but it is difficult to establish water treatment plant in so many locations but consumption of without treated drinking water can cause mild or severe health issues. Due to high turbidity in river water, it requires more and more coagulant to remove colloidal or finer particles from river to treat the water, in water treatment plant. Due to requirement of high quantity of coagulant government tries to avoid to start any new treatment plant, So for reducing the cost of coagulant RBF (river bank filtration) is one of the most effective and economical technique. RBF is one of the

method which is low cost and sustainable to improve the quality of surface water, thus it helps to eliminate the problems of turbid surface water source. During RBF, the water in the river with various contaminants is naturally treated as it passes from river bank to the pumping well. RBF results in removal of suspended or colloidal, dissolved particles and reduction of bacteria, viruses, pollutant, inorganic and organic compounds through river bank aquifer medium is very incredible. RBF diagram shown the process of RBF technique, which is responsible for the good quality of water is shown in Figure-1. The efficiency of RBF to treat river water polluted by dairy's waste and pharma content is very high. In fact, RBF systems provide 15% in Germany, 20% in USA and 65 % in Netherlands of drinking water supply. RBF technique have also been practiced in India from ancient time and its effectiveness and advantage makes it a better solution of pretreatment.

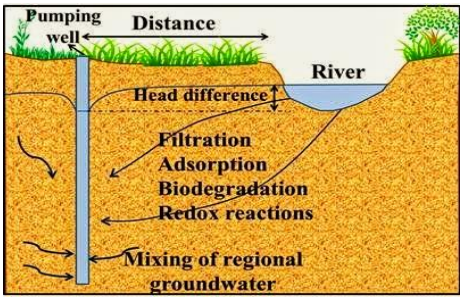

Fig-1: simplified diagram of showing RBF technique processes

In many developing nations like India, Africa and Indonesia the cost of imported chemical such as aluminium sulphate (Alum) for coagulation and chlorine for disinfection and other chemical for conventional water purification is expensive and Also these coagulant generate solid waste in large amount which is difficult and expensive to handle it. Alum is most widely used coagulant in water and waste water treatment, however recent studies indicated serious drawback of alum such as Alzheimer's disease and other similar health problems related with residual of Aluminium in treated water. there is also natural alkalinity and PH problem associated with alum. As compared to other countries, usage of RBF for water supply in India is very less. The advantage of RBF in India is

very high because of its geography. RBF improves the water quality in terms of physical, chemical and biological parameters. Hence, the present research was based on the investigation report and study carried out on RBF in Jabalpur city on the treatment of narmada river (Lalpur water treatment plant).

2. STUDY AREA

Jabalpur which is an important city and also a division of Madhya Pradesh. It is located between Longitude 79.974° E and latitude 23.1815° N. Lalpur water treatment plant is one of the major treatment plant in jabalpur, which is situated in gwarighat Lalpur. This plant treat the water of narmada river and it's capacity is 55MLD (Million litre per day) and this plant supply drinking water to half of the city, major area where plant supply water is : Bheem nagar, gwarighat, shardanagar, SBI colony, civil line, bhola nagar, bailbag, Katanga etc. The population of Jabalpur city is 1,496,000 which is increases 1.4 to 1.65 % rate. In this work of study pre-existing borewells of household considered as a vertical well (collector well) in site, which is situated in the range of 50 to 200m from the river bank. Therefore the study area was treatment plant with narmada river. RBF treated water considered with natural ground water due to deep RBF wells, treated water was mixed with ground water.

3.1 Water Treatment Process Flow Diagram In Lalpur Water Treatment Plant

In lalpur plant, water extract from narmada river intake well which is 1km far from treatment plant. Then do screening, coagulation, flocculation and clarification, sedimentation, filtration, disinfection then store treated water in overhead tank for supply in a city.

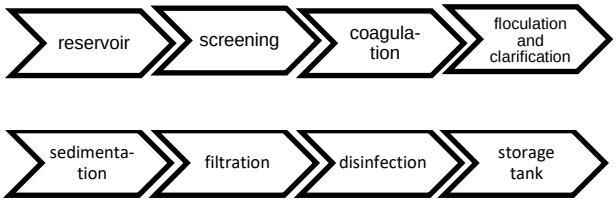

Fig-2 flow diagram of process of treatment plant

2.2 Geology And Soils

The catchment area of our lalpur site is in the form of depression in south - west with elevated portions in north - East direction. The western part is open and residential houses situated in eastern elevated portion. The major part of study area is coverd with deep black soil and mixed with silty and gravely sand in elevated area. The location of narmanda river point E and other point G, D, C and F were shown in fig-1. The nearest RBF well point 'G' is 50 meter and the last point F is 200 meter far from river were shown in fig-2 and fig-1 respectively.

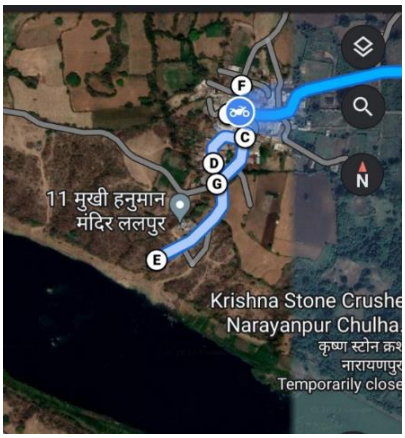

Fig-3: google map of RBF wells point at site

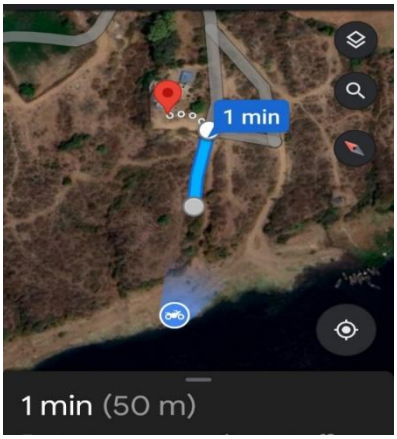

Fig-4: Google map location of nearest RBF well point from River

3.MATERIAL AND METHOD

The Aim of the current study is to present the technical applicability of river bank filtration technique for the pre-treatment and find out the turbidity removal efficiency of RBF technique for river water. For this purpose, previous reported data and present analysis of water sample from narmada river water and From RBF well sample were tested in lab. For investigation of RBF efficiency to treat the raw water (river water) flowing through aquifer different test were used on water sample for different parameters such as, turbidity, PH, TDS, alkalinity, hardness, chloride, fluoride, calcium, zinc, nitrate, iron, sulphate, Dissolve oxygen, BOD, COD and jar test.

3.1 Collection Of Water Sample

For the analysis of water quality of raw water and RBF treated water samples were collected from lalpur site. Checked and calculated the volume of sample in the laboratory for various water test such as turbidity, ph, TDS, alkalinity, total hardness, chloride, Fluoride calcium, zinc, nitrate, iron, sulphate and dissolve oxygen, B.O.D, and COD. Gloves and eye protection were used at the time of sample collection. The plastic bottles and cap were washed three time with sample water then kept the water in cool and Dry place in laboratory.

3.2 Alum Solution

1 gram alum was added to 1000ml of distilled water and stirred by the use of magnetic stir. after completely dissolved in distilled water we get 0.1% weight solution. Each 1 ml of this stock solution will equal to 0.1 mg/l (ppm) alum when added to 1000 ml of water to be tested.

3.3 Lime Solution

1 gram lime was added to 1000ml of distilled water and stirred by the use of magnetic stir. After completely dissolved in distilled water we get 0.1% weight solution of lime. Each 1 ml of this stock solution will equal to 0.1 mg/l (ppm) lime, when added to 1000 ml of water to be tested. Half amount of alum, lime solution is used to maintain PH level.

3.4 RBF Well Types And Other Considerations

Vertical RBF wells, Caisson RBF wells and radial RBF collector wells are the general types of RBF wells used in India. We used vertical filter wells in this study.

A. Vertical Collector Wells:

Vertical collector wells are the typical water bring out structures which is widely used around the world including India. maintenance is less, cost effective, more water bringout capacity are the major advantages of vertical wells. The diameter and depth depend upon the river bank aquifer conditions and surface water hydrology. These wells are preferred in comparatively

Table-1: observed water quality parameters of river water and RBF well treated sample.

parameters	IS 10500-2012		River water	RBF Treated water			
	Desirablelimit	Permissible limit	Intake point 'E'	'G'	'D'	'C'	'F'
Turbidity, NTU	1	5	22.5	1.3	0.8	0.7	0.5
PH	6.5-8.5	No relax.	7.2	6.9	6.85	6.81	6.7
TDS, mg/l	500	2000	130	198	172	158	124
Alkalinity, mg/l	200	600	120	115	110	108	104
Total hardness, mg/l	200	600	140	128	124	122	116
Chloride, mg/l	250	1000	32	75	39	35	15
Fluoride, mg/l	1	1.5	0.28	0.28	0.28	0.22	0.1
Calcium, mg/l	75	200	21	40	36	35	18
Zinc, mg/l	5	15	0.02	0.04	0.03	0.01	0.01
Nitrate, mg/l	45	No relax.	5	20	12	5	3
Iron, mg/l	0.3	No relax.	0.18	0.06	0.05	0.05	0.03
Shulphate, mg/l	200	400	12	16	17.5	18	20
DO, mg/l	6.5	8.5	7.1	2.6	2.11	1.98	1.71
BOD,mg/l	1	2	1.1	0.42	0.31	0.25	0.11
COD, mg/l	1	NA	8.2	1.2	0.98	0.52	0.22

high permeable aquifer. In lalpur site well diameter was generally 6 inches with depth is vary from 80m to 150m deep and distance of the RBF well from river was 50 to 200m. In RBF, distance is generally decided by considering the gradient between the river and the well. If the groundwater from the river bank takes many days to reach the RBF wells the microbial content will be eliminate effectively which will save the cost of post treatment. to maximize the production of treated water, number of wells can be construct at minimum distance parallel to the river bank.

4. RESULT AND DISCUSSION

4.1water Quality Investigation

The water quality status of narmada river and the RBF wells treated water quality in the nearby aquifers is shown in Table - 1. Study shown that water quality increases with respect to the distance of wells from river bank. Physicochemical parameters such as turbidity, PH, TDS, alkalinity, total hardness, chloride, Fluoride calcium, zinc, nitrate, iron, sulphate, dissolve oxygen, B.O.D, and C.O.D. were considered in RBF technique study.

Table-1 shows the effect of RBF on physicochemical parameters. Turbidity level had reduced adequately because of the effective filtration of water by the aquifer. In RBF well, its values ranged from 1.3 to 0.5 NTU while it was 22.5 before treatment. All values in RBF well water was under the desirable limit of IS10500-2012 (second revision), which shows the turbidity removal efficiency of RBF is 94.22 % and RBF is effective to make water suitable for drinking.

It is observed in river samples and RBF well water samples, PH level fluctuated in a limited range from 7.2 and from 6.9 to 6.7, respectively. All these PH values were well within the desirable limit as per BIS. This indicates that the RBF process effectively maintains the PH level with in the limit.

Alkalinity and hardness were decreased gradually in RBF filtration due to the ion exchange processes that are taking place during RBF process. While fluoride, zinc, and iron reduce noticeable and RBF kept all of them nearly to constant in all four points. TDS, chloride, calcium and sulphate were increased in RBF process but all were under the limit

Also The concentration of Dissolve oxygen, BOD and COD were observed in river water 7.1, 1.1 and 8.2 mg/l respectively while in RBF wells it was observed 2.6 to 1.71 mg/l, 0.42 to 0.11mg/l and 1.2 to 2.22 mg/l respectively. it means RBF is also efficient in removal of organic and inorganic matter.

4.2 Bank Filtrate Quality

it observed in this study and some other research papers study that RBF results in filtering contaminated turbid surface water during flow through the river bank aquifer. The filtration capacity depends on the aquifer material, the constituents in the water and its interaction with aquifer medium as well as the flow velocity. Hence, the results would have different in different sites regard to the improvement in quality of water extracted from RBF well.

4.3 Turbidity Removal Efficiency

One of the main purpose of this study was to observe the quality analysis of water specially in terms of turbidity parameter because it is one the major parameter of pretreatment technique. We observed that RBF is capable to remove turbidity with high efficiency and very effective and economic technique to strain the suspended and colloidal or finer particle of water.in this study it observed that turbidity removal percentage is increases with respect to distance between river and RBF wells.

$$\text{TRE :-} \quad \frac{initial\ turbidity - final\ turbidity}{initial\ turbidity} \text{ x } 100$$

Turbidity Removal Efficiency = TRE

4.4 Quantity Of Coagulant

It observed in this study that RBF technique can save much more quantity of coagulant in WTP (water treatment plant) and in community level treatment, which we use in remove the suspended and colloidal or finer particle in sedimentation process. This technique is considerably Adequate and economic for reducing the quantity of coagulant because in this method aquifer's pores media strain majority of the suspended and colloidal or finer particle and give relatively zero turbidity, but it can be show different result for other sites, according to geological condition of that area.

5.CONCLUSION

This paper highlighted the various advantages of river bank filtration technique. The effect of bank filtration on water quality parameters such as Turbidity, PH, Total Hardness, TDS, and Chloride, fluoride, calcium, zinc, nitrate, iron, sulfate, DO, BOD and COD were discussed in this paper. The study revealed that the RBF treated water quality is better than the surface water quality and that can be used for pre treatment technique for river water as well for drinking purpose for community supply. Also RBF is very adequate and Economic technique to reduce the expenditure of treatment plant by its high percentage of turbidity removal property and It helps to minimize the quantity of coagulant in sedimentation process. Physical, chemical and biological contaminants were decreased gradually during the RBF process. Thus, the potential of RBF to treat the surface water by the aquifer is very effective. The feasibility of bank filtration need to be apply in various other locations in the part of India AS a pretreatment technique. This will be a effective and economical solution to at least partly fulfill the present water demand in India.

However more study is required to obtain more information about RBF technique for pretreatment and also for community supply. RBF have a high potential in removing turbidity from river water.

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