ENGLISH FOR ENGINEERS

2/28/2019

Assessment – 6: Report Writing

RECOMMENDATION REPORT:

WATER QUALITY &

WATER RESOURCE MANAGEMENT

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REPORT SUMMARY/ABSTRACT

This report was written in response to an assessment for our English for Engineers class. We were asked to prepare a report on a topic of our choosing. In this report, we discuss about the quality of water found in different regions and also how to efficiently manage this resource.

We conclude that water resources can be managed by increasing supply, by reducing degradation and by reducing waste and use. The combination of these three measures would surely help in fixing the water supply and controlling its quality as well.

To develop information for this report, we followed a four-step research plan:

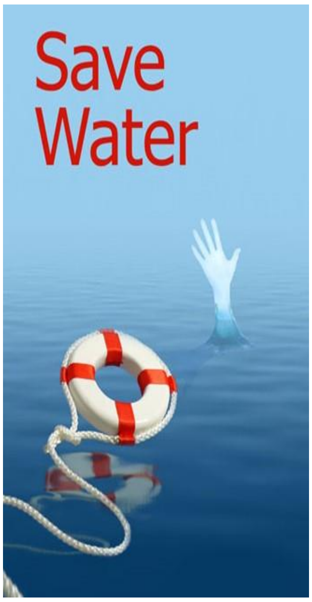
(1) Researched about tests to check quality of water
(2) Conducted experiments to determine hardness of different samples of water
(3) Analysed the situation of water management in nearby areas
(4) Researched appropriate methods to save and improve water resources

The results of our research are subject to minute errors due to unavailability of proper equipment for conducting the quality checks. Nonetheless the results are still reliable and show that it is of utmost importance to ensure better quality of water is circulated in the pipelines. We conclude that adopting the suggested methods would definitely help manage the available water resources more efficiently hence eradicate the threat of overexploitation.

CHAPTER I: INTRODUCTION

Water resource management is a very important for sustainable development. It covers availability, quality and management of water resources and requires extensive hydrological information.

Water quality on the other hand refers to the physical, biological and chemical characteristics of water.



The purpose of this report is to show the degrading levels of water quality in our vicinity and to recommend methods to rectify the same. This report also discusses the importance of *management* of resources.

While water is technically abundant, not all of it is fit for human use or consumption. We argue that it is of utmost importance to do proper checking, planning etc. of the available water resources. We recommend that the government start investing on protecting the present water resources from future harm and also to ensure that water being provided to the public is fit for the purpose.

India has had a long history of human intervention in the management of water because of its distinctive climatic binary conditions of intense monsoons followed by prolonged droughts. Furthermore, rainfall is confined to a few months each year and that too uncertain, erratic and uneven. Thus, making Indian agriculture dependent heavily on various types of irrigation. This dependence has led people and the successive ruling regimes from pre-colonial to colonial and the post-colonial time, to make choices across space and time, from a wide range of technologies. Water holds its association to culture and spirituality along with economic value. This in the process of sacred and profane makes its management more complex, as various stakeholders and parties are involved with different aspiration. Water management has been a cautious affair in India due to socio-economic-political and ecological reasons that has affected water management policies across diverse social groups. India attained its independence from the British rule in August 1947. With independence came partition of India and loss of large productive irrigated lands to Pakistan; and bulk of the public irrigation networks that British had created ended up in Pakistan (Shah, 2009). Government of India's main aim after independence was to accelerate development and address the regional disparity of investment, as it was facing serious food grains shortage and rapid rates of population increase. The slow pace of irrigation development during the last decades of colonial regime had also aggravated to the current problem situation of food shortage.d Independent India's water management can be further divided into small scale community-based management and groundwater revolution.

In September 2018, we were asked to conduct experiments as our final project for our Engineering Chemistry class. We chose to do a quality check of different samples of water by testing their hardness levels.

In the following sections we shall see how the quality checks were carried out and analyse studies conducted by different organisations on the same.

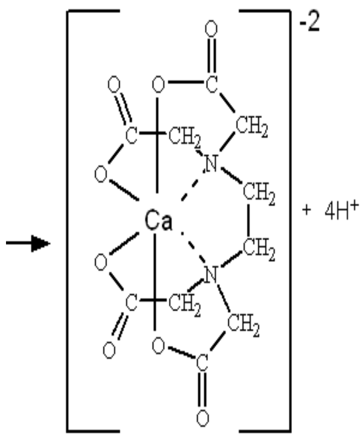
We shall also see what we learnt from our research on water resource management.

CHAPTER II: METHODOLOGY

WATER QUALITY CHECK:

We conducted EDTA and Ion-Exchange testing to check hardness of different samples of water. It is the most basic level technique used by chemists worldwide to get an idea of the purity level of water.

Hard water is water that has a high mineral content. The main components of these minerals are calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. But there are also dissolved metals, bicarbonates and sulphates.



soluble chelate

Water hardness is the traditional measure of the capacity of water to precipitate soap. Hard water requiring a considerable amount of soap to produce leather. Scaling of hot water pipes, boilers and other houses hold appliances is due to hard water. Hardness of water is no specific constituent but is a variable and complex mixture of cations and anions. It is caused by dissolved polyvalent metallic ions. In fresh water, the principle hardness causing ions are calcium and magnesium. The other ions like Strontium, Iron, Barium and Manganese also contribute. Hardness is commonly expressed as $CaCO_3$ in mg/L. The degree of hardness of drinking water has been classified in terms of the equivalent $CaCO_3$ concentration as follows:

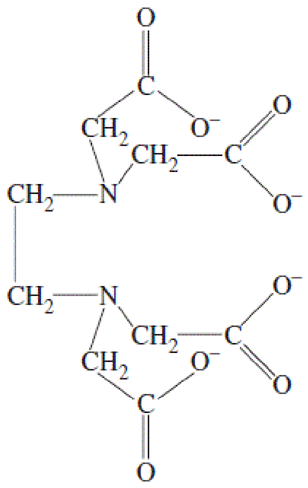
Soft: 0-60 mg/L;

Medium: 60-120 mg/L;

Hard: 120-180 mg/L;

Very hard: > 180 mg/L;

Although hardness is caused by cation, it may also be discussed in terms of carbonate (temporary) and non-carbonate (permanent) hardness. Carbonate hardness refers to the amount of carbonates and bicarbonates in solution that can be removed or precipitated by boiling. This type of hardness is responsible for the deposition of scale in hot water pipes and kettles. When total hardness is numerically greater than that of



total alkalinity expressed as $CaCO_3$, the amount of hardness equivalent to total alkalinity is called 'carbonate hardness'. The amount of hardness in excess of total alkalinity expressed as $CaCO_3$ is non-carbonate hardness. Non-carbonate hardness is caused by the association of the hardness of causing cation with sulphate, chloride or nitrate and is referred to as "permanent hardness" because it cannot be removed by boiling. Usage of hard water causes a lot of problems like fading laundry, spotty dishes, hard-to-clean tubs, dull hair, plumbing build-up etc.

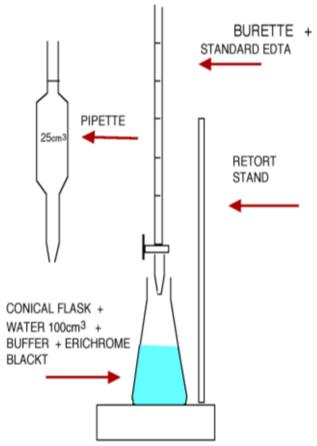
EDTA stands for Ethylene Diamine Tetra-acetic Acid. It is an amino-poly-carboxylic acid and a colourless, water-soluble solid. It is widely used to dissolve limescale. Its usefulness arises because of its role as a hexadentate("six-toothed") ligand and chelating agent, i.e., its ability to sequester metal ions such as Ca^{2+} and Fe^{3+}. EDTA is produced as several salts, notably disodium EDTA and calcium disodium EDTA.

EDTA forms colourless stable complexes with Ca^{2+} and Mg^{2+} ions present in water at pH = 9-10. To maintain the pH of the solution at 9-10, buffer solution (NH_4Cl + NH_4OH) is used. Erichrome Black-T (EBT) is used as an indicator. The sample of hard water must be treated with buffer solution and EBT indicator which forms unstable, wine red coloured complexes with Ca^{2+} and Mg^{2+} ions present in water.

Ion exchange is a reversible process. When hard water is passed through cation ion-exchange resins packed in a narrow column, Ca^{2+} and Mg^{2+} cations in hard water are exchanged with Na^+ or H^+ ions in the resins. The exhausted resins can be regenerated by passing 10% dilute HCL through the column.

The reagents and solutions we used for conducting the experiment were Standard Hard Water, 0.01N EDTA solution, EBT indicator, hard water samples, ammonia buffer solution, and ion-exchange resins.

The apparatus required was burette, pipette, conical flask, standard flask, burette stand, and ion-exchange column.



The procedure was as follows:

1. **Preparation of Reagents**

   1.Buffer solution:
   Dissolve 16.9 g NH_4Cl in 143 ml NH_4OH. Add 1.25 g magnesium salt of EDTA to obtain sharp change in colour of indicator and dilute to 250 ml. If magnesium salt of EDTA is not available, dissolve 1.179 g disodium salt of EDTA (AR grade) and 780 mg $MgSO_4.7H2O$ or 644 mg $MgCl_2.6H2O$ in 50 ml distilled water. Add this to above solution of NH_4Cl in NH_4OH and dilute to 250 ml.

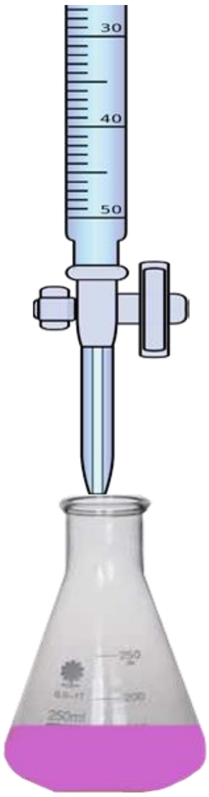
   2.Inhibitor:
   Dissolve 4.5 gm hydroxyl amine hydrochloride in 100 ml 95% ethyl alcohol or isopropylalcohol.

   3. Eriochrome black T(EBT) indicator:
   Mix 0.5 gm dye with 100 gm NaCl to prepare dry powder.

   4. Muroxide Indicator:
   Prepare a ground mixture of 200 mg of murexide with 100 gm of solid NaCl.

   5. NaOH (2N):
   Dissolve 80 gm NaOH and dilute to 1000 ml.

   6. Standard EDTA Solution 0.01M:
   Dissolve 3.723 gm EDTA disodium salt and dilute to 1000 ml. Standardized against standard calcium solution, 1ml =1mg $CaCO_3$



7. Standard Calcium Solution:
Weigh accurately 1gm $CaCO_3$ and transfer to 250 ml conical flask, then add 1:1 HCl till $CaCO_3$ dissolve completely. Add 200 ml dist. water and boil for 20 to 30 min, then cool and add methyl red indicator. Add NH_4OH 3N drop wise till intermediate orange colour develops. Dilute to 1000 ml to obtain 1ml=1mg $CaCO_3$.

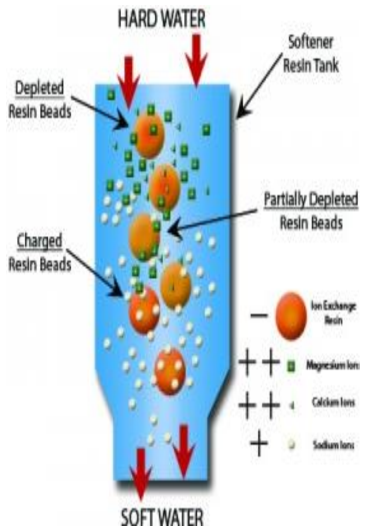
2. **Standardisation of EDTA**
20ml of standard hard water was pipetted into a conical flask. 5ml of buffer solution and few drops of Erichrome Black-T were added. The indicator which is originally blue in colour acquired a wine-red colour. The solution was then titrated with EDTA solution taken in the burette till the wine-red colour changed to a steel blue which was the end point. This burette reading of EDTA was taken to be V1ml. Therefore, 1ml EDTA required 20/V1 mg of $CaCO_3$ for complexation.

3. **Determination of total hardness**
The above titration method was repeated for the different samples of hard water and the burette reading thus obtained was taken to be V2ml. Then by using unitary method, the total hardness was calculated.

4. **Removal of Permanent hardness**
The water sample was passed through a cation exchange resin and the titration was repeated with the same sample. The burette reading was noted as V3. Again, by using unitary method, the temporary hardness was calculated since permanent hardness gets removed on passing through the resin.

ION-EXCHANGE PROCESS

An ion is an atom or molecule that has a positive or negative electrical charge. Calcium and magnesium ions are released into water as it dissolves rocks and minerals. These mineral ions in the water can cause scale buildup in plumbing, fixtures and appliances and affect their performance. In the hot water heater, heat removes some calcium carbonate and magnesium carbonate from water, resulting in scale formation and buildup, which can then slow the heating process and increase energy usage. Cleaning agents used with hard water are not able to completely remove dirt and grime. Clothes may become dingy and gray with time and feel harsh or scratchy. Glassware may become spotted as it dries. Films may be left on shower doors or curtains, walls, and tubs, and hair washed in hard water may look dull and not feel clean. Hard water is considered a nuisance problem, but removing hardness ions isn't necessary for health reasons.

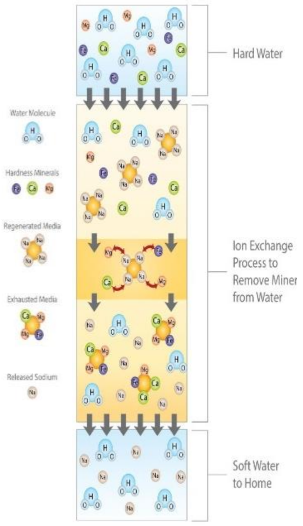


Water is made soft by the use of a water softener using ion exchange resin. The troublesome calcium and magnesium ions in hard water are exchanged for sodium, which is much more soluble and does not precipitate out to form scale or interfere with soap.

Ion exchange resins are very small porous round plastic beads. For water softening applications, the polymer structure of the resin bead contains a fixed negative ion that is permanently attached. This cannot be removed. In simple terms, the resin bead has a fixed negative charge.

Each negatively charged exchange site can hold a positively charged ion. In this case, sodium (which has a positive charge) is attached to the exchange site (negative and positive charges attract – think of magnets).

In the end you have a mobile sodium ion attached to each of the fixed negative charges on the resin bead. When hard water is passed through the resin bead, the calcium and magnesium ions have a stronger positive charge than sodium does. As a result, the calcium and magnesium have a stronger attraction to the negatively charged resin bead than sodium does.

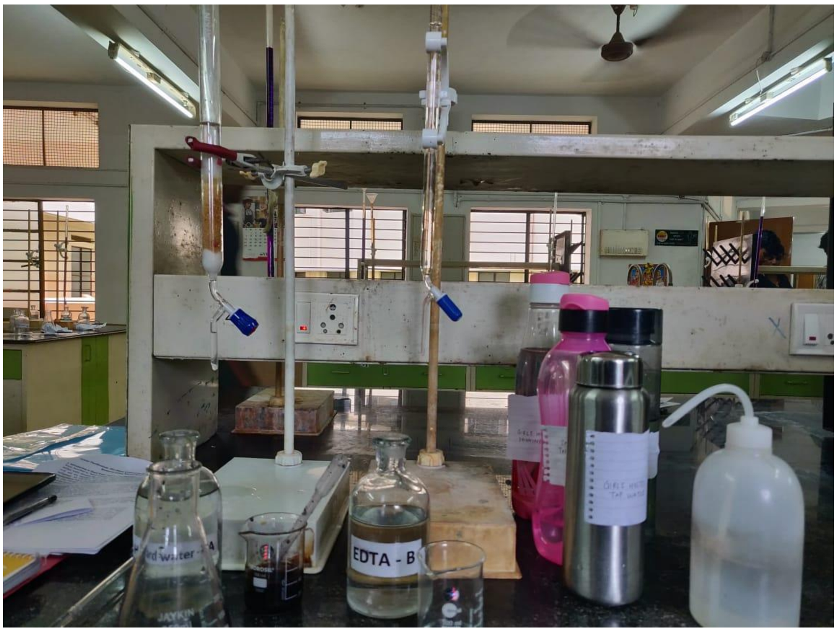


The sodium ion is then ‘kicked off’ the resin bead as the calcium and magnesium take its place (and remains attached to the bead). As a result, the less desirable calcium and magnesium ions are exchanged for more desirable sodium ions. It is important to note that the salinity of the water does not change; it is simply an exchange of one salt for another.

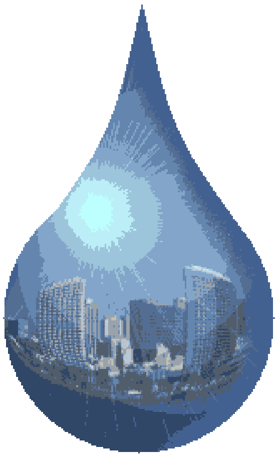
Eventually, the resin beads become saturated with hardness such as calcium and magnesium and there are no more exchange sites left to produce soft water. The resin beads have reached exhaustion and must be regenerated.

In simple terms, the ion exchange resin is soaked in a strong solution of sodium chloride (brine) where the sheer volume of brine solution causes the calcium and magnesium ions in the resin beads to become dislodged. At the same time, the sodium in the brine solution again becomes affixed to the resin bead. After regeneration, the excess brine and hardness causing ions are rinsed to drain and the resin beads are ready for use again.

SAMPLES/APPERATUS:



WATER RESOURCE MANAGEMENT



In India, the total utilizable water resource is assessed as 1123 BCM. Keeping a provision of about 71 BCM per year out of 433 BCM of groundwater, 362 BCM per year of the resource is estimated to be available for irrigation. The net draft of groundwater for irrigation is around 150 BCM per year. The per capita availability of water at national level has been reduced from about 5177 cubic meters in 1951 to the estimated level of 1,820 cubic meters in 2001 with variation in water availability in different river basins. Given the projected increase in population by the year 2025, the per capita availability is likely to drop to below 1,000 cubic metres, which could be labelled as a situation of water scarcity (GOI, 2006). India has a highly seasonal pattern of rainfall, with 50% of precipitation falling in just 15 days and over 90% of river flows occurring in just four months. A total storage capacity of 212.78 Billion Cum (BCM) has been created in the country through major and medium projects. The projects under construction will contribute to an additional 76.26 BCM, while the contribution expected from projects under consideration is 107.54 BCM. The total availability of water in the 76 major reservoirs was109.77 BCM at the major reservoirs was109.77

BCM at the end of the monsoon of 2005 (GOI, 2006). The irrigation potential of the country has been estimated at around 139.9 mha without inter-basin sharing of water and 175 mha with inter-basin sharing. The Central Ground Water Board (CGWB) has estimated that it is possible to increase the groundwater availability by about 36 BCM, by taking up rainwater harvesting and artificial recharge over an area of 45 mha through surplus monsoon runoff. Thus, the groundwater availability may correspondingly increase. The recent estimates (GOI, 2006) on water demand are made by:

a) Standing Sub-Committee of the Ministry of Water Resources (MoWR) and

b) the National Commission for Integrated Water Resources Development (NCIWRD); their estimates (shown in Chapter 3: Results) are made till the year 2050.

Both of them have triggered warning bells on the intensity of the problem. The estimates by MoWR indicates that, by year 2050, India needs to increase by 5 times more water supplies to industries, and 16 times more for energy production, while its drinking water demand will double, and irrigation demand will raise by 50 percent. To address the water-related issues and thereby launch a massive awareness programme all over the country, the Government of India has declared year 2007 as “Water Year”.

Water Sector Reforms in India:

National and international influences have influenced broad-ranging ‘water sector reforms’ carried out partly through projects seeking, for instance, to introduce changes in specific places, such as reforms in water services in specific cities, or in specific activities such as the introduction of participatory management in irrigation. While these reforms are linked to the water policies highlighted above, they were at first often not

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NATIONAL WATER POLICY

backed by legislative changes. Over time, there has been an increasing emphasis of regulatory changes to ensure the diffusion of water reforms, their predictability and stability. While water law reforms are largely state specific, they are similar because they are based on similar national or international policy interventions. First, states like Andhra Pradesh, Rajasthan and Maharashtra foster the participation of farmers in irrigation schemes along the principles of 'participatory irrigation management' (Andhra Pradesh Farmers Management of Irrigation Systems Act 1997; Maharashtra Management of Irrigation Systems by Farmers Act 2005; Rajasthan Farmers' Participation in Management of Irrigation Systems Act 2000). Second, several states, including Andhra Pradesh and Maharashtra have adopted sweeping legislation seeking to restructure the water institutional framework (Andhra Pradesh Water Resources Development Corporation Act 1997; Maharashtra Water Resources Regulatory Authority Act 2005). The rationale for setting up a new water authority is to remove some power from existing water bureaucracies and to ensure that reforms are successfully implemented. Third, several states have now adopted groundwater legislation

National Water Policy:

In 1987 and 2002 The National Water Policy adopted by the Indian National Water Resources Council recognizes that water is a scarce and precious resource and thereby outlines the broad principles that govern the management of the country's water resources.

The first National Water Policy was adopted in September, 1987. However, very little has been achieved in the fulfilment of the objectives laid down was thus adopted in 2002 with a few more in the first policy. Hence, there was a need to revise the National Water Policy of 1987 and introduce new policy provisions (GOI, 1987; 2002).

(See Appendix)

CHAPTER III: RESULTS

EDTA & Ion-Exchange Test:

1. **Standardisation of EDTA**

S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V1
1	20	0	17.9	17.9
2	20	0	18.0	18.0
3	20	0	18.0	18.0

Concordant Titre value = 18 ml

Therefore, V1= 18 ml.

2. **Sample 1: VIT Boys' Hostel Tap Water**

Determination of Total Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	5.7	5.7
2	20	0	5.8	5.8
3	20	0	5.8	5.8

Concordant Titre value = 5.80 ml

Therefore, V2= 5.80 ml

Total Hardness, X= V2/V1 x 1000 ppm = 322.23 ppm

Determination of Residual Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.6	0.6
2	20	0	0.7	0.7
3	20	0	0.6	0.6

Concordant Titre value = 0.6 ml

Therefore, V3= 0.6 ml

Residual Hardness, Y= V3/V1 x 1000 ppm = 33.33 ppm

Hardness removed = X – Y ppm =288.90 ppm

3. Sample 2: VIT SMV Building Tap Water

Determination of Total Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	6.1	6.1
2	20	0	6.2	6.2
3	20	0	6.2	6.2

Concordant Titre value = 6.2 ml

Therefore, V2=6.2 ml

Total Hardness, X= V2/V1 x 1000 ppm = 344.40ppm

Determination of Residual Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.9	0.9
2	20	0	0.9	0.9
3	20	0	1.0	1.0

Concordant Titre value = 0.9 ml

Therefore, V3=0.9 ml

Residual Hardness, Y= V3/V1 x 1000 ppm = 50.00 ppm

Hardness removed = X – Y ppm = 294.40 ppm

4. Sample 3: VIT Girls' Hostel Tap Water

Determination of Total Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	5.6	5.6
2	20	0	5.6	5.6
3	20	0	5.6	5.6

Concordant Titre value = 5.6 ml

Therefore, V2= 5.6 ml

Total Hardness, X= V2/V1 x 1000 ppm = 311.12 ppm

Determination of Residual Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.3	0.3
2	20	0	0.3	0.3
3	20	0	0.4	0.4

Concordant Titre value = 0.3 ml

Therefore, V3= 0.3 ml

Residual Hardness, Y= V3/V1 x 1000 ppm = 16.66 ppm

Hardness removed = X – Y ppm = 294.46 ppm

5. **Sample 4: VIT TT Building Tap Water**

Determination of Total Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	5.9	5.9
2	20	0	6.0	6.0
3	20	0	6.0	6.0

Concordant Titre value = 6.0 ml

Therefore, V2= 6.0 ml

Total Hardness, X= V2/V1 x 1000 ppm = 333.34 ppm

Determination of Residual Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.3	0.3
2	20	0	0.4	0.4
3	20	0	0.3	0.3

Concordant Titre value = 0.3 ml

Therefore, V3= 0.3ml

Residual Hardness, Y= V3/V1 x 1000 ppm = 16.66 ppm

Hardness removed = X – Y ppm = 316.68 ppm

6. Sample 5: VIT Girls' Hostel Drinking Water

Determination of Total Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.7	0.7
2	20	0	0.8	0.8
3	20	0	0.8	0.8

Concordant Titre value = 0.8 ml

Therefore, V2= 0.8 ml

Total Hardness, X= V2/V1 x 1000 ppm = 44.44 ppm

Determination of Residual Hardness				
S.No.	Volume of SHW (mL)	Initial Burette Reading (mL)	Final Burette Reading (mL)	V2
1	20	0	0.1	0.1
2	20	0	0.1	0.1
3	20	0	0.1	0.1

Concordant Titre value = 0.1 ml

Therefore, V3= 0.1 ml

Residual Hardness, Y= V3/V1 x 1000 ppm = 5.55 ppm

Hardness removed = X – Y ppm = 38.89 ppm

RESULT			
Sample No.	Total Hardness (ppm)	Residual Hardness (ppm)	Hardness Removed (ppm)
1	322.23	33.33	288.90
2	344.40	50.00	294.40
3	311.12	16.66	294.46
4	333.34	16.66	316.68
5	44.44	5.55	38.89

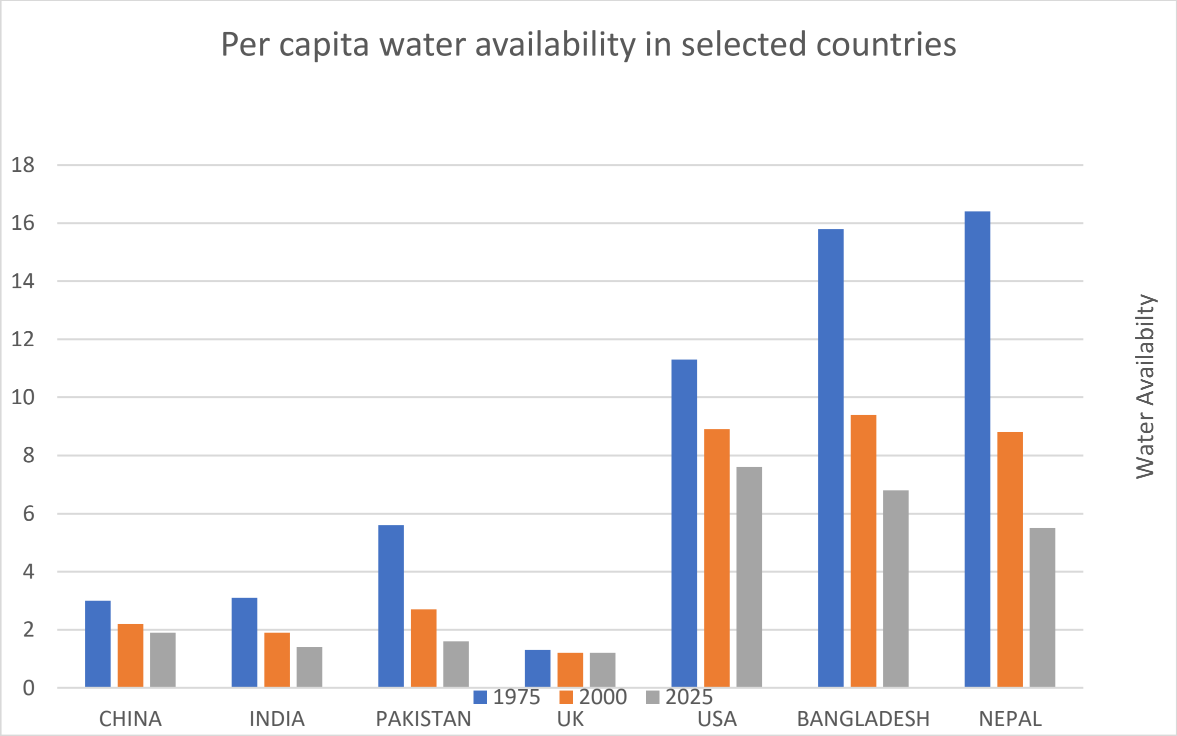
Type of Water	**Hardness (ppm)**
Soft water	0-43
Slightly hard water	43-150
Moderately Hard Water	150-300
Hard Water	300-450
Very hard water	Over 450

On comparing the results of our study with the parameters available we discovered that except the drinking water sample, rest all samples come under the category of very hard water. On the other hand, we can see that on completing the ion-exchange process the hardness of all samples is significantly reduced.

CHAPTER IV: DISCUSSION

Water is precious natural resource for sustaining life and environment. Effective and sustainable management of water resources is vital for ensuring sustainable development. Quality is an important variable that determines the suitability of water for a particular purpose and hence quantity and quality issues are inter-linked (Moench and Metzger 1992; Kumar 1995a; Biswas 1996). There are numerous biological, physical and chemical parameters that determine the quality of water.

The graph below illustrates the availability of water in China, India, Pakistan, UK, USA, Bangladesh and Nepal. Clearly the water availability in every country is dwindling down with time. India is lagging behind countries like USA, Nepal etc. hence why proper water management is necessary.



Management of water resources in India is of paramount importance to sustain one billion plus population. Water management is a composite area with linkage to various sectors of Indian economy including the agricultural, industrial, domestic and household, power, environment, fisheries and transportation sector. The water resources management practices should be based on increasing the water supply and managing the water demand under the stressed water availability conditions. For maintaining the quality of freshwater, water quality management strategies are required to be evolved and implemented.

Decision support systems are required to be developed for planning and management of the water resources project. There is interplay of various factors that govern access and utilization of water resources and in light of the increasing demand for water it becomes important to look for holistic and people-centred approaches for water management.

Clearly, drinking water is too fundamental and serious an issue to be left to one institution alone. It needs the combined initiative and action of all, if at all we are serious in socioeconomic development. Safe drinking water can be assured, provided we set our mind to address it.

The alarming level of hardness found in the tested samples is also of concern even though the drinking water was safe. We use tap water for washing, bathing etc. and hence it is necessary to improve its quality as well. The hardness of this water should be within certain limits.

Water softeners are now available in the market. Almost small to big companies sell water softeners. Permanent hardness of water can be a removed by the following ways:

(a) By the use of soda:

Soda removes both temporary and permanent hardness. It is also inexpensive and easy to use. This makes it the ideal substance for softening water in the home.

(b) Other softening agents in the home:

It is difficult for the housewife to be very precise in the use of soda and the water softened by soda may often contain an excess of it, which even if it is slight, may damage certain fabrics. Hence, other softening agents could be used. They are:

(i) Soap:

Soap is used as a softening agent. However, the use of soap as a softening agent is extravagant on account of its high cost compared with soda.

(ii) Caustic soda:

t removes temporary hardness but reduces permanent hardness only when the lather is very slight.

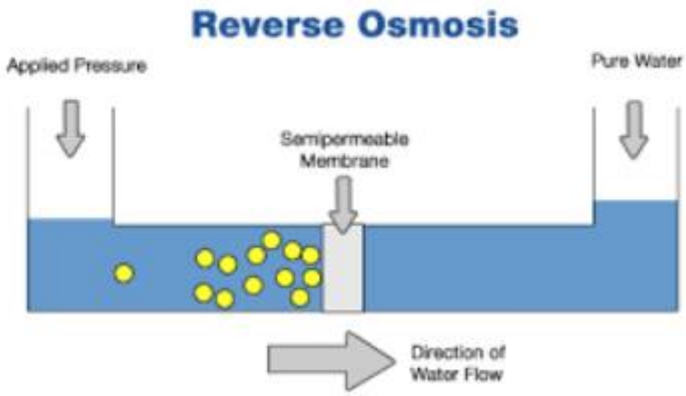
(iii) Solution of Ammonia:

It may be used for softening water, when the fabrics to be treated would be harmed by soda. If used in excess, ammonia may destroy the lustre of rayon's, discolour and injure animal fabrics and loosen the dyes of coloured articles. Since, it is not possible to be very certain of the quantity to be used; this is not practicable for softening water.

CHAPTER V: RECOMMENDATIONS

Ion Exchange is the leader in this field and do good work. Softeners are chosen based on the hardness level. Synthetic resins are available which when put in use absorbs Calcium and Magnesium ions from hard water and releases Sodium ions. Regeneration is required with brine solution (Sodium Chloride solution).

Other methods recommended to soften water are Salt-Free Water Conditioning: Template Assisted Crystallization (TAC) / Nucleation Assisted Crystallization (NAC), Reverse Osmosis, Chelation, etc. (*See Appendix)*



Coming back to water management, with the resources increasingly becoming scarce, new water development projects hardly add to the aggregate supplies, and only allocates the available supplies among alternative uses. Thus, the priorities of these institutions need to change from managing supplies to conservation and demand and allocation management (Frederick 1993). There are several fiscal instruments that can potentially impact on the social systems to affect reduction in demand or in other word that can create incentives for efficient use of water in competitive use and disincentive for pollution (Pearce and Warford 1993).

The second draft legislation, Model Bill for the conservation, protection, regulation and management of groundwater, seeks to guide the states to enact their own laws to restore and ensure groundwater security. At present, the vintage Easement Act, 1882 treats groundwater as a private property resource, which makes it difficult to regulate use. The proposed legislation seeks to treat groundwater as a common pool resource.

In conclusion, Ion exchange method to soften water should be used and the government should focus on proper implementation of water laws.

APPENDIX

National Water Policy

The main emphasis of National Water Policy 2012 is to treat water as *economic good* which the ministry claims to promote its conservation and efficient use.[4] This provision intended for the privatization of water-delivery services is being criticized from various quarters.[5] The policy also does away with the priorities for water allocation mentioned in 1987 and 2002 versions of the policy. The policy was adopted with a disapproval from many states..

Reference https://en.wikipedia.org/wiki/National_Water_Policy

Salt-Free Water Conditioning: Template Assisted Crystallization (TAC) / Nucleation Assisted Crystallization (NAC)

This form of water conditioning is relatively new in commercial usage, and is now available at domestic household scale. The technology has been proven in controlled tests undertaken by the University of Arizona to reduce lime-scale production in hard water by over 96%.

Reference https://softeningwater.com/4-best-methods-of-water-softening/

Salt-Free Water Conditioning: Reverse Osmosis (RO)

Reverse osmosis is a process of forcing water through a series of extremely fine filters under pressure, in order to filter all impurities out of the water, down to molecular level. The resulting product is similar to distilled water, with all chemicals and organic dissolved solids, including hardness-causing calcium and magnesium ions, having been removed. As such, it can be considered a form of water softening.

Reference https://softeningwater.com/4-best-methods-of-water-softening/

GLOSSARY

Polyvalent

1: having a chemical valence greater usually than two

2: effective against, sensitive toward, or counteracting more than one toxin, microorganism, or antigen

Alkalinity

refers to the capability of water to neutralize acid. This is really an expression of buffering capacity

Buffer Solution

a solution to which an acid can be added without changing the concentration of available H+ ions (without changing the pH) appreciably

Reagent

a substance or compound added to a system to cause a chemical reaction, or added to test if a reaction occurs

Inhibitor

a substance which slows down or prevents a particular chemical reaction or other process or which reduces the activity of a particular reactant, catalyst, or enzyme

Indicator

a substance (such as litmus) used to show visually (as by change of colour) the condition of a solution with respect to the presence of a particular material (such as a free acid or alkali)

Chelation

a type of bonding of ions and molecules to metal ions. It involves the formation or presence of two or more separate coordinate bonds between a polydentate (multiple bonded) ligand and a single central atom

Scale Formation

deposition of mineral solids on the interior surfaces of water lines and containers, most often occurs when water containing the carbonates or bicarbonates of calcium and magnesium is heated

CALCULATIONS

EBT + Ca^{2+} /Mg^{2+} $\rightarrow$ EBT -Ca^{2+} /Mg^{2+}

EBT -Ca^{2+} /Mg^{2+} + EDTA $\rightarrow$ EDTA-Ca^{2+} /Mg^{2+} + EBT

(Wine red) (Steel blue)

Standardisation of EDTA

1 ml of 0.01 M EDTA ≡ 1 mg of $CaCO_3$

V1 ml of EDTA ≡ V1 mg of $CaCO_3$

Calculation of total hardness

Volume of EDTA solution consumed = ………… ml

Volume of hard water taken = …………. ml

Total hardness = (Volume of EDTA solution consumed * 1000) / (Volume of the hard water taken) ppm

= ………………….. ppm

Calculation of permanent hardness

Volume of EDTA solution consumed = ………… ml

Volume of boiled water taken = …………. ml

Permanent Hardness = (Volume of EDTA solution consumed * 1000) / (Volume of the boiled water taken) ppm

= ………………….. ppm

Calculation of temporary hardness

Temporary hardness of the given sample of water = Total hardness - Permanent hardness

= ……………….. ppm

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