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Analysis of Raw Water Treatment Plant in Karnal Village

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Abstract: ***Karnal is village located in Sangli district having total population of about 6000. Village has water treatment plant constructed in 2013. The prime objective of a water supply agency is to provide hygienic and safe water to its consumers. Analysis of various parameters was done to check the quality of treated water. The methods used were EDTA, Winkler's Method, Jar test, pH meter, Gravimetric method, Titration method. It was found that except hardness and turbidity all other parameters were well within limits and ion exchange method was used to reduce hardness and proper coagulant dose was given to reduce turbidity by 84%.***

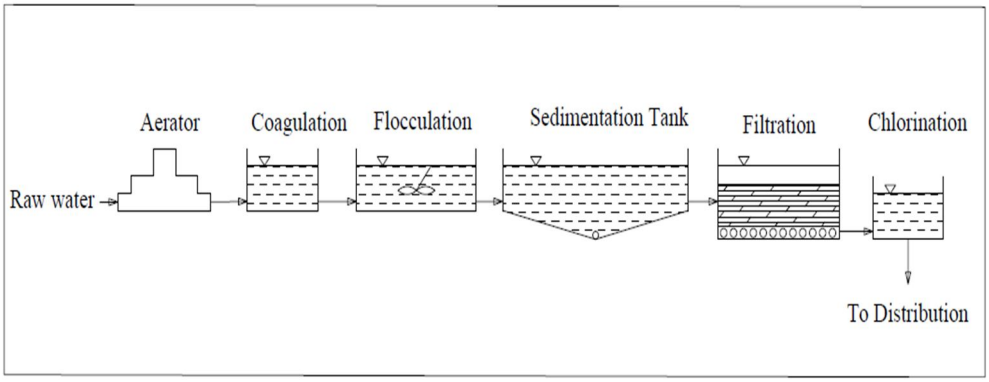
Keywords: Hardness, Turbidity, Dissolved Oxygen, Chloride, Jar test, Ion exchange, Alkalinity, Acidity, Total Dissolved Solids.

I. INTRODUCTION

Water is a precious commodity. Most of the earth water is sea water. About 2.5% of the water is fresh water that does not contain significant levels of dissolved minerals or salt and two third of that is frozen in ice caps and glaciers. In total only 0.01% of the total water of the planet is accessible for drinking purpose. Clean drinking water is a basic human need. Unfortunately, more than one in six people still lack reliable access to this precious resource in developing world. The trend of urbanization in India is exerting stress on civic authorities to provide basic requirement such as safe drinking water, sanitation and infrastructure. The rapid growth of population has exerted the portable water demand, which requires exploration of raw water sources, developing treatment and distribution systems.

The raw water quality available in India varies significantly, resulting in modifications to the conventional water treatment scheme consisting of aeration, chemical coagulation, flocculation, sedimentation, filtration and disinfection. The backwash water and sludge generation from water treatment plants are of environment concern in terms of disposal. Therefore, optimization of chemical dosing and filter runs carries importance to reduce the rejects from the water treatment plants. Also, there is a need to study the water treatment plants for their operational status and to explore the best feasible mechanism to ensure proper drinking water production with least possible rejects and its management. With this backdrop, the Central Pollution Control Board (CPCB), studied water treatment plants located across the country, for prevailing raw water quality, water treatment technologies, operational practices, chemical consumption and rejects management.

In this dissertation, various parameters of water quality are analyzed such as dissolved oxygen (D.O), pH, hardness, turbidity, TDS and TSS, acidity, alkalinity and chloride content. This analysis will give a clear picture about what measures are needed for rectification so that good quality of water is provided to the consumers and that there is a minimum rejection of raw water.



Flowchart of Water Treatment Plant

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II. METHODOLOGY

1) *Dissolved Oxygen (D.O):* Two sampling points for DO determination by Winkler's method were taken, that is, before aeration and after aeration. In case of aerator, a large growth of algae caused decrease in oxygen level in water. Algae consumes oxygen present in water after their death and for its decomposition. The solution for this problem is to clean and maintain the aerator periodically.
2) *pH:* pH value of water is determined by the relative concentrations of H+ ion and OH- ion. It used to measure the hydrogen ion concentration present in water. For pH measurement using pH meter two sampling points were taken that are before aeration and after chlorination. To ensure prevention of corrosion in treatment plant and distribution system and interference in coagulation and chlorination pH should be within limit.
3) *Turbidity:* Three sampling points for turbidity determination were taken using Turbidity meters that are after aeration, after settling after filtration. Turbidity was measured by using Nephelometer. To removes excess turbidity, jar test was conducted to determine the optimum dose of alum used for coagulation.
4) *Hardness:* A single sampling point for hardness determination by EDTA method was taken that is after filtration. Zeolite process is used to remove the hardness of the water. By zeolite process the hardness of water is reduced almost to zero. Zeolite is a complex compound of aluminum, silica and soda. Hard water is passed through a bed of ion exchange material commonly known as zeolite. Calcium and magnesium are removed from water as these are substituted by sodium by ion exchange process.

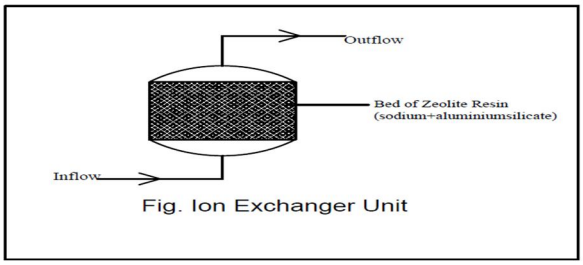
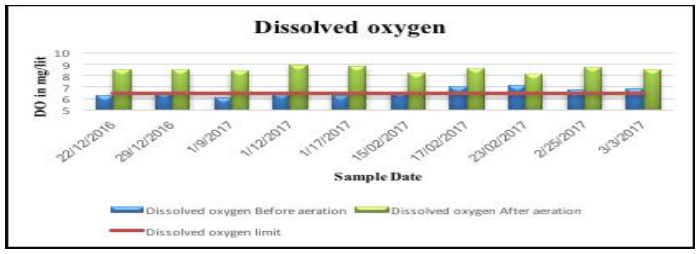


Fig. Ion Exchanger Unit

5) *Total Dissolved Solids and Total Suspended Solids:* A single sampling point for TDS determination was taken that is after aeration and three sampling points for TSS determination were taken that are after aeration, after settling and after filtration. The TDS and TSS were measured by using gravimetric method. TDS can be removed by the process of distillation or reverse osmosis and TSS can be removed by proper coagulation, flocculation and filtration
6) *Acidity and Alkalinity:* Total acidity and alkalinity of drinking water are needed to be maintained. More acidity causes undesirable taste and odour.A single sampling point for acidity determination was taken, that is, after filtration. Acidity was measured using titration method. More alkalinity causes undesirable taste and odour. A single sampling point for alkalinity determination was taken, that is, after filtration. Alkalinity was measured using titration method.
7) *Chloride:* It indicates the pollution of water. Salinity is the total of all non-carbonate salts dissolved in water. A single sampling point for chloride determination was taken, that is, before aeration. Chloride was determined by using titration method using silver nitrate solution. Reverse osmosis is a process which can be used to remove chlorides.

III. RESULTS

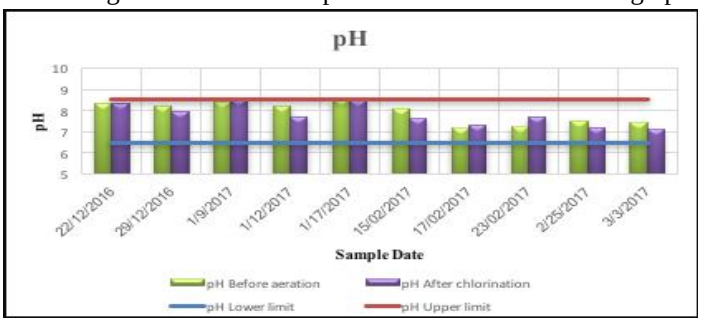
1) *Dissolved Oxygen(D.O):* The maximum and minimum values of DO before aeration found are 8.04mg/l and 7.5mg/l respectively. And the maximum and minimum values of DO after aeration found are 8.9mg/l and 8.4mg/l respectively. Acceptable range as per IS.10500 (2012) is 4.5-7.5mg/l for the drinking purpose. So it is within limit and no further measures are required. DO saturation % may imply with higher chlorine demand. The variation of DO as shown below:



Graphical Representation of Dissolved oxygen

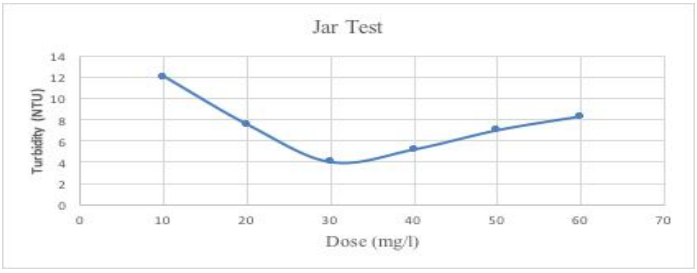
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2) *pH:* The maximum and minimum values of pH before aeration found are 8.39 and 7.9 respectively. The maximum and minimum values of pH after chlorination found are 8.5 and 7.69 respectively. The acceptable limit of pH according to IS.10500 (2012) is 6.5-8.5 so, it is within the range. The variation of pH is as shown below in the graph:-

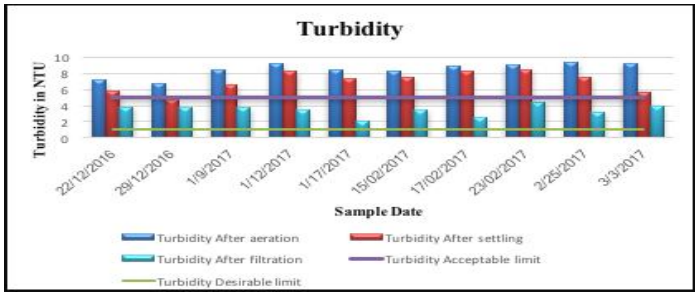


Graphical Representation of pH

3) *Turbidity:* Turbidity measured after aeration, after settling and after filtration are found to be 9.134 NTU, 8.059 NTU and 3.73 NTU respectively and the acceptable range for turbidity as per IS.10500 (2012) after filtration is 1NTU for the drinking purpose. So it is not within limit hence suitable measures required for turbidity removal. Hence Jar test was performed to determine the optimum dose of coagulant which came out to be 30mg/l. The variation of turbidity as shown below:

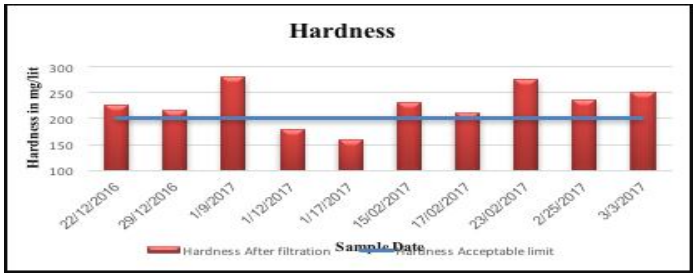


Graphical Representation of Optimum Coagulant Dose



Graphical Representation of Turbidity

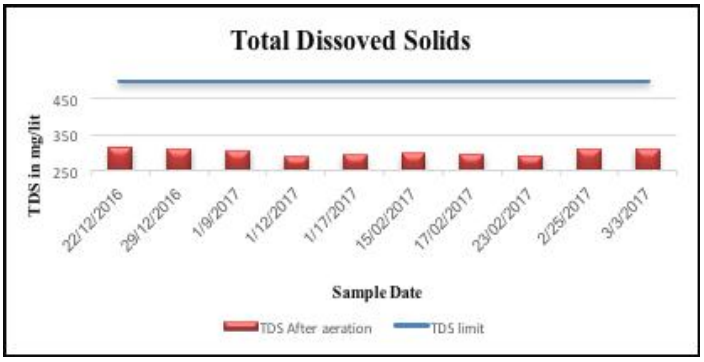
4) *Hardness:* The maximum and minimum value of hardness found is 280mg/l and 265mg/l, and the acceptable range for hardness as per WHO 200mg/l for the drinking purpose. So it is not within limit. Hence, Ion exchanger was used to bring the hardness well under limits. The variation of Hardness as shown below:



Graphical Representation of Hardness

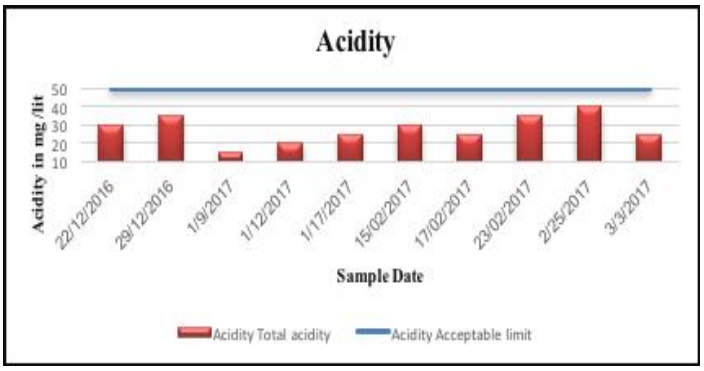
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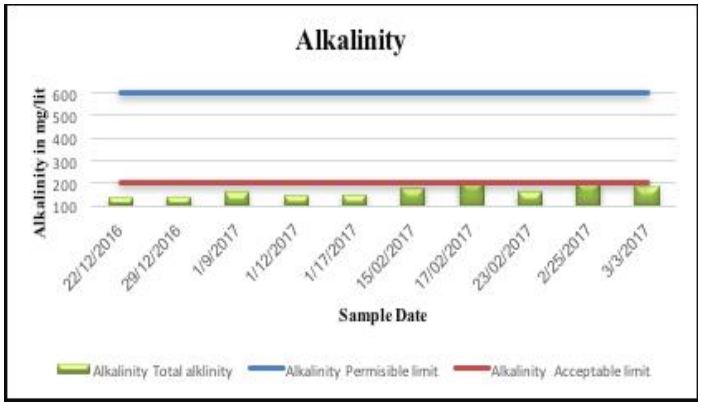
5) *Total Dissolved Solids and Total Suspended Solids:* The maximum value of TDS after aeration is 316mg/l. The minimum value of TDS after aeration, found is 287mg/l. And the acceptable range for TDS as per IS. 10500(2012) is 500mg/l for the drinking purpose. So it is within limit. No suitable measures required for TDS removal. The maximum values of TSS after aeration, settling, and filtration found are 375mg/l, 170mg/l and 110mg/l respectively. The minimum values of TSS after aeration, settling, and filtration found are 312 mg/l, 142 mg/l and 85 mg/l respectively. The acceptable range for TSS as per IS.10500 (2012) is 1000 mg/l for the drinking purpose which is within limit. No suitable measures required for TSS removal. The variation of TDS is shown below:



Graphical Representation of Total Dissolved Solids

6) *Acidity and Alkalinity:* It is found that mineral acidity is absent for all sample and total acidity is 28mg/l. It is found that phenolphthalein alkalinity is absent for all sample and total alkalinity is 166.5mg/l. The variation of acidity and alkalinity are as shown below:

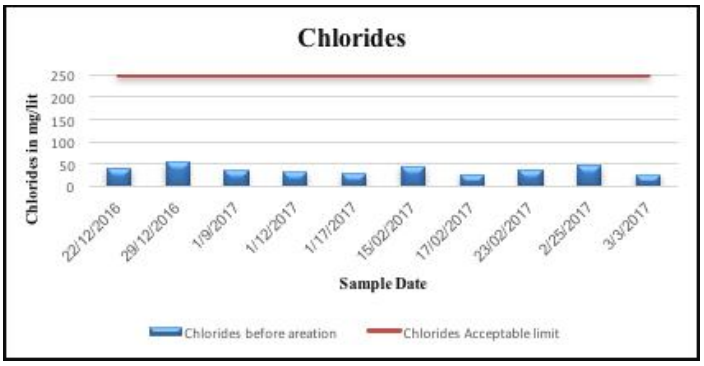




Graphical Representation of Acidity and Alkalinity

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7) *Chloride:* It is found that maximum value of chloride content is 54mg/l and minimum value is 25mg/l which is within limit. Hence, no further measures are required. The variation of chlorides is as shown below:-



Graphical Representation of Chlorides

IV. CONCLUSION

The dissertation work deals with the analysis of raw water treatment plant. After analyzing, it was found that except turbidity and hardness, all other parameters of raw water were well within limits and required no further measures to rectify them. However, after installation of ion exchanger and after using optimum dose of coagulant following conclusions were seen:

A. The turbidity of water after filtration was found to be 0.6 NTU which is less than 1 NTU. Thus, the turbidity was reduced by 84%.

B. The hardness of water was reduced to zero by the installation of ion exchanger and then artificial hardness was induced to increase the hardness up to 80 mg/l as minimum 75mg/l is required for human body.

C. Other parameters such as Dissolved Oxygen, pH, TDS, TSS, Alkalinity, Acidity, and Chloride were well under limits and required no further measures.

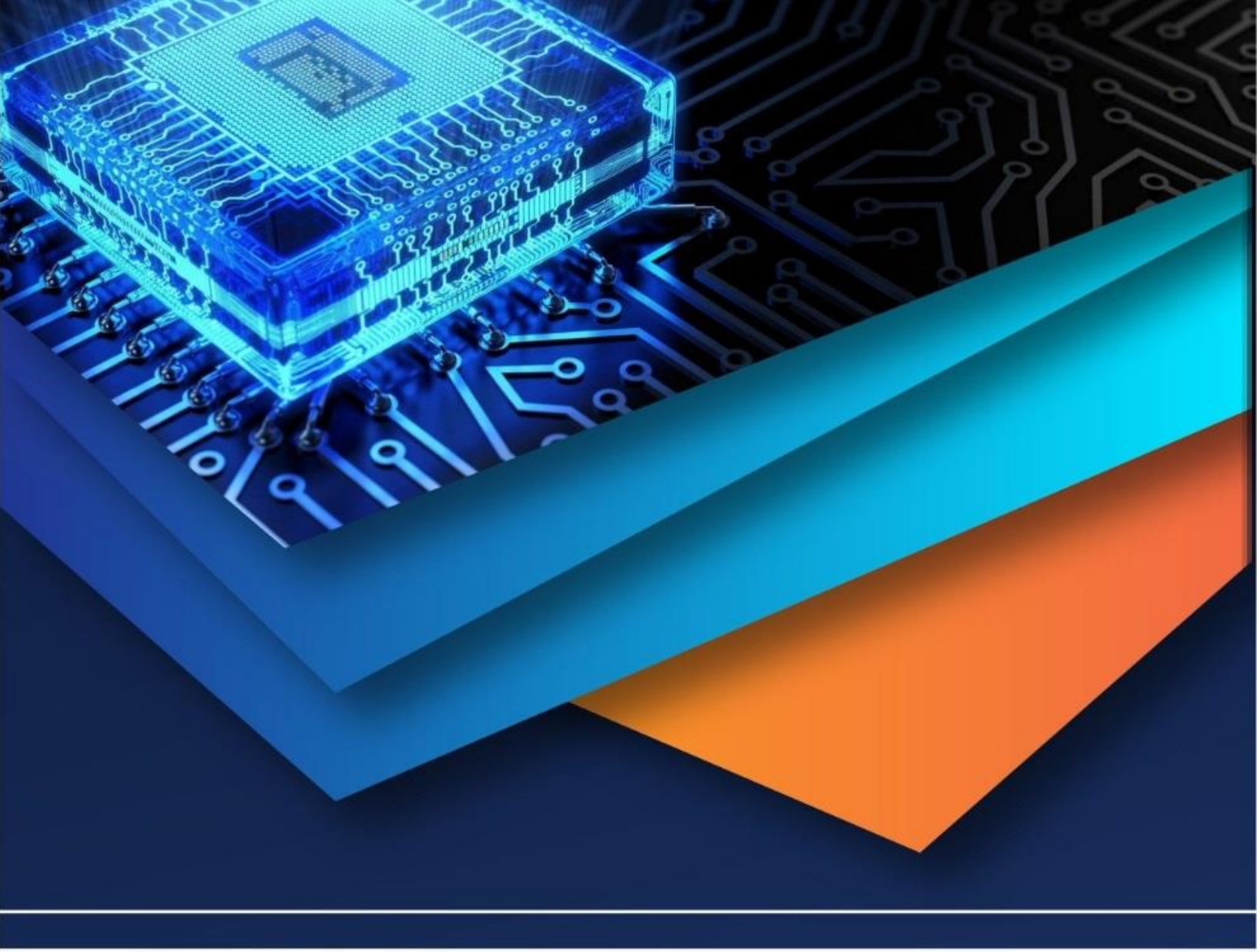
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NOMENCLATURE

1) mg/l Milligram per Liter.
2) NTU Nephelometric Turbidity Unit.
3) TDS Total Dissolved Solids.
4) TSS Total Suspended Solids.
5) D.O Dissolved Oxygen.
6) EDTA Ethylene-diamine-tetra-acetic.
7) WHO World Health Organization.

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