

A Study on the Water Quality of NIT Rourkela

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF

**BACHELOR OF TECHNOLOGY
IN
CIVIL ENGINEERING**

BY

SHIKHAR FIRMAL



**DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
ROURKELA 769008
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Under the Guidance of

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**National Institute of Technology
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CERTIFICATE

This is to certify that the thesis entitled “*A Study on Water Quality of NIT Rourkela* ” submitted by Sri Shikhar Firmal, Roll No. 10501034 in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Civil Engineering at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diploma.

Date:

(Prof. KAKOLI K. PAUL)

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My heart pulsates with the thrill for tendering gratitude to those persons who helped me in completion of the project.

The most pleasant point of presenting a thesis is the opportunity to thank those who have contributed to it. Unfortunately, the list of expressions of thank no matter how extensive is always incomplete and inadequate. Indeed this page of acknowledgment shall never be able to touch the horizon of generosity of those who tendered their help to me.

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ABSTRACT

The present study the quality of drinking water supplied to the hostels, canteens and campus of National Institute of Technology, Rourkela, through tap, which includes tests for temperature, pH value, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, jar test, BOD and DO. Rourkela is one of the most important industrial complexes in the state of Orissa which has Integrated Rourkela Steel Plant, a number of sponge iron industries, cement manufacturing unit, chemicals, explosives, ceramics and distillery units and large number of small and medium industries. A water quality standard is a rule or law comprised of the uses to be made of a water body or segment and the water quality criteria necessary to protect that uses. The average temperature, concentration of pH, turbidity, TDS (Total Dissolved Solids), TSS (Total Suspended Solids), DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), total hardness, alkalinity and chloride are found to be 27.38 °C, 7.37, 2.438 NTU, 156.8 mg/l, 2.653 mg/l, 42.156 mg/l, 3.6 mg/l, 8.65 mg/l, 102.3mg/l and 21.2 mg/l respectively. The results obtained from the water quality criteria parameter are within the drinking water standard. (IS: 10500).

Keywords:

water quality, IS: 10500, pH, hardness, total solids, total suspended solids, residual chlorine, alkalinity, turbidity, BOD, dissolved oxygen, chloride.

CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION

All biological reactions occur in water and it is the integrated system of biological metabolic reactions in an aqueous solution that is essential for the maintenance of life. Most human activities involve the use of water in one way or other. It may be noted that man's early habitation and civilization sprang up along the banks of rivers. Although the surface of our planet is nearly 71% water, only 3% of it is fresh. Of these 3% about 75% is tied up in glaciers and polar icebergs, 24% in groundwater and 1% is available in the form of fresh water in rivers, lakes and ponds suitable for human consumption (Dugan, 1972). Due to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously. Moreover considerable part of this limited quality of water is polluted by sewage, industrial waste and a wide range of synthetic chemicals. Fresh water which is a precious and limited vital resource needs to be protected, conserved and used wisely by man. But unfortunately such has not been the case, as the polluted lakes, rivers and streams throughout the world testify. According to the scientists of National Environmental Engineering Research Institute, Nagpur, India, about 70 % of the available water in India is polluted (Pani, 1986).

1.2. LITERATURE SURVEY

This chapter reviews the literature relevant to the objective of the study, i.e., status of water quality as well as information on the development of adsorbent and their use in the removal of pollutants from water. A brief review of the different adsorbents to remove the pollutants has also been included. A discussion on the current thinking about the water quality for rural people has also been incorporated. The most common and wide spread threat associated with water is contamination, either directly or indirectly, by sewage, by other wastes or by human or animal excrement. If such contamination is recent, and if among the contributors, there are carriers of communicable enteric diseases, some of the living casual agents may be present. The drinking water so contaminated or its use in the preparation of certain foods may result in further cases of infection.

Water quality criteria of various groundwater has been studied from different sources e.g. Tube well, Dug well, Bore well etc. by a number of Researchers. A few of them has been listed. Quality of well water near the Mae-Hia waste disposal site has been evaluated by Karnchanawong et al. (1993). It has been reported that well water in the study area was not

suitable for drinking due to high contamination of Total and Fecal coliforms and moderate contamination by nitrate and manganese. Nitrate pollution of groundwater in 14 cities of Northern China due to nitrogen fertilizer has been reported by Zhang et al. (1996). The potential impacts of mine wastes on ground and surface water has been studied by Herzog (1996). Groundwater contamination due to stormwater infiltration has been reported by Mikkelsen et al. (1997). Impact of mining activation on the pH of ground water has been reported by Lind et al (1998). Similarly the impact of agriculture on groundwater quality in Slovenia has been assessed by Maticie (1999). It has been reported that among 12 main groundwater aquifers in Slovenia, the amount of nitrate exceeds the allowable level (50 mg/l) for drinking water. Shamruck et al. (2001) studied the effect of chemical fertilizers on groundwater quality in the Nile Valley aquifer, Egypt and found the major ion concentration of Nitrate (20 to 340 mg/l), Sulphate (96 to 630 mg/l), Phosphate (7 to 34 mg/l) and Potassium (7 to 28 mg/l). Ammann et al. (2003) reported about the groundwater pollution by runoff. Almasri et al. (2004) evaluated regional long-term trends and occurrence of Nitrate in the groundwater of agricultural watersheds in Whatcon County, Washington.

In India, pioneering studies on limnology of river and lake ecosystems were carried out by Chakrabarty et al. (1959) on River Yamuna, David (1963) on river Gandak, Ray et al. (1966) on river Ganga and Yamuna, Pahwa and Mehrotra (1966) on river Ganga, Vyas (1968) on Pichhola lake, Udaipur and David et al. (1969) on Tungabhadra reservoir, John (1978) on the river Kallayi, Kerala, Raina et al. (1984) on river Jhelum, Tiwari et al. (1986) on river Jhelum and (1988) on river Subarnarekha, Qadri et al. (1993) on river Ganga, Das et al. (1994) on river Ganga, Hosetti et al. (1994) on Jayanthi nalla and river Panchaganga at Kolhapur, Rao et al. (1994) on Ooty lake, Murugesan et al. (1994) on river Tamraparani, Chaurasia (1994) on river Mondakini, Mishra et al. (1994) on river Subarnarekha, Mitra et al. (1995) on river Mahanadi, Choubey (1995) on river Tawa, Desai (1995) on river Dudhsagar and Khandepar river, Kataria et al. (1995) on river Kubza, Chandra et al. (1996) on river Ramaganga, Lal (1996) on Pushkar Sarovar, Banerjee et al. (1999) on river Tikara and Brahmani, Gambhi (1999) on Maithon Reservoir, Jain (1999) on Khnop Reservoir, Koshy et al. (1999 and 2000) on river Pamba, Bhuvaneshwaran et al. (1999) on river Adyar, Patel (1999) on Pitamahar Dam, Sharma et al. (1999) on river Yamuna, Singh et al. (1999) on River Damodar, Gyananath et al. (2000) on river Godavari, Kausik et al. (2000) on river Ghaggar, Chatterjee et al. (2001) on river Nunia in Asansol, West Bengal, Kaur et al. (2001) on river Satluj, Garg et al. (2002) on western Yamuna

canal from Tajewala (Haryana) to Haiderpur treatment plant (Delhi), Abbasi et al. (2002) on Buckingham canal, Martin et al.(2003) on river Tamiraparani, Srivastava et al. (2003) on river Gaur at Jabalpur, Sinha et al. (2004) on river Ram Ganga, Singh et al. (2004) on river Yamuna and Guru Prasad et al. (2004) on Sarada river basin.

With the increasing ease of generating, collecting and storing data, we are living in an expanding universe of too much data (Sorensen & Janssens, 2003). Extracting useful information is a must from these abundant data. Based on the observations and chemical analyses (explained in section 4.2), a case study of the tap water quality supplied inside the NIT Rourkela campus is performed, in order to check the quality of water supplied. Concentrations of major chemical elements in the tap water were related to the distance downstream from the source, with surface water in the upstream reaches of good quality. (Jinzhu et al., 2009).

CHAPTER 2

STUDY AREA

2. STUDY AREA

Pollution is commonly regarded as the result of the industrial revolution. Environmental quality of the area deteriorates mainly as a result of the increasing industrial activity. In order to find out the current status of the pollution in the area, due to the increasing trend in the industrial activities, it is very much essential to identify the various sources of pollution. Water is essential for the survival of any form of life. On an average a human being consume about 2 liter of water everyday during his whole life period. The exploding population, increasing industrialization and urbanization causes water pollution. The water pollution by agricultural, municipal and industrial sources has become a major concern for the welfare of mankind. The following is the list of few industries which are the main sources of pollution generating unit in the area:

- a) Hall 2 of NIT Rourkela,
- b) Hall 5 of NIT Rourkela,
- c) Homi Bhabha hall of residence of NIT Rourkela,
- d) Hexagon canteen,
- e) Institute building of NIT Rourkela..

Rourkela is located at 84.54E longitude and 22.12N latitude in Sundergarh district of Orissa at an elevation of about 219 meters above mean sea level. The area of Rourkela is 200 square kilometers approximately. Red and laterite soils are found here which are quite rich in minerals. The area near Rourkela is rich in iron-ore hence a steel plant is situated in Rourkela. Rourkela is situated in a hilly region which adds to the natural beauty of the city. The Koel and Sankha rivers meet at Vedvyas, Rourkela and flow as a single river called Brahmani. Hence Rourkela is the confluence of Koel, Sankha and Brahmani.

Rourkela comes under tropical monsoon climate and is more like that of the Deccan Plateau. Being in the North Eastern corner of the Deccan Plateau, the climate is milder than the climate of the main Deccan region. The climate is with hot and dry having high humidity (85 %) during Summer season. Normally, there is heavy rainfall during the South West monsoon and that of light rainfall during the pre-monsoon seasons. The South West monsoon usually onsets during second week of June and retreats by mid September.

The humidity is generally high mostly in the monsoon and post monsoon periods. The relative humidity is low during Summer season. The mean values of the humidity, however in a year ranges from 35% to 85% and the annual average is 66%.

It can be observed that normally the wind in the area is light to moderate except in summer and South West monsoon periods in which it is little bit high. The direction of the wind is mostly from the direction between north and east. During most of the days the wind speed is repeated to be in the range of 7.2 to 32 km/hour. The annual average wind speed has been observed to be 16.1 km/hr. The two parameters i.e., temperature and humidity, taken together represents an index of the pleasantness and comfortability of the climate to human beings.

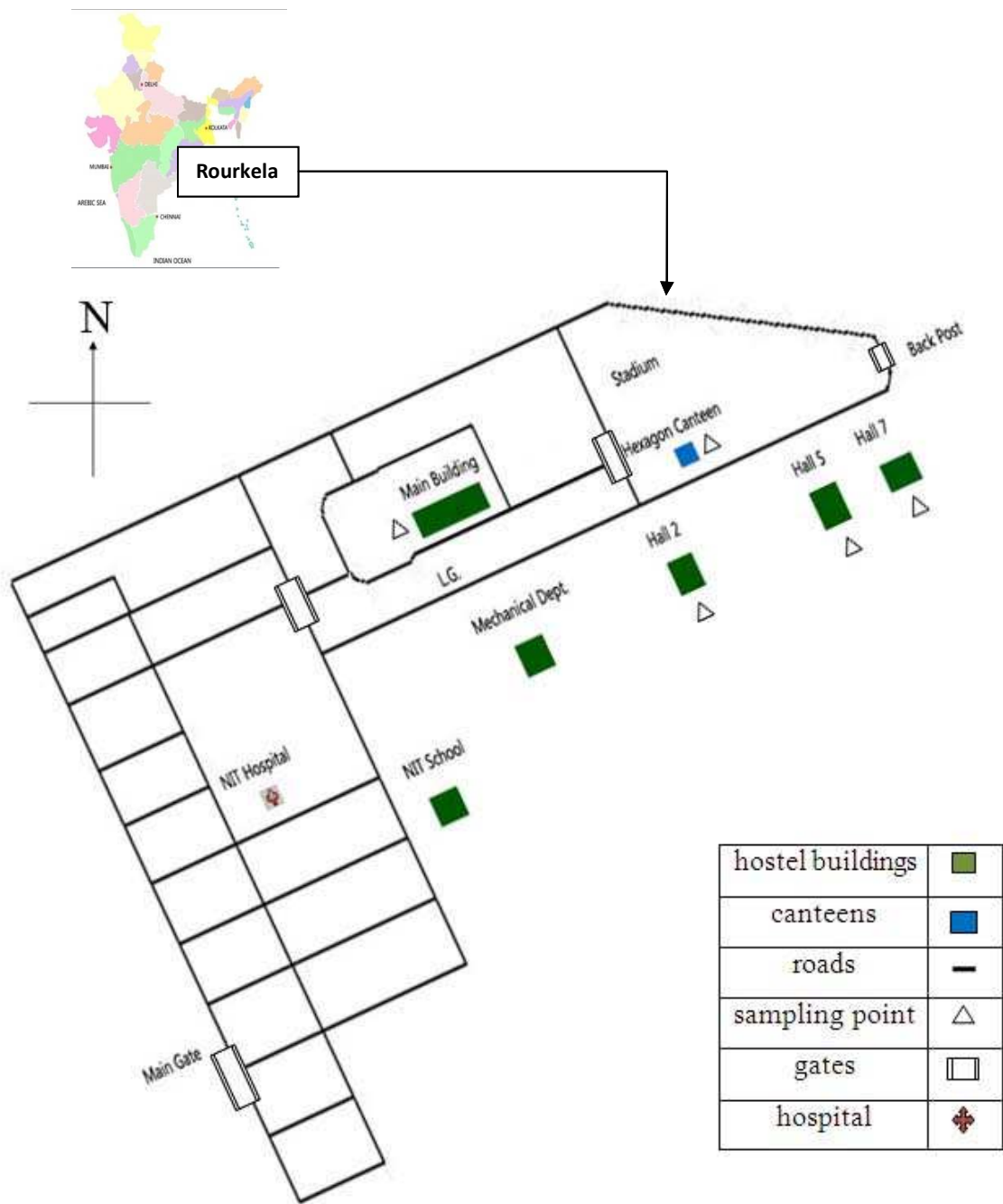


Fig.2.1. Map of NIT Rourkela

CHAPTER 3

EXPERIMENTAL METHODS

3. EXPERIMENTAL METHODS

3.1. WATER SAMPLING PROCEDURE AND ANALYSIS

The water samples were analyzed for various parameters in the laboratory of Environmental Engg, National Institute of Technology Rourkela. Various physical and chemical parameters like Temperature, pH, Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Hardness, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Residual Chlorine, Chloride, Alkalinity have been monitored for the tap water of different locations.

Plastic bottles of 1.5 liter capacity with stopper were used for collecting samples. Each bottle was washed with 2% Nitric acid and then rinsed three times with distilled water. The bottles were then preserved in a clean place. The bottles were filled leaving no air space, and then the bottle was sealed to prevent any leakage. Each container was clearly marked with the name and date of sampling.

3.1.1. SAMPLING POINTS

In institute campus samples collected from the sampling point as marked in fig.1 and are as follows:

1. Hall 2 of NIT Rourkela,
2. Hall 5 of NIT Rourkela,
3. Homi Bhabha hall of residence of NIT Rourkela,
4. Hexagon canteen in NIT Rourkela campus,
5. Institute building of NIT Rourkela.

3.2. WATER QUALITY PARAMETERS

1. Temperature of the tap water from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
2. pH value of the tap water from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.

3. Total solids of the tap water from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
4. Total suspended solids in the tap water of hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
5. Dissolved oxygen in the water samples from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
6. Biochemical oxygen demand of the tap water from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
7. Turbidity of the water samples from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
8. Alkalinity of the water samples from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
9. Total hardness of the water samples from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.
10. Presence of residual chlorine in the water samples from hall 2, hall 5, Homi Bhabha hall, hexagon canteen and institute building.

The results of the analyzed parameters of tap water of the different locations of NIT Rourkela are compared with the related standards for drinking water prescribed by IS:10500 and USPHS. The drinking water standard is given in the table no.3.

Table No. 3.1. DRINKING WATER STANDARDS (IS: 10500)

Sl. No.	Parameters	Permissible value	Standard
1.	Color	Unobjectionable	IS: 10500
2.	Taste	Agreeable	IS: 10500
3.	pH	6.5-7.5	IS: 10500
4.	Turbidity (Max NTU)	5	IS: 10500
5.	TDS	500	IS: 10500
6.	TSS	5	USPHS
7.	BOD	Nil to 5	USPHS
8.	DO	4.0 to 6.0	USPHS
9.	Total hardness	300	IS: 10500
10.	Chloride	250	IS: 10500
11.	Alkalinity	120	USPHS
12.	Residual chlorine	0.2	IS: 10500

(Except pH and turbidity other parameters are in mg/l)

USPHS stands for United States Public Health Service.

3.3. MATERIALS AND METHODS

3.3.1. METHODOLOGY FOR THE MEASUREMENT OF TEMPERATURE

PROCEDURE

- a. Temperature was measured with the thermometer immersed directly in the water body, after a period of time sufficient to permit constant reading.

- b. Make measurement of the temperature of a water body at a particular depth with the thermometer immersed directly in the water body. After sufficient time has elapsed to allow the thermometer to come to the exact temperature of the water, take a reading.

3.3.2. METHODOLOGY FOR MEASUREMENT OF pH VALUE (ELECTROMERIC METHODS)

pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect pH value of water. The overall pH value range of natural water is generally between 6 and 8. In case of alkaline thermal spring waters pH value may be more than 9 while for acidic thermal spring waters the pH may be 4 or even less than 4. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of water. The pH value obtained in the laboratory may not be the same as that of water at the time of collection of samples due to loss or absorption of gases, reactions with sediments, hydrolysis and oxidation or reduction taking place within the sample bottle. pH value should preferably be determined at the time of collection of sample. The pH value may be determined either electrometrically or calorimetrically. The electrometric method is more accurate but requires special apparatus. The calorimetric method is simple and requires less expensive apparatus, and is sufficiently accurate for general work. It is, however, subject to interference by color, turbidity, high saline content, free chlorine and various oxidants and reductants.

3.3.2.1. PRINCIPLE

The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury/calomel electrode). Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH. Several types of electrodes have been suggested for electrometric determination of pH value. Although the hydrogen gas electrode is recognized as primary standard the glass electrode in combination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the fact that a change, of 1 pH

unit produces an electrical change of 59.1 mV at 25°C. The active element of a glass electrode is a membrane of a special glass. The membrane forms a partition between two liquids of differing hydrogen ion concentration and a potential is produced between the two sides of the membrane which is proportional to the difference in pH between the liquids.

3.3.2.2. APPARATUS

1. pH meter - With glass and reference electrode (saturated calomel), preferably with temperature compensation.
2. Thermometer - With least Count Of 0.5°C.

3.3.2.3. SAMPLE HANDLING AND PRESERVATION

1. Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.
2. High purity waters and waters not at equilibrium with the atmosphere (ground waters or lake waters collected at depth) are subject to changes when exposed to the atmosphere, Therefore the sample containers should be filled completely and kept sealed prior to analysis.

3.3.2.4. PROCEDURE

After required warm-tip period, standardize the instrument with a buffer solution of pH near that of the sample and check electrode against at least one additional buffer of different pH value. Measure the temperature of the water and if temperature compensation is available in the instruments adjust it accordingly. Rinse and gently wipe the electrodes with solution. If field measurements are being made, the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to ensure sufficient sample movement across the electrode sensing element as indicated by drift free readings (< 0.1 pH unit). If necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air-water interface of the sample. Note and record sample pH and temperature. However, if there is a continuous drift, take a second reading with the fresh aliquot of sample without stirring and report it as the pH value.

3.3.3. METHODOLOGY FOR MEASUREMENT OF TURBIDITY

3.3.3.1. PRINCIPLE

It is based on comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions.

3.3.3.2. APPARATUS

1. Sample Tubes - The sample tubes should be of clear and colorless glass.
2. Turbidimeter- The turbidimeter shall consist of a nephelometer with a light source for illuminating the sample and one or more photo electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidimeter should be so designed that little stray light reaches the detector in the absence of turbidity and should be free from significant drift after a short warm-up period.

3.3.3.3. PROCEDURE

Turbidimeter Calibration-Follow the manufacturer's operating instructions. Measure the standards on turbidimeter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of calibration.

Turbidity less than 40 units - Shake the sample to disperse the solids. Wait until air bubbles disappear. Pour sample into turbidimeter tube and read turbidity directly from the instrument scale or from calibration curve.

3.3.4. METHODOLOGY FOR MEASUREMENT OF TOTAL SOLIDS

Preparation of Glass Fiber Filter Disc- Place the glass fiber filter on the membrane filter apparatus or insert into bottom of a suitable Gooch crucible with wrinkled surface up. While vacuum is applied, wash the dish with three successive 20 ml volumes of distilled water. Remove all traces of water by continuing to apply vacuum after water has passed through. Remove filter from membrane filter apparatus (or both crucible and filter, if Gooch crucible is used) and dry in an oven at 103-105°C for 1 hour. Transfer to a

desiccator and weigh after half an hour. Repeat the drying cycle until a constant mass is obtained (mass loss is less than 0.5 mg in successive weighing). Weigh immediately before use. After weighing, handle the filter or crucible filter with forceps or tongs only.

- i. If determinations are to be carried out at 180°C then the filter or crucible/filter shall be dried at 180°C.
- ii. Sample Volume- In potable waters non-filterable residue is usually small. Relatively large volume of water is passed through filter so as to obtain at least 2.5 mg residue. For deciding volume to be taken, turbidity values may be taken into consideration. If turbidity values of a sample is less than 50 units, filter 1 liter sample and if turbidity value exceeds 50 units, filter sufficient sample so that non-filterable residue is 50 to 100 mg.
- iii. Stir volume of sample with a magnetic stirrer or shake it vigorously. Assemble the filtering apparatus and begin suction. Wet the filter with a small volume of distilled water to seat it against the fitted support.
- iv. Shake the sample vigorously and quantitatively transfer the predetermined sample volume selected according to 4.2 to the filter using a graduated cylinder. Remove all traces of water by continuing to apply vacuum after sample has passed through.
- v. With suction on, wash the graduated cylinder, filter non-filterable residue with portions of distilled water allowing complete drainage between washings. Remove all traces of water by continuing to apply vacuum after the wash water has passed through.
- vi. After filtration, transfer the filter along with contents to an oven maintained at either 103-105°C or 179-181°C for at least 1 hour. Cool in a desiccator and weigh. Repeat the drying cycle till constant mass is obtained. Alternatively, remove crucible and filter from crucible adapter, wipe dry from outside with filter paper and dry at 103-105°C or 179-181°C in an oven. Cool in a desiccator and weigh. Repeat the drying cycle to constant mass till the difference in the successive mass is less than 0.5 mg.

3.3.5. METHODOLOGY FOR MEASUREMENT OF TOTAL SUSPENDED SOLIDS

1. Heat the clean evaporating dish to 180°C for 1 hour. Cool, desiccate, weigh and store in desiccator Until ready for use.
2. Select volume of the sample which has residue between 25 and 250 mg, preferably Between 190 and 200 mg. This volume may be estimated from values- of specific conductance. To obtain a measurable residue; successive aliquots of sample may be added to the sample dish.
3. Pipette this volume to a weighed evaporating dish placed on a steam-bath. Evaporation may also be performed in a drying oven. The temperature should be lowered to approximately WC to prevent boiling and splattering of the sample. After complete evaporation of water from the residue, transfer
4. the dish to an oven at 103-105°C, or 179-181°C and dry to constant mass, that is, till the difference in the successive weightings is less than 0.5 mg. Drying for a long duration (usually 1 to 2 hours) is done to eliminate necessity of checking for constant mass. The time for drying to constant mass of sample when a number of samples of nearly same type are to be analyzed should be determined by trial.
5. Weigh the dish as soon as it has cooled avoiding residue to stay for long time as some residues.
6. Are hygroscopic and may absorb water from desiccant which may not be absolutely dry.

3.3.6. METHODOLOGY FOR MEASUREMENT OF DO

3.3.6.1. APPARATUS

1. Incubation bottles
2. DO meter
3. Air incubator

3.3.6.2. PROCEDURE

After taking water in incubation bottle, it is kept in incubator and a magnetic stirrer is put inside the bottle. The magnetic stirrer continuously rotates inside the bottle. Then with the help of DO meter 3 readings have been noted, first reading has been taken at the bottom, second at mid point and third at top of the bottle. Now the average of the readings will give the dissolved oxygen present in the water sample.

3.3.7. METHODOLOGY FOR MEASUREMENT OF BOD

3.3.7.1. PRINCIPLE

The biochemical oxygen demand (BOD) test is based on mainly bio-assay procedure which measures the dissolved oxygen consumed by micro-organisms while assimilating and oxidizing the organic matter under aerobic conditions. The standard test condition includes incubating the sample in an air tight bottle, in dark at a specified temperature for specific time.

3.3.7.2. APPARATUS

i) Incubation Bottles

300 ml capacity narrow neck special BOD bottles with planed mouth with ground glass stoppers. New bottles should be cleaned with 5 N hydrochloric acid or sulphuric acid followed by rinsing with distilled water. In normal use, bottles once used for Winkler's procedure should only be rinsed with tap water followed by distilled water. During incubation (if incubator is used) to ensure proper sealing, time to time, add water to the flared mouth of the bottle.

ii) Air Incubator

Air incubation with thermostatically controlled $27^{\circ}\text{C} \pm 1^{\circ}\text{C}$. Avoid light to prevent possibility of photosynthetic production of oxygen.

3.3.7.3. PROCEDURE

After taking water in incubation bottles, 4 capsules (or 4 gm) of NaOH has been kept at the neck of the bottle. A magnetic stirrer is put inside the bottle. The magnetic stirrer continuously rotates inside the bottle. Then it is kept air tight by the special caps attached with an electronic meter, which directly records BOD reading at every 24 hour. Now the bottles are preserved in the incubators for days as per requirement of study. The same procedure follows for BOD 3 days and BOD 5 days.

3.3.8. METHODOLOGY FOR MEASUREMENT OF TOTAL HARDNESS EDTA METHOD (ETHYLENEDIAMINE TETRAACETIC ACID)

3.3.8.1. PRINCIPLE

This method depends on ability of ethylenediamine tetraacetic acid ($C_{10}H_{16}O_8N_2$) or its disodium salt to form stable complexes with calcium and magnesium ions. When the dye eriochrome black T (EBT) ($C_{20}H_{13}N_3O_7S$) is added to a solution containing calcium and magnesium ions at pH 10.0 a wine red complex is formed. This solution is titrated with standard solution of disodium salt of EDTA, which extracts calcium and magnesium from the dye complex and the dye is changed back to its original blue color. Eriochrome black T is used to indicate the end-point for the titration of calcium and magnesium together.

3.3.8.2. REAGENTS

1. Buffer solution- Dissolve 16.9 g ammonium chloride (NH_4Cl) in 143 ml concentrated ammonium hydroxide (NH_4OH), add 1.25 g of magnesium salt of EDTA and dilute to 250 ml with distilled water. Store the solution in a polyethylene bottle tightly stoppered to prevent loss of ammonia or pick-up of carbon dioxide for no longer than 1 month. Dilute 10 ml of the solution to 100 ml with distilled water and check that the pH value is 10.0 ± 0.1 .
2. Standard calcium solution- 1.00 ml = 1.00 mg calcium carbonate ($CaCO_3$). Dry analytical grade calcium carbonate ($CaCO_3$) in an oven at $180^\circ C$ for 1 hour. Weigh 1.000 g, suspend it in distilled water and add 1:1 hydrochloric acid AR quality, drop wise slowly to dissolve the solid. Use minimum amount of acid. Boil for a few minutes, cool, add a few drops of methyl red indicator and adjust to orange colour with 3N ammonium hydroxide or 1 : 1 hydrochloric acid. Dilute to 1 000 ml with distilled water.
3. Eriochrome black T indicator solution- Dissolve 0.40 g eriochrome black T and 4.5 g hydroxylamine hydrochloride ($NH_2OH HCl$) in 100 ml 95 percent ethanol. This indicator is stable for more than 2 months. Alternatively, dissolve 0.5 g eriochrome black T in 100 ml triethanolamine or 2-methoxyethanol or mixed 0.5 g EBT dye and 100 g sodium chloride in a pestle and mortar. Store in a tightly stoppered bottle. All indicator formulations tend to deteriorate especially when exposed to moisture. If the

end point color change is not sharp enough it is either due to the presence of some interfering ions or due to deterioration of the indicator. In the latter case, addition of inhibitor sodium cyanide or sodium sulphide (NaCN or Na_2S) does not sharpen the end point color change.

- i. Hydroxylamine hydrochloride solution — Dissolve 45 g hydroxylamine hydrochloride ($\text{NH}_2\text{OH}\cdot\text{HCl}$) in demineralised water and dilute to 1 liter, or dissolve 4.5 g hydroxylamine hydrochloride in 100 ml of 95 percent ethanol or isopropanol.
- ii. Potassium ferrocyanide crystals
- iii. Sodium sulphide inhibitor — Dissolve 5.0 g sodium sulphide ($\text{Na}_2\text{S}\cdot 9\text{H}_2\text{O}$) or 3.7 g $\text{Na}_2\text{S}\cdot 5\text{H}_2\text{O}$ in 100 ml distilled water. Tightly stopper so as to avoid excessive contact with air.
- iv. Sodium cyanide solution — Dissolve 2.5 g sodium cyanide (NaCN) in demineralised water and dilute to 100 ml. As sodium cyanide is extremely poisonous, it should be handled with care. The solution should not be made acidic and should be flushed down the drain with large amounts of water when it is to be disposed off.

- v. Standard EDTA solution — Dissolve 3.723 g EDTA ($\text{Na}_2\text{H}_2\text{C}_{10}\text{H}_{12}\text{O}\cdot 2\text{H}_2\text{O}$) which has been dried overnight in a sulphuric acid desiccator, in demineralised water and dilute to 1 000 ml. The reagent is stable for several weeks and large volume is usually prepared. Check the reagent by titrating 25 ml of standard calcium solution as described in 2.4.1. Store in polyethylene bottles.

3.3.8.3. PROCEDURE

1. Standardization — Pipette 25.0 ml of standard calcium solution in a porcelain basin and adjust the volume to 50 ml with distilled water. Add 1 ml buffer solution.
2. Add 1 to 2 drops of indicator.
3. Titrate slowly with continuous stirring until the redish tinge disappears, adding last few drops at 3 to 5 second interval. At the end point the colour is sky blue.

3.3.8.4. CALCULATION

Calculate the hardness as follows:

$$\text{Total hardness as (CaCO}_3\text{), mg/l} = \frac{100(V_1 - V_2)}{V_3} \times CF$$

Where:-

- V_1 = volume in ml of the EDTA standard solution used in the titration for the sample,
- V_2 = volume in ml of the EDTA solution used in the titration for blank,
- V_3 = volume in ml of the sample taken for the test,
- $CF = X_1/X_2$ = correction factor for standardization of EDTA,
- X_1 = volume in ml of standard calcium solution taken for standardization, and
- X_2 = volume of ml of EDTA solution used in the titration.

3.3.9. METHODOLOGY FOR MEASUREMENT OF ALKALINITY

3.3.9.1. SAMPLE PREPARATION

The sample aliquot used for analysis should be either free from turbidity or should be allowed to settle prior to analysis.

3.3.9.2. APPARATUS

- pH Meter
- Burette - 50-ml capacity.
- Magnetic Stirrer Assembly

3.3.9.3. REAGENTS

- Distilled Water - Distilled water used should have pH not less than 6.0. If the water has pH less than 6.0, it shall be freshly boiled for 15 minutes and cooled to room temperature. Deionized water may be used provided that it has a conductance of less than 2 $\mu\text{s/cm}$ and a pH more than 6.0.
- Sulphuric Acid - Dilute 5.6 ml of concentrated sulphuric acid (relative density 1.84) to one litre with distilled water.

- Standard Solution of Sulphuric Acid - 0.02 N.
- Phenolphthalein Indicator - Dissolve 0.5 g of phenolphthalein in 100 ml, 1 : 1 (v/v), alcohol water mixture.
- Mixed indicator Solution - Dissolve 0.02 g methyl red and 0.01 g bromocresol green in 100 ml, 35 %, ethyl or isopropyl alcohol.

3.3.9.4. PROCEDURE

Pipette 20 ml of sample into a 100-ml beaker. If the pH of the sample is over 8.3, then add 2 to 3 drops of phenolphthalein indicator and titrate with standard sulphuric acid solution till the pink color observed by indicator just disappears (equivalence of pH 8.3). Record the volume of standard sulphuric acid solution used. Add 2 to 3 drops of mixed indicator to the solution in which the phenolphthalein alkalinity has been determined. Titrate with the standard acid to light pink color (equivalence of pH 3-7). Record the volume of standard acid used after phenolphthalein alkalinity.

3.3.9.5. CALCULATION

Calculate alkalinity in the sample as follows:

$$\text{Total alkalinity (as mg/l CaCO}_3\text{)} = \frac{(A + B) \times N \times 5000}{V}$$

where

A = ml of standard sulphuric acid used to titrate to pH 8.3,

B = ml of standard sulphuric acid used to titrate from pH 8.3 to pH 3.7,

N = normality of acid used, and

V = volume in ml of sample taken for test.

3.3.10. METHODOLOGY FOR MEASUREMENT OF CHLORIDE PRESENT

3.3.10.1. PRINCIPLE

Chloride can be titrated with mercuric nitrate because of the formation of soluble, slightly dissociated mercuric chloride. In the pH range 2.3 to 2.8. diphenyl carbazone indicates the end point by the formation of a purple complex with excess mercuric ions.

3.3.10.2. APPARATUS

- Erlenmeyer flask - 250 ml capacity.
- Microburette - 5 ml with 0.01 ml graduation intervals.

3.3.10.3. REAGENT

- Standard sodium chloride solution
- Nitric acid - 0.1 N
- Sodium hydroxide - 0.1 N
- Reagents for chloride concentrations below 700 mg/l
- Indicator-acidifier reagent - The nitric acid concentration of this reagent is an important factor in the success of the determination and can be varied as indicated in (a) or (b) to suit the alkalinity range of the sample. Reagent (a) contains sufficient nitric acid to neutralize a total alkalinity of 150 mg as CaCO_3/l to the proper pH in a 100 ml sample. Adjust amount of nitric acid to accommodate samples of alkalinity different from 150 mg/l.

a) Dissolve, in the order named, 250 mg s-diphenylcarbazone, 4-O ml. concentration nitric acid and 30 mg xylene cyanol FF in 100 ml 95 percent ethyl alcohol or isopropyl alcohol. Store in a dark bottle in a refrigerator. This reagent is not stable indefinitely. Deterioration causes a slow end point and high results.

b) Because pH control is critical, adjust pH of highly alkaline or acid samples to 2.5 ± 0.1 with 0.1 N nitric acid or sodium hydroxide not with sodium carbonate (Na_2CO_3). Use a pH meter with a nonchloride type of reference electrode for pH adjustment. If only the usual chloride-type reference electrode is available for pH adjustment, determine amount of acid or alkali required to obtain a pH of 2.5 ± 0.1 and discard this sample portion. Treat a separate sample portion with the determined amount of acid or alkali and continue analysis. Under these circumstances, omit nitric acid, from indicator reagent.

- Standard mercuric nitrate titrant – 0.014 I N. Dissolve 2.3 g mercuric nitrate [$\text{Hg}(\text{NO}_3)_2$ or 2.5 g $\text{Hg}(\text{NO}_3)_2 \cdot 12\text{H}_2\text{O}$] in 100 ml distilled water containing 0.25 ml concentrated nitric acid. Dilute to just under 1 liter. Use replicates containing 5.00 ml standard sodium chloride solution and 10 mg sodium bicarbonate (NaHCO_3) diluted to 100 ml with distilled water. Adjust titrant to 0.014 I N and make a final standardization; $1.00 \text{ ml} = 500 \mu\text{g Cl}^-$. Store away from light in a dark bottle.

- Mixed indicator reagent - Dissolve 0.50 g diphenylcarbazone powder and 0.05 g bromophenol blue powder in 75 ml 95 percent ethyl or isopropyl alcohol and dilute to 100 ml with the same alcohol.

- Strong standard mercuric nitrate titrant – 0.141 N.

3.3.10.4. PROCEDURE

Use a 100 ml sample that the chloride content is less than 10 mg. Add 1.0 ml indicator-acidifier reagent. For highly alkaline or acid waters, adjust pH to about 8 before adding indicator-acidifier reagent. Titrate with 0.41 1 N mercuric nitrate to a definite purple end point. The solution turns from green blue to blue a few drops before the end point. Determine the blank by titrating 100 ml distilled water containing 10 mg of sodium bicarbonate.

$$\text{Chloride, mg/l} = \frac{(V_1 - V_2) \times N \times 35450}{V_3}$$

where

V_1 = volume in ml of silver nitrate used by the sample,

V_2 = volume in ml of silver nitrate used in the blank titration,

V_3 = volume in ml of sample taken for titration and

N = normality of silver nitrate solution.

CHAPTER 4

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSIONS

4.1. TEMPERATURE

It is found that the temperature of the water supplied to the hostels, canteens and the institute building are within the permissible limit as per IS:10500. As the result in figure 4.1 shows the temperature of the tap water collected from hall 2, hall 5, Homi Bhabha hall of residence, hexagon canteen and institute building during winter.

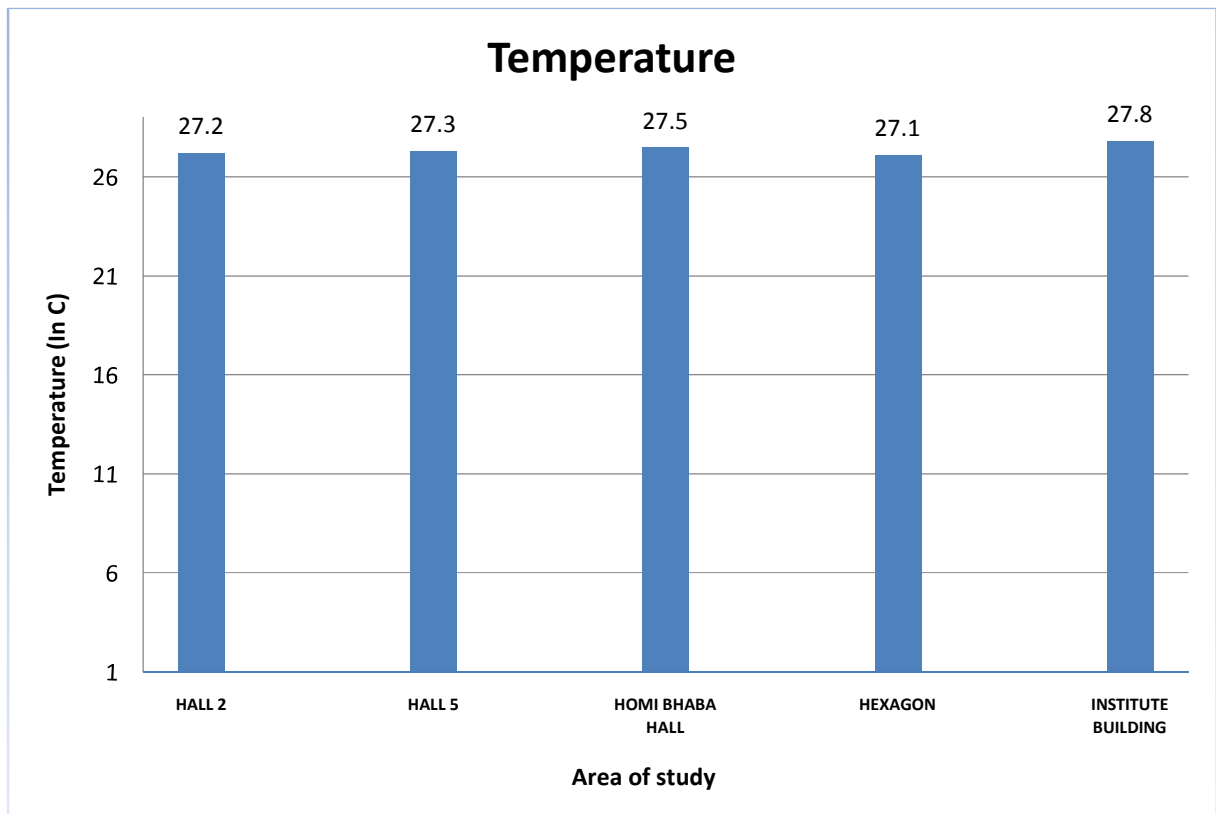


Fig.4.1. Average Temperature of tap water from different areas during winter.

4.2. pH VALUE

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse affect on health, however, a low value, below 4.0 will produce sour taste and higher value above 8.5 shows alkaline taste. A pH range of 6.5 – 8.5 is normally acceptable as per guidelines suggested by ISI. In the present study, the fluctuation of pH in the samples is from 7.32 to 7.53.

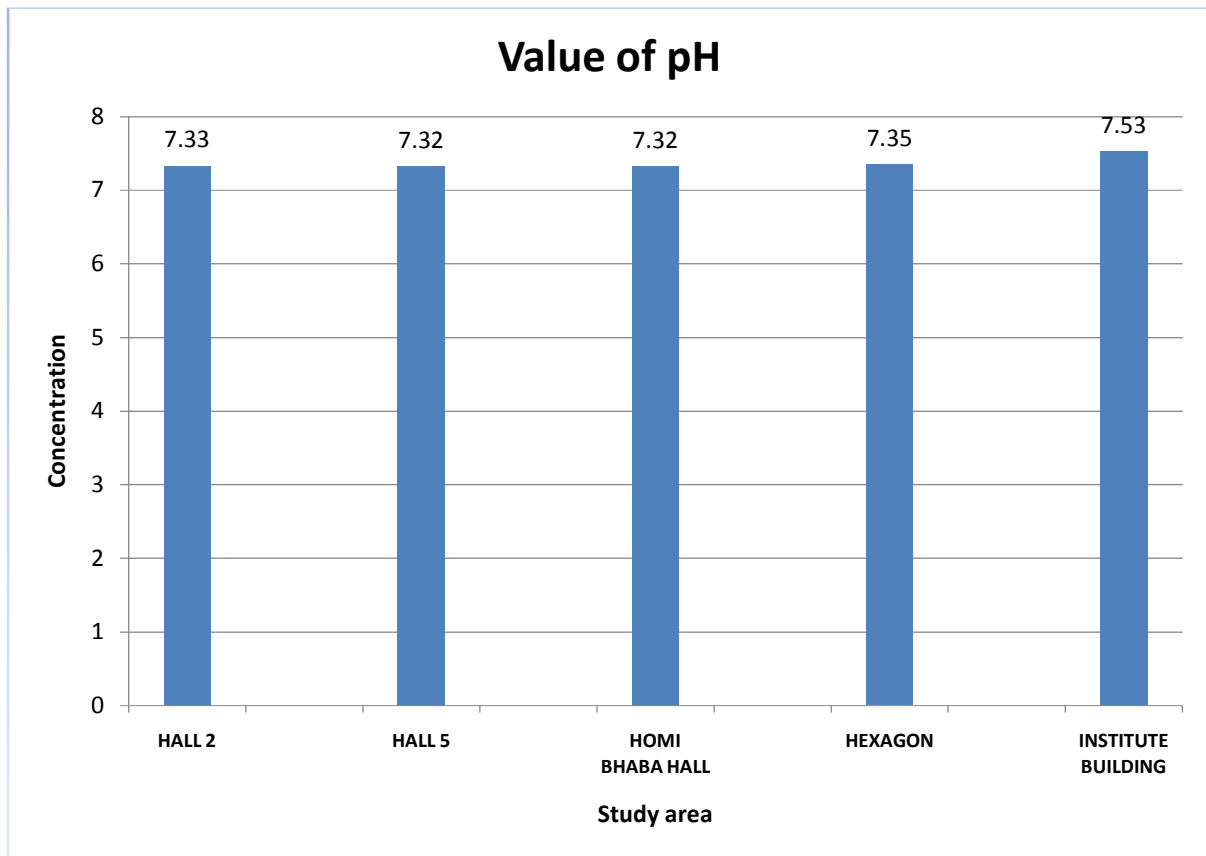


Fig.4.2. Average pH of the water samples from different areas.

4.3. TURBIDITY

Measurement of Turbidity reflects the transparency in water. It is caused by the substances present in water in suspension. In natural water, it is caused by clay, silt, organic matter and other microscopic organisms. It ranged from 2.31 to 2.56 NTU. However the prescribed limit of Turbidity for drinking water is 5 NTU (IS: 10500). Turbidity was found within the permissible limit in all the water samples.

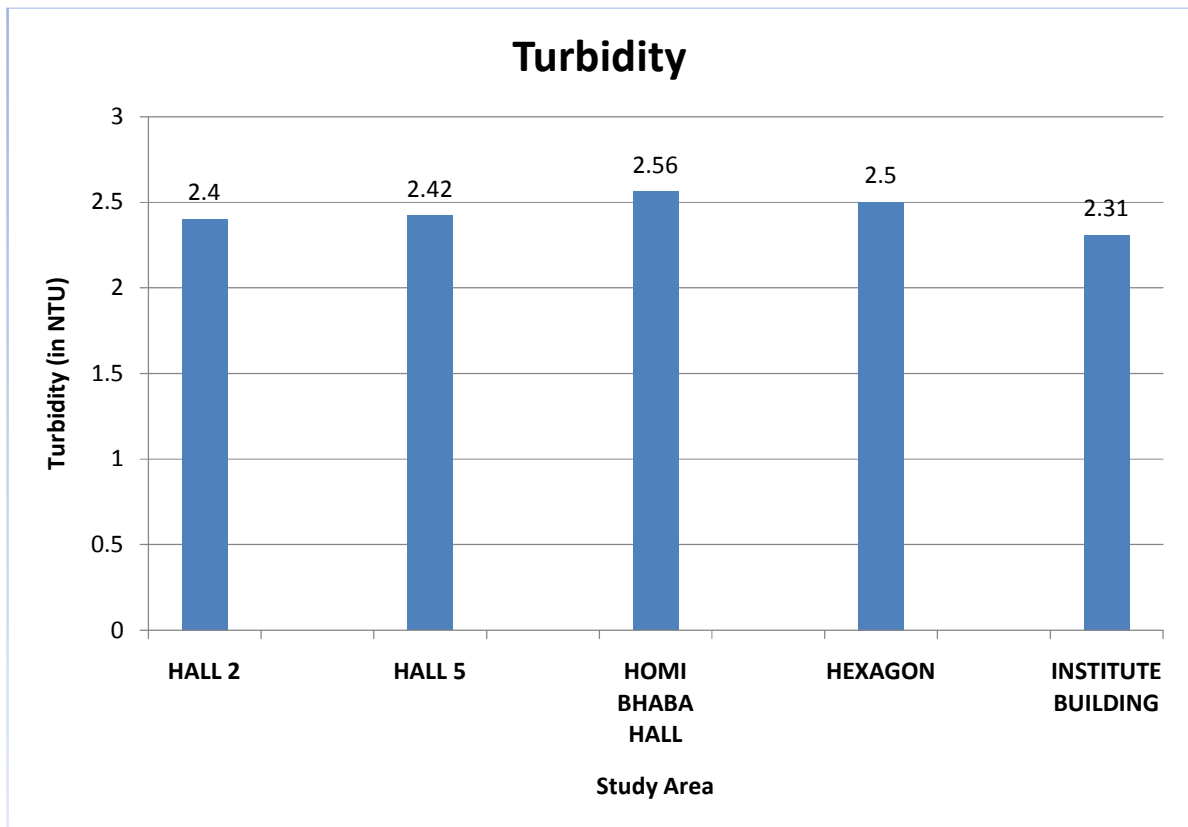


Fig.4.3. Average Turbidity of the water samples from different areas.

4.4. TOTAL SOLIDS AND TOTAL SUSPENDED SOLIDS

Total Dissolved Solids may be considered as salinity indicator for classification of groundwater. The TDS in groundwater is due to the presence of Calcium, Magnesium, Sodium, Potassium, Bicarbonate, Chloride and Sulphate ions. In the study area TDS varied from 145 to 175 mg/l. As prescribed limit of TDS for drinking water is 500 mg/l, all the water samples have TDS concentration well below the prescribed limit. Total Suspended Solids in the study area varied from 2.419 to 2.863 mg/l.

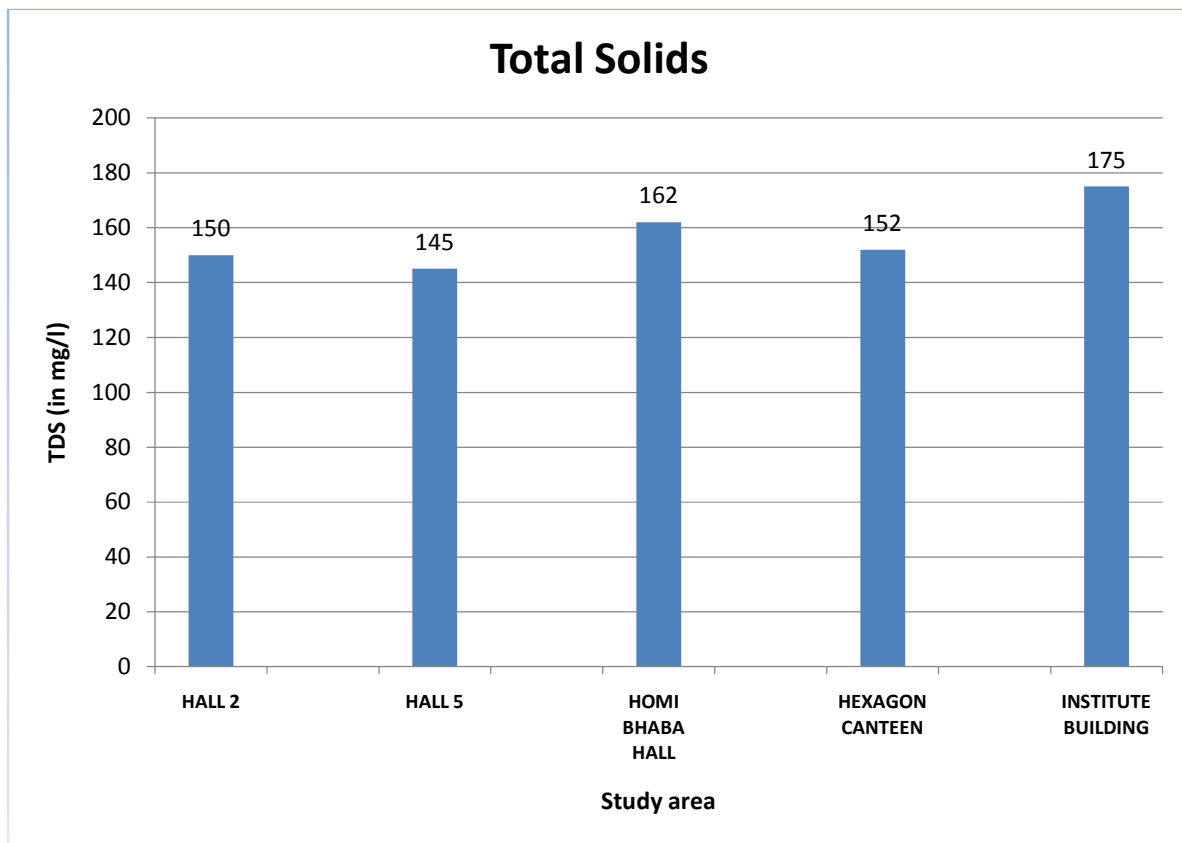


Fig.4.4.(a) Average Total solids in the water samples from different area

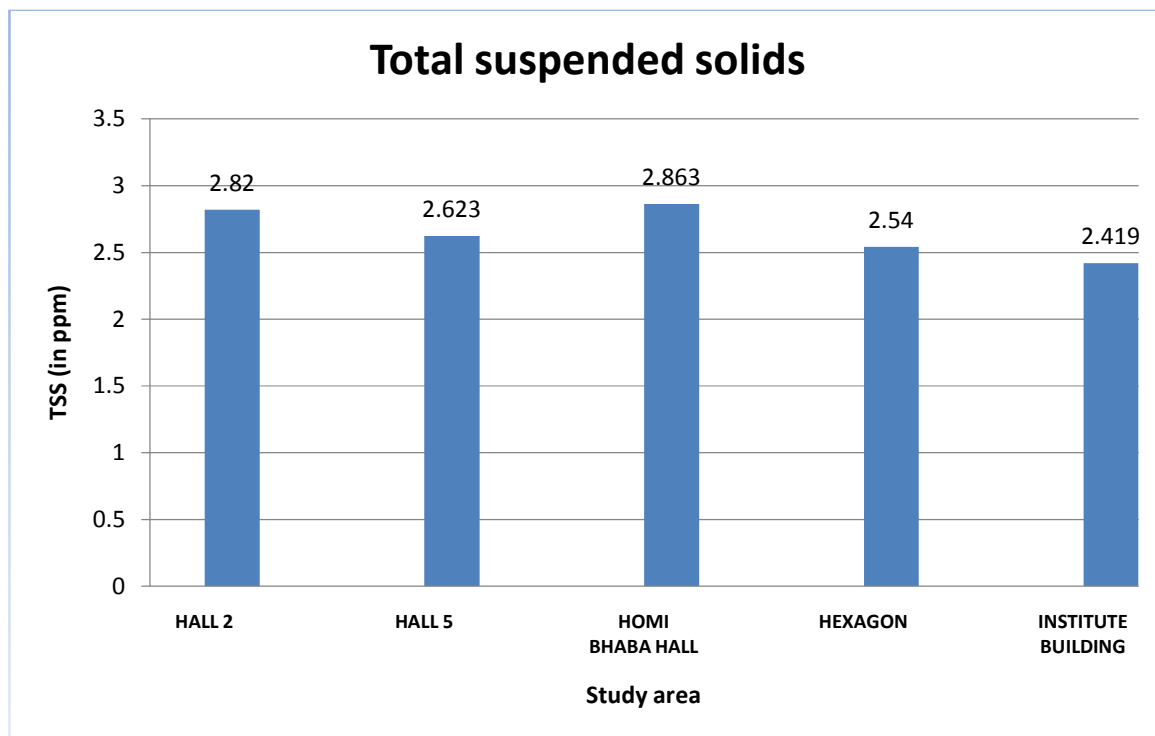


Fig.4.4.(b) Average Total suspended solids of the samples from the different area.

4.5. TOTAL HARDNESS

Hardness of water is objectionable from the view point of water use for laundry and domestic purposes since it consumes a large quantity of soap. Based on present investigation, hardness varied from 40.2 to 45.2mg/l. However the permissible limit of Hardness for drinking water is 300 mg/l (IS 10500). According to Hardness classification (Durfor and Backer, 1964), the no of water samples of the study area can be classified as given in table 4.1. It is found that the water supplied to the hostels, canteens and institute building is soft.

Table 4.1. Classification of the water according to hardness.

TDS Range	Description
0-60	Soft
61-120	Moderately hard
121-180	Hard
>180	Very hard

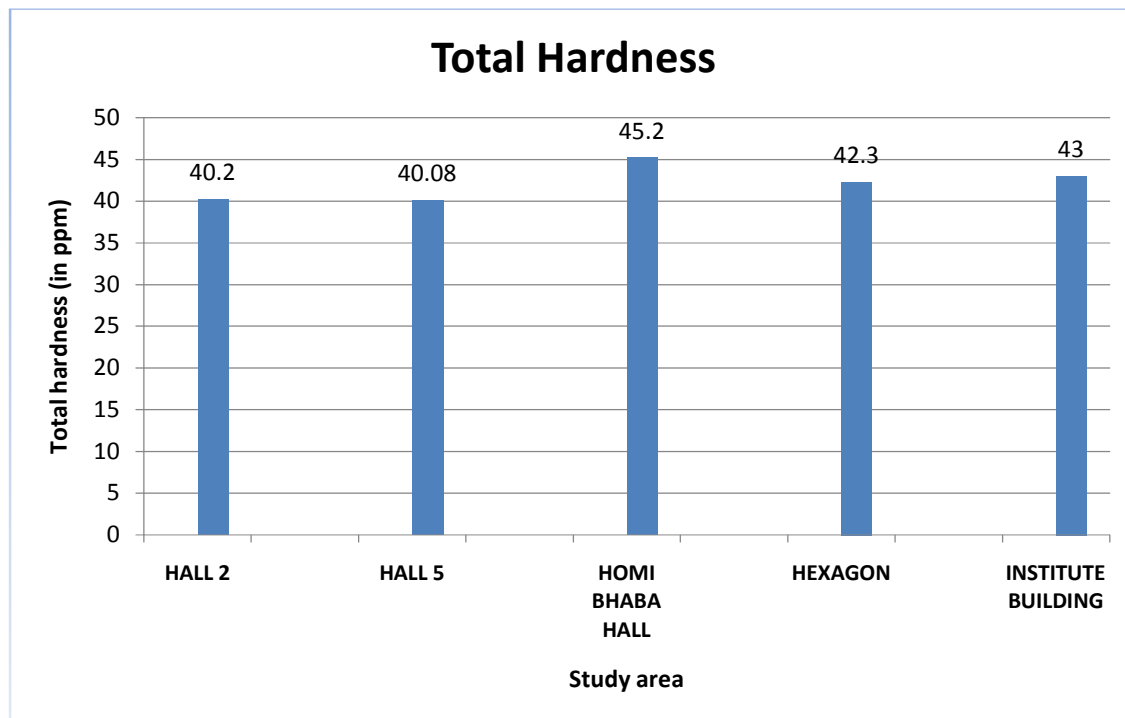


Fig.4.5 Average hardness of the water samples from different areas.

4.6. BIOCHEMICAL OXYGEN DEMAND (BOD)

BOD gives a quantitative index of the degradable organic substances in water and is used as a measure of waste strength. The low BOD value in all samples showed good sanitary condition of the water. It is found that all the water supplied to the institute is within the permissible limit.(ie;3 to 4 mg/l) .

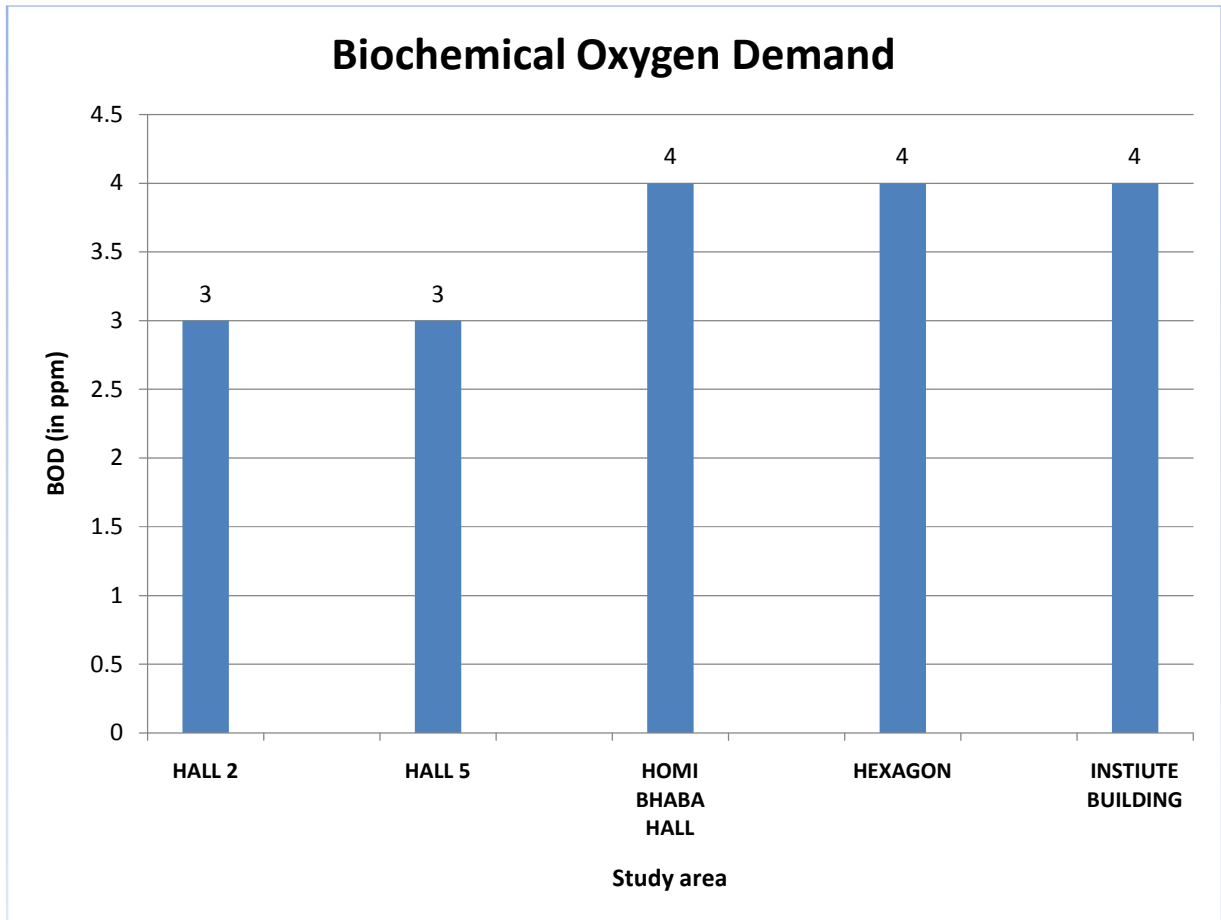


Fig.4.6. Average BOD of the water samples from different areas.

4.7. DISSOLVED OXYGEN (DO)

Dissolved oxygen content in water reflects the physical and biological processes prevailing in water and is influenced by aquatic vegetation. Low oxygen content in water is usually associated with organic pollution. DO is ranged from 8.61 to 8.96 mg/l in the study area, where as the prescribed limit for DO is 5.0 mg/l.

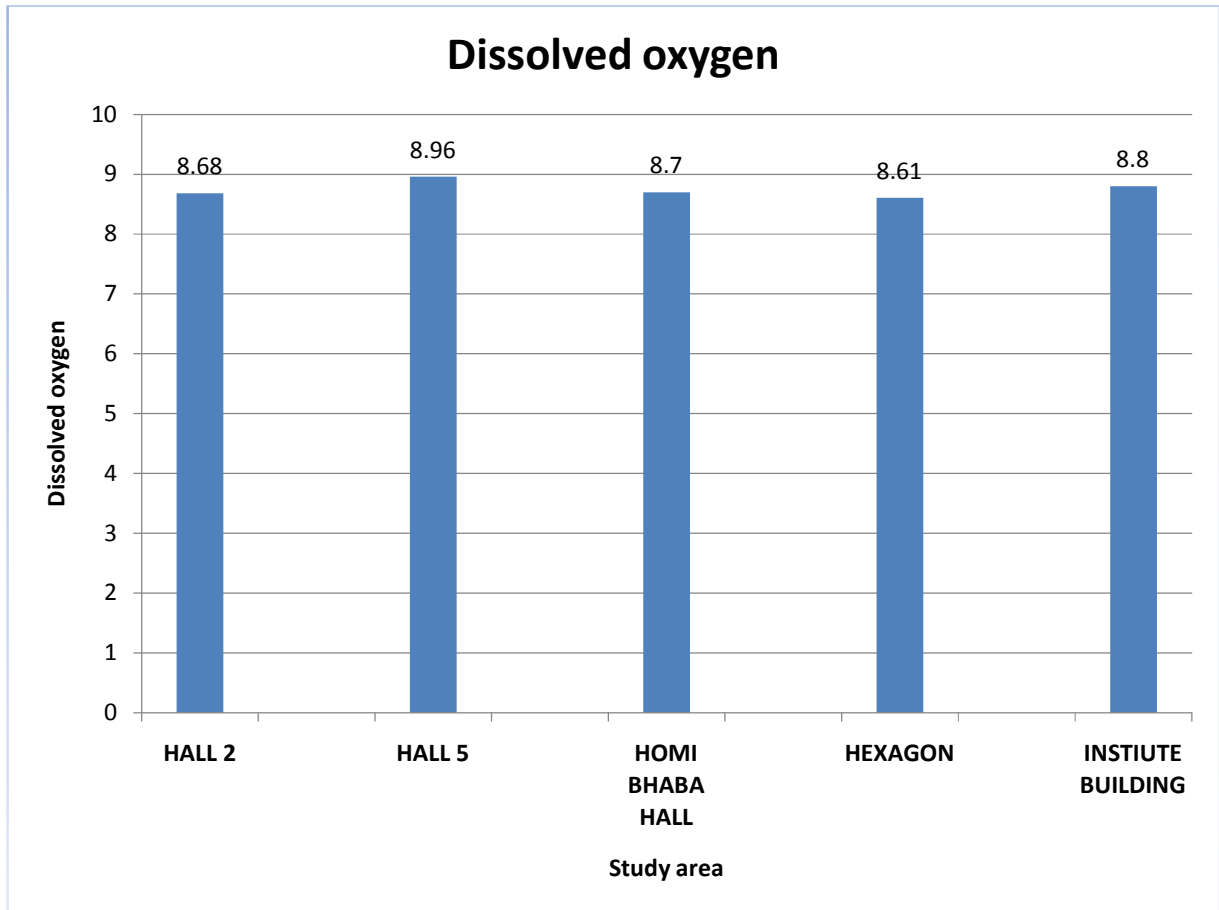


Fig.4.7. Average DO of the samples from different areas.

4.8. ALKALINITY

In the present study Phenolphthalein Alkalinity was absent in all samples and Methyl Orange Alkalinity was ranged from 98 mg/l to 106.3 mg/l, this indicates the absence of Hydroxyl and Carbonate and presence of Bicarbonate. However the prescribed limit for Total Alkalinity is 120 mg/l.

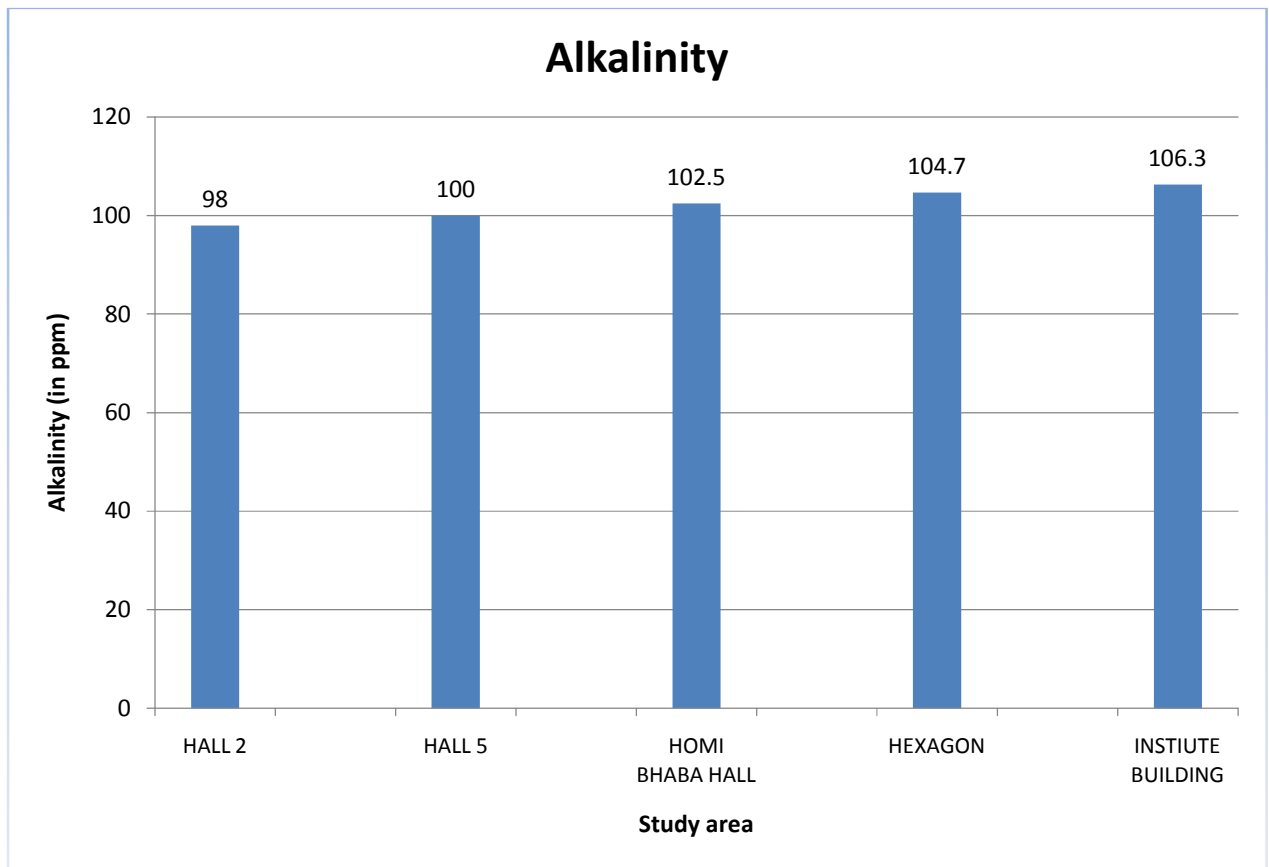


Fig.4.8. Average Alkalinity of the water samples from different areas.

4.9. CHLORIDE

In the study area there is no significant change in chloride concentration and it ranged from 21.0 to 21.4 mg/l. Chloride which have been associated with pollution as an index are found below the permissible value set at 250 mg/l in most of the study area. Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high Chlorides can be subjected to laxative effects.

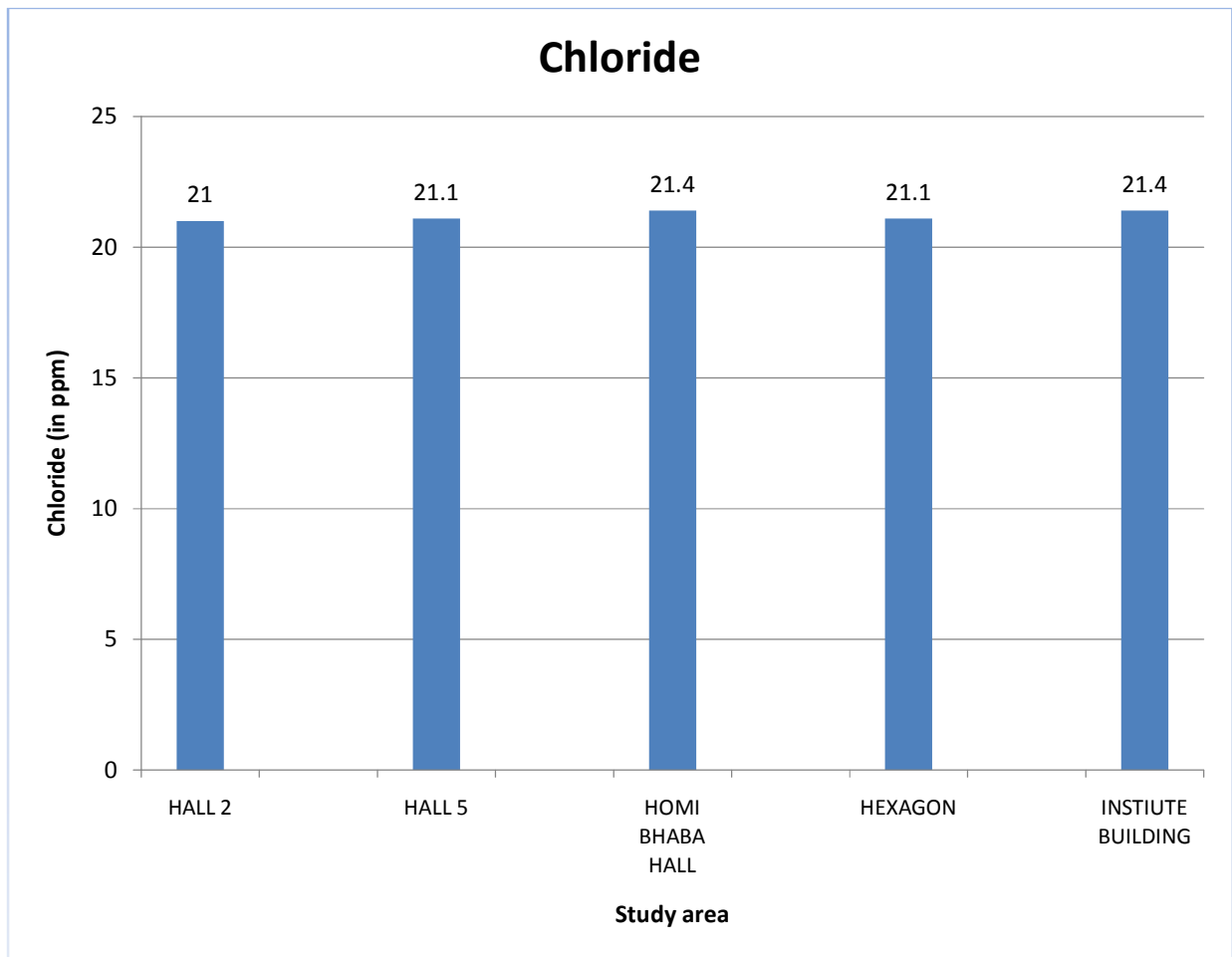


Fig.4.9. Average chloride present in the samples from different areas.

CHAPTER 5

CONCLUSION

5. CONCLUSIONS

The average ranges of physical, chemical and biological characteristics of water quality are as per the ground water quality. The pH ranges from 7.32 to 7.53. The Turbidity, TDS and TSS ranged from 2.31 to 2.56 NTU, 145 to 175 mg/l and 2.419 to 2.863 mg/l respectively. The value of Turbidity was found to be within the permissible limit in all the. Hardness, ranged from 40.08 to 45.2 mg/l and it is found that the water supplied to the campus area is soft. The DO and BOD were in the range of 8.68 to 8.96 mg/l and 3 to 4 mg/l. The Chloride and Alkalinity were in the range of 21 to 21.4 mg/l and 98 to 106.3 mg/l respectively. The parameters studied resemble the drinking water quality.

CHAPTER 6

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6. REFERENCES

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