WATER QUALITY MANAGEMENT

An internship report

Submitted by

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According to the syllabus of

A P J ABDUL KALAM KERALA TECHNOLOGICAL UNIVERSITY

3-6-2016 TO 2-7-2016

ENVIRONMENTAL ENGINEERING LAB

DEPARTMENT OF CIVIL ENGINEERING

JYOTHY ENGINEERING COLLEGE

CHERUTHURUTHY, THRISSUR-679531

ACKNOWLEDGEMENT

First I would like to thank **Prof. JOSEPH JOSHY,** PAT office, Jyothy engineering college cheruthuruthy, for giving me this wonderful opportunity for internship at jyothi. It was really a good experience, working at environmental engineering lab. I express my sincere thanks to **Prof. S.RATHISH,** Head of the department of civil engineering, Jyothy engineering college, for his concern towards me and gave me opportunity to work at environmental engineering lab of civil department. I am deeply indebted and gratefully acknowledge the constant support and valuable patronage of my Internship guide **Prof. M. G CYRIAC,** associate professor, civil engineering department. I am unboundedly grateful to him for timely corrections and scholarly guidance.

I express my hearty thanks to **Ms VINI P**, the chemist, environmental engineering lab of civil department, who helped me in the whole process in the lab and for caring me and taught me my lessons. I express my sincere thanks to computer faculty members and librarian for their services. At last, but not the least I would like to thanks the entire Jyothi team, principal, management, all faculties those who had inspired and helped me to achieve my goal.

EXECUTIVE SUMMARY

As part of my first year internship, I chose the subject "water quality testing" which come under the civil department (environmental engineering lab). The program starts with an orientation hence we understand the importance of internship. Later I registered to the internship program.

The period of my internship extended to four weeks, from 3-6-2016 to 2-7-2016. Each week is scheduled for different routine. Our duty is to finish the work up to the dead line. We got the instructions, guidelines from Prof. Joseph joshy and Ms Rinu. Two members are there from civil department to do internship, me and my friend Bhavya George.

first two weeks are mend for self study, we 'interns' got full access user ID at computer lab, free to enter at JECC library, digital library at any time during the period. We got so much of information from these sources. Other than this, we got the presentations from Prof. S Rathish, Prof. M G Cyriac. On the third week onwards we entered into the lab, start doing water quality test, with the help of Prof. M.G Cyriac and chemist Ms Vini. We checked out almost ten parameters. We got about one hour class from Cyriac sir during the experimental days, who worked as an engineer at water authority. He also taught us about the major water quality issues in Kerala, importance of water quality etc.

This internship was really enjoying and informative one. I felt that I extended my knowledge to the next level. It's really an interesting one because we dealt with water! The elixir of life.

TABLE OF COTENTS

I. INTRODUCTION

"Water has become a highly precious resource. There are some places where a barrel of water costs more than a barrel of oil" this is the statement by the Llyod Anworthy , foreign minister of Canada in a news conference. Water is a basic necessity and also a valuable resource on earth (Ref.1).

In the last three decades, growing water shortage and water pollution in both the developed and developing countries have plunged the world into a water crisis. The world's finite supply of fresh water is being threatened by increasing population, rising standard of living and pollution. Already there are millions of people without access to drinking water and proper sanitation. This would lead to commodification of water which would not serve the purpose.

In this contest the "water quality management" is a very important subject to discuss. As an engineering student I want to go for technical side of water quality rather than economic and social issues. This is the main reason that I select this topic as my internship subject. Water quality determines the goodness of water for a particular purpose. Parameters and standards are also created for check out this quality. In our country the water quality standards are determined by three organizations.

1) BIS (Bureau of Indian standards)

2) CPHEEO (Central public health and environmental engineering organization)

3) ICMR (Indian council for medical research)

We here checked out about ten parameters, like physical parameters, chemical parameters, bacteriology (MPN number only) and COD. These parameters are mainly used for a first level analysis. first level analysis is quite enough to determine the usual issues and remedies, if the situation is more fatal even remedies can't withstand, next level or research level remedies want to be tried.

II. OBJECTIVE

The main objective or goal of this internship is to experience the water quality management. 'Experience' includes study, analysis, enrich the knowledge etc. Main goals are given below.

- Study about water quality testing, water quality issues in kerala, it's remedial measures.
- Analysis of water quality at least for two samples, by experiment the samples in the lab.
- Compare the result with standard values of each parameter.
- Understand how water quality issues are relevant today.
- Observe how engineering disciplines can utilize for water quality management.

These objectives leads us to a good understanding about water quality management. We would get a wide knowledge about water quality issues, history behind each issues, region specific water quality issues etc. Since I'm a civil engineering student water, soil, air, are which is nature and main areas of studies I have to be stress more. I think I would get proper information about 'water quality' by doing this internship.

Also my objective includes, to create a communicative web at Jyothi, higher experience level, over all enhancement of in life.

III. METHODOLOGY

Methods of internship include self study about the subject, receive as much knowledge about the subject, experiment the water quality of any sample.

1) **SELF STUDY** [6-6-2016 to 20-6-2016]

The first two weeks were self study. Main source of study is through internet. From JECC library we got sufficient books that including the subject. PPT's prepared by eminent personalities are also helped us in these contest.

2) **TESTING WATER QUALITY** [22-6-2016 to 28-6-2016]

For water quality testing, different parameters are identified by different means. Probably physical parameters are checked by using instruments. Chemical, through titration. Different methods that we used are represented below.

PHYSICAL PARAMETERS

1) PH

H_2O--- H^++OH^- (theory of Ionization). H^+ ion is having a significant effect on the quality of water pH Concept was introduced by Sorenson in 1909. He was a chemist in the Carlsberg laboratory in Denmark. It is measured by using pH meter.

Fig.III.1 digital pH meter

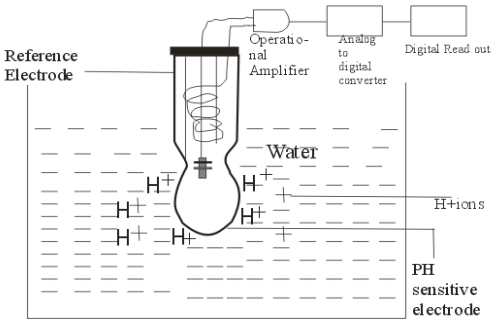


Fig.III. 2 process behind pH measurement

pH meter consist of a glass electrode which have an ability to attract H+ ions. H+ ions produce potential on pH electrode. Another potential is arise between reference electrode and electrolyte .The difference between these potential is amplified & display as digits in pH meter (Ref.2)

PH meter [microprocessor based] is we used here for measurement, We first standardized it with water sample having ph 4 and 7. Then placed our sample, reading noted. If pH is less than 7 it is acidic and greater than 7 it is alkaline. 7 is said to be neutral.

2) TURBIDITY

The materials like soil, plant parts, algae, other carbonic compounds that do not dissolve in water cause turbidity to water. 1 unit turbidity is the turbidity caused by 1 mg of silica dissolved in 1 liter of distilled water. Nephelo turbidity meter is used to measure turbidity. It's unit is NTU (nephelo turbidity unit).

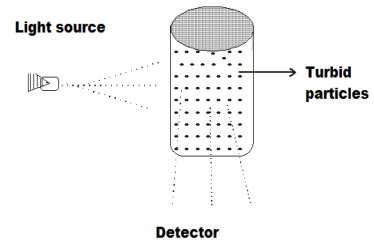


Fig. III. 3 process in turbidity meter ***Fig III. 4 Nephelo turbidity meter***

When light is passed to the equipment turbid water get reflected by hitting on the particles and the intensity of this reflected light rays are detected by using photo electric detector. For the measurement, First we calibrate it, set the range and standard. Formazine concentrate is used to standardize it. Then placed our sample and get the turbidity in NTU (Ref.2)

3) TOTAL DISSOLVED SOLIDS (TDS)

It is measured by evaporating to dryness water in a porcelain dish and thereafter finding out the weight of the residue. TDS is proportional to conductivity.

This also can be identified by using equipment. First standardize it, and then measure it with distilled water to get 00.1. Then wipe out the residue and then used for our sample.

CHEMICAL PARAMETERS

Chemical parameters are mainly identified by using volumetric analysis. For iron and manganese we look for colorimetry.

Volumetric Analysis

Reaction between two mutually reactive chemicals. A chemical of known strength is used which is termed as reagent. End point is denoted by color change using an indicator. Indicator reacts with the excess chemical added and thus the color is formed. Color chart of volumetric analysis is given below.

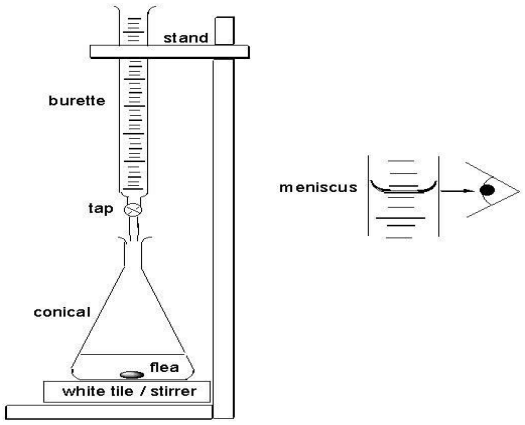


Fig. III. 5 arrangements for volumetric analysis (Ref.3)

SL NO	Chemical to be evaluated	Reagent	Indicator	End point color
1	Acidity	Sodium Hydroxide	Phenolphthalein-Lein	Pink
2	Alkalinity	Sulfuric acid	Methyl orange	Orange
3	Hardness	EDTA	Erichrome Black T	Blue
4	Chloride	Silver Nitrate	Pottasium Chromate	Red deposit

Table III. 1 Table of volumetric analysis

1) HARDNESS

Hardness is identified by titrating it against EDTA with indicator as EBT. Ammonia buffer is used for maintain ph. This is also called complexometric method. Its end point is wine red to blue.

2) CHLORIDE

The method is called argentometric method. 0.0141 silver nitrate is used as titrant, potassium chromate as indicator. End point is yellow to reddish brown.

3) ALKALINITY

For alkalinity we use 0.02 H2SO4 as titrant, phenolphthalein is used as indicator. End point is yellow to golden yellow.

Colorimetric analysis

In colorimetry formation of color is due to the reaction of a Chemical in the water with a predetermined chemical in the prescribed mode. Formation of color takes place and Intensity of the color is proportional to the quantity of chemical present in the water. Simple method commonly used is the measurement of residual Chlorine.

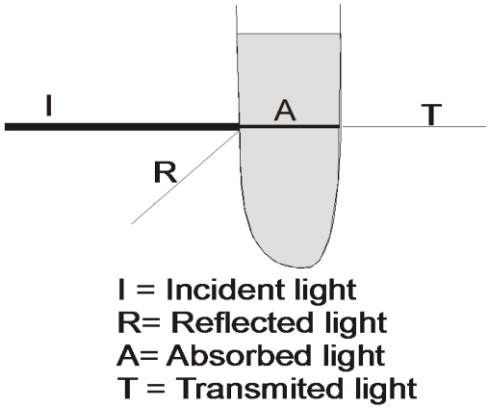
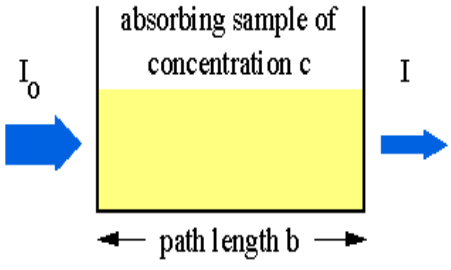


Fig. III. 6 changes that happened when light rays pass through a colored meadium(Ref.2)

Colorimetry is based on two laws that is Lamberts law and beer's law.

LAMBERTS LAW

According to Lamberts law, when monochromatic light pass through a medium, the intensity of transmitted light is inversely proportional to the thickness of the medium.



Mathematical Expression of Lamberts law

That is, $T=I/I0=10^{-a1e}$, Where, T=Transmittance

I0= The intensity of light entering the medium

I = the intensity of transmitted light

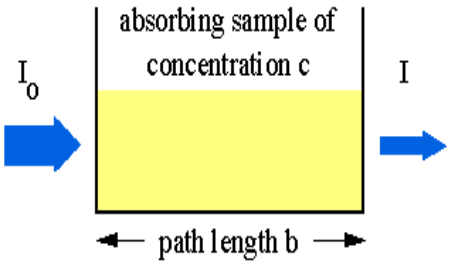
a 1 = Constant of the medium

e = The thickness of the medium absorbing the light

Fig.III.7schematic diagram of lamberts law(Ref.3)

BEER'S LAW

According to this rule, the intensity of a beam of light passing through a medium which absorb light, is inversely proportional to the colour intensity of that medium.



That is, $T= I/IO = 10^{-a2C}$

Where, a2 = the constant of a particular medium.

C= The colour concentration of the medium

Fig.III.7scematic diagram of lamberts law

Iron and manganese are used to identify by using spectrophotometer and principles of colorimetry. We used to check out only Iron and manganese. By using colorimetry.

4) IRON

Iron is identified by using spectrophotometer. First of all 25 ml sample is taken, then add 1ml of conc.HCL and 0.5 ml hydroxylamine hydrochloride. Then boil it since it become it's 1/3 rd portion, cool it. After cooling add 5 ml of ammonium acetate buffer and 1,10-phenanthroline.It is then make up to 50 ml. Then we standardize the equipment with distilled water taken in cuvette. Then we get the measure of iron content of our water sample taken in another cuvette.

5) MANGANESE

For manganese take 50 ml sample, 5 ml special reagent and dilute it into 90 ml. Add 1 gram of ammonium persulphate, boil for 1 minute and cool. After that dilute to 100 ml with distilled water. Then standardized the equipment and measurement can be taken.

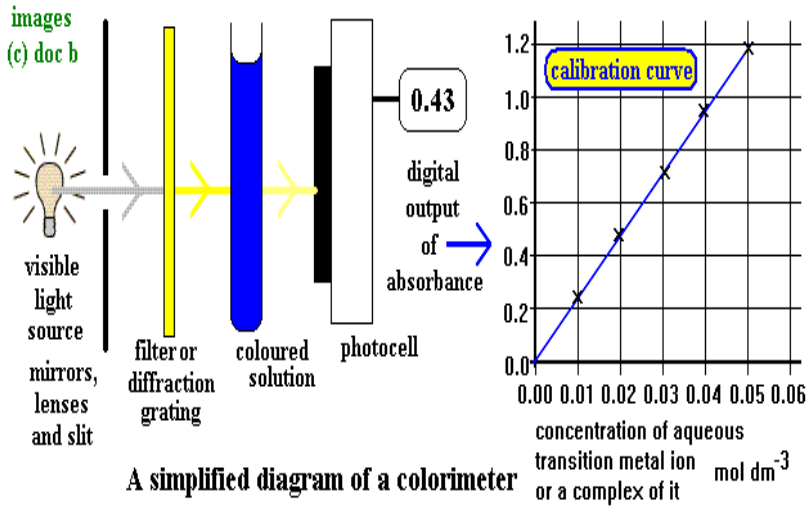


Fig. III. 8 Calibration of calorimetric instrument

Chemical to be estimated	*Chemical to be added*	*Color*	*Wavelength*
Iron	1.10 Phenanthroline	Light brown	510
Fluoride	Ammonium acetate and spands reagent	Reduction in colour with increase in fluoride	570
Nitrate	HCl	Not detected by naked eye	210 & 275

Table III. 2 Colorimetric analysis

TESTES TO IDENTIFY ORGANIC POLLUTION

- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)

We didn't check the BOD in our lab. COD is checked.

1) COD

Chemical oxygen demand is defined as the oxygen required for the water sample for the oxidation of organic and inorganic matter with a strong oxidizing agent in acidic medium. It is an indication of total oxidisable material present in water. Sauckslet extraction mantle is used for COD determination.

20 ml sample is taken in round bottomed flask, add 0.4 grams of mercuric sulfate, 10 ml of potassium dichromate. Then add 30 ml conc. sulfuric acid, shake it well and keep at sauckslet apparatus.We have to place Graham's condense tube on the flask. Then preserve it for 2 hour as reflection time. Then cool it, add ferroin indicator and titrated against ferrous ammonium sulfate. After that we can calculate the COD value.

BACTERIOLOGY

Mainly bacteriology includes detection of disease causing organisms like, Bacteria, Virus, Fungi, Algae and Protozoa. For those type of detection, a higher level or most sterilized lab is needed. Here we are using method of indicator organism. Commonly Used Indicator Organisms are

a*) Coliform* bacteria

b) Faecal *Coliforms*

c) Escherichia Coli

In India mainly *coliform* bacteria are used as indicator organism. In our lab also we went to check out MPN number. Advantages of *coliforms* include,

- 10% of the bacteria in the human excreta consists of coliforms,
- On an average a human being discharges 100 to 400 billion coliforms per day
- Compared to other bacteria in the human excreta life period of coliform is maximum after coming out of the intestine.
- Analysis of coliform is simple

Growing the bacteria in a favourable condition by providing food and other environment and counting its growth by a suitable method

Commonly used methods are

a) Standard plate count method

b) Membrane filtration technique

c) Multiple tube method

Presumptive and confirmative test are there for checking bacteriology. Here we used presumptive test only.in the case of presumptive test, we kept water sample in macconky broth and incubate it for 24 hours at 30 degree Celsius. If no gas is found, inside the durharm's tube it indicates negative for coliforms. If it contain gas, it shows positive. Later that positive tubes want to be kept at 24 hours and 44.5 degree celcius. Then if it indicates negative coliform will be absent and present it shows positive.

The number of tubes have to be noted according to gas production and we have to check it out according to the chart. Hence we can find the MPN number.mainly in the case of open well there is a chance of increase in MPN number.

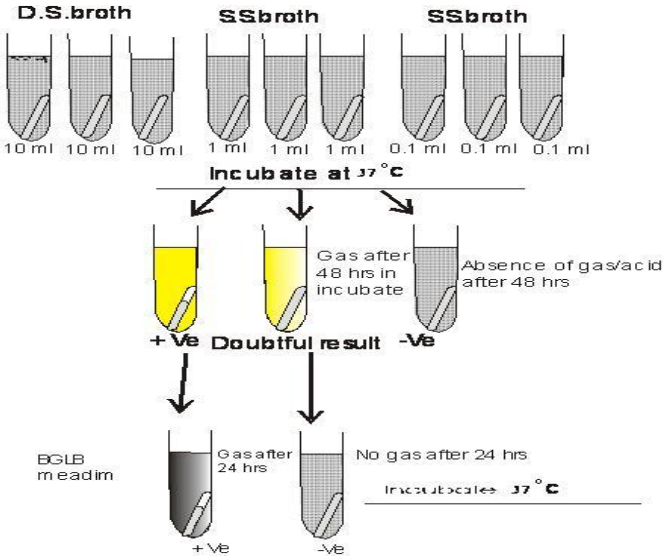


Fig III.9 multiple tube method for bacteriology

Thomas equation for estimation of MPN

$$MPN = \frac{\text{No; of positive tubes} * 100}{\sqrt{\text{Ml in negative tubes} * \text{ML in all tubes}}}$$

FigIII.10 MPN equation(Ref.2)

IV. INTERNSHIP ACTIVITIES

The entire internship is done in four weeks. The process that we had done is explained below.

WEEK ONE

The first week were used for self study. Our first duty is to prepare a statement of purpose (SOP). That will be annexed later as annexure 1. We have a dead line to submit it before 4:30 PM and we successfully prepared and submitted it. On that week itself we started to collect information about water quality testing. We were free to enter into the computer lab and JECC library. We collected the books called 'JHALAM' which is published by the Kerala water authority, SAWYER MCCARTY PARKIN, "CHEMISTRY for ENVIRONMENTAL ENGINEERING and SCIENCE" fifth edition .K. GOEL,"WATER POLLUTION causes , effects and control", new age international publishers and started to read it. Our next duty is to prepare the report based on the questions that got from Joshy sir related to our subject. That is given as annexure 2, later.

WEEK TWO

Week two is also mend for self study. On this week we got some PPT's from prof. Rathish s and prof. M .G Cyriac, those who worked as engineers in water authority. Our third duty is to prepare a PPT consist of three slides and present it, by referring those PPTs and by watch some videos. We prepared the PPT and presentation. Ready to present it. Some of the videos and PPTs that we watched are, https://www.youtube.com/watch?v=LU6Mwmi49eo –water quality-sampling and analysis, https://www.youtube.com/watch?v=h7uyiNrRIY – how do we test water quality, Bacteriological Analysis of Water- prof. M G Cyriac, coagulation, floculation and filtration- Jolly Thomas. State specific Water quality issues – Remedial measures- prof. M G Cyriac.

WEEK THREE

We started to do our testes on third week. Before going to that we have an interactive session with Cyriac sir, he ask some questions to us and we answered almost, he taught us something more about this subject. That afternoon session was introducing the equipments. The very next day itself we started to do our water quality testing with samples that we brought from our home. With the assistance of Ms Vini, the chemist in the lab we complete testes one by one. The samples that we brought are from different wells, my water sample is from bore well and Bhavya's from open well. Since the samples are from different regions we were able to study deeply.

Fig IV. 1 analysis performance at environment engineering lab at Jyothi

WEEK FOUR

Week four is mainly utilized for report preparation. The entire internship is want to be summarized as a report and preserved as hard copy. Our report is subjected to corrections and changes several times.

V. RESULT AND DISCUSSION

parameters	Drinking water standards as per BIS	BHAVYA	ROSEWIN
PH value	6.5 -8.5	5.3	6.2
Turbidity NTU	5 - 10	3.3	0.4
TDS PPM	500 - 2000	45	160
Hardness mg/l	300 - 600	96	114
Chloride mg/l	250 - 1000	9	25
Alkalinity mg/l	200 - 600	10	70
Iron mg/l	0.3 – 1. 0	0.15	0.18
Manganese mg/l	0.1 – 0.3	0	.05
MPN number	-	150	11
COD mg/l	-	7	9

Table V. 1 result of sample experimented

According to the measurement both samples each water sample has its own identities, Bhavya's water sample is from open well and mine from bore well. So we can understand the facts easily. When we compared to the BIS standard, in the case of both water samples, they are acidic. 1rst sample from open well is little bit acidic.2nd one is almost near to the standard. The reason for this will be discussed later. In the case of turbidity and MPN number bore well shows least. Remaining all other parameters like TDS, Hardness, Chloride, Alkalinity, Iron, Manganese, COD open well shows the least.

Sl no	Problem	Reason	Remarks
1	Turbid	Improper maintenance of well or geogenic problems or other problems	
2	Smell	Do	
3	Black colour	presence of organic matter or other problems	Identify the pollution source and remove
4	Sour taste	Low pH	Site specific conditions
5	Alkaline taste	High pH	Depending on type of source – borewells
6	1)change in color when exposed into the atmosphere 2)excess requirement of milk to prepare tea of required flavor 3)staining in vessels and clothes and bathroom floors 4)decomposition of mud after the water is boiled	Presence of iron	Site specific conditions –more in bore wells
7	1)white deposit on boiling 2)more consumption of soap	hardness	

8	Salty taste	Chloride prsence	Sea water intrusion or geogenic reasons

Table V. 2 Water quality issues and it's remedies (Ref.3)

Prominent water quality problems in Kerala

- Excess bacterial presence
- Excess iron
- Deviation in pH
- Excess turbidity
- Excess fluoride
- Excess chloride
- Presence of pesticides
- Excess conductivity/TDS
- Organic pollution
- Measured BOD/COD
- Excess hardness
- Excess nitrate
- Growth of algae
- Carbonate decomposition

PH

In the case of ph value 60% of sample are having law ph. High ph occurs in limited places. Law ph imparts sour taste and corrosive in nature. It's main reason may be carbon dissolution from the surface of the earth and subsequent chemical reaction. Law ph can be increased by adding any suitable alkaline substances. High ph can be increased by adding acidic substances.

In a shallow well pH will be less but in a deep well or bore well pH will be high. In a deep well hardness, calcium, magnesium ,alkalinity will be more compare to shallow well. Dissolved minerals will also be more in deep water sources.

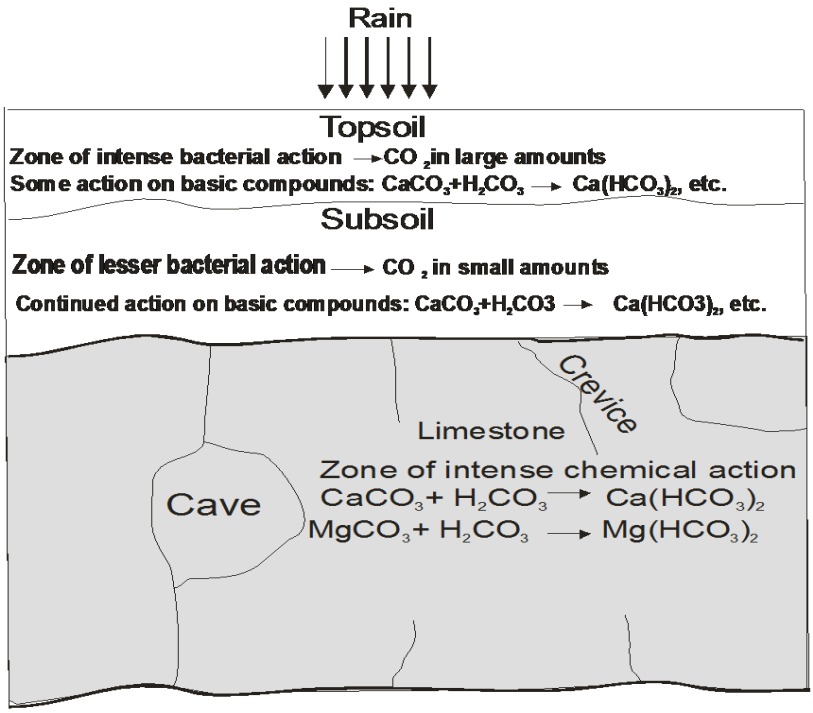


Fig V. 1 chemical changes when water percolates through earth

IRON

Iron constitutes 6% of the earth crust. 3% in soluble Fe2+ form and 3% in insoluble Fe 3+ form. While rain water is percolated through the earth Fe2+ dissolves in the water. Bad effects of iron are, Change in colour when exposed to atmosphere (oxidation of ferrous Iron to ferric Iron), $Fe^{2+} + O_2 + H_2O$ changes to $Fe(OH)_3 + H^+$

Excess requirement of milk to prepare tea of required flavor (Iron +Tannin = black color), Staining in vessels, Deposition of mud after the water is boiled, (More oxidation on heating), Oily appearance on the surface of water.

TREATMENT FOR REMOVAL OF IRON FROM DRINKING WATER

- Increase the pH of water by adding suitable alkaline materials (lime, Soda ash, bleaching powder).
- Aerate the water for oxidation to take place.
- Allow for settling and thereafter for filtering.
- Disinfect to make it potable.

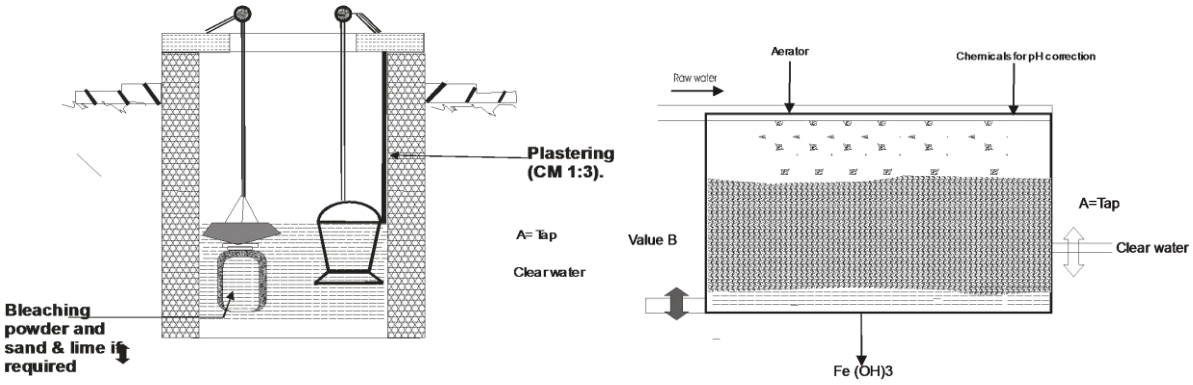


Fig V.2 removal of iron from open well (Ref.2)

HEALTH EFFECTS OF FLUORIDE

Fluoride dissolves from the crust of the earth. Fluoride presence will be more in water sample with less calcium. Ca +F changes to CaF_2 ,In Kerala Alappuzha and Palakkad is mainly affected. Domestic kit using activated Alumina is suitale for removal of Flouride.

Excess consumption of flouride results in to Flourosis. Flourosis are three types

- Dental Flourosis
- Skeletal Flourosis
- Non Skeletal Flourosis

HARDNESS

Hardness is caused by multivalent metallic cations. Deep water sources are generally hard. Calcium and Magnesium are generally causes hardness. If topsoil is thick hardness will be more. Softeners are which remove calcium and magnesium are commonly used for its removal

GROWTH OF ALGAE

In wells water is good in the morning but as sunlight falls color change occurs, it indicates Water sources get polluted. Mainly Algae is water plant which requires sunlight for its growth. Treatment for algae growth is prevention of sunlight, chlorine or copper sulphate.

CARBONATE DEPOSITION

As water percolates through the earth CaCo3 dissolves in water Ca (HCO3)2. H2O+CO2 changes to H2CO3 and Ca (CaCO3+H2CO3) changes to HC03. In deep water sources Ca (HC03)2 will be more and as it is pumped to open areaCO2 starts escaping and CaCO3 starts depositing. Predominant in bore well water.

BACTERIOLOGICAL QUALITY (BIS STANDARDS)

Water in distribution system

a. Throughout any year 95% of samples should not contain any coli form organism in 100 ml.

b. No sample should contain E.Coli in 100 ml.

c. No sample should contain more than 10 coliform organisms per 100 ml.

d. Coliform organisms should not be detectable in 100 ml of any two consecutive samples (Ref.3)

VI. CONCLUSION

The purpose of internship is to increase the experience level, rather than studying. Environmental lab of Jyothi engineering college has the approval of Kerala pollution control board. This internship was great opportunity for us. It's our first experience of doing an internship in a college. As our coordinator said, we build a network here in the college. Using JECC library, computer lab, since we didn't even much used these places.

More over I got the chance to understand the water quality testing, area specific water quality issues, water quality issues in kerala, remedial measures used for it's treatment. It is really a wonderful experience for me to do internship here at Jyothi. All my internship goals are met, through this internship and enjoyed a lot.

Civil is the subject that closely related to nature and I think by doing this internship I can do something to nature in my future. "all of us can't do great things but we can do small things greatly". Hence we still want to understand the importance of water and do at least small things to conserve water, which is the life blood of our planet.

IX. ANNEXURE-1

STATEMENT OF PURPOSE

Why I am interested in doing internship in water quality testing?

Ismail Serageldin said that "The wars of the twenty –first century will be fought over water".Yes, water! The worlds first and foremost medicine is going to be extinct by 'black human hands'.It is our great duty to conserve it for the upcoming generation.

We can do many things in these areas to save water and protect it. Being an engineering student I can go for its technical side like water quality tests and its remedial measures , and it is the reason that I selected the area of water quality testing for my first year internship.

Water quality determines the goodness of water for a particular .Water quality tests will give information about the health of the waterway by testing water a period of time. Observations of water quality mainly refers to concentration of dissolved constituents in water in terms of physical (like turbidity, conductivity), chemical (like sodium, potassium) and biological parameters (like algae, bacteria).Data on water quality requires collection of water sample followed by analysis for specific water quality parameters. Some of this water quality parameters can be measured at site, that is field parameters and the other is analyzed in laboratories.

Hence by testing this quality we can go for its solutions by means of chemical, physical treatments. By testing some samples and realize its fact I think I may be able to determine water quality and it become a new insight to my future.

ANNEXURE-2

REPORT OF WATER QUALITY TESTING

Date: 10-6-2016

Submitted by: ROSEWIN SEBASTIAN, CE, S2

Submitted to: Prof JOSHY JOSEPH, JECC

Subject: 'Report on water quality testing'

"Water has become a highly precious resource. There are some places where a barrel of water costs more than a barrel of oil" this is the statement by the Llyod Anworthy , foreign minister of Canada in a news conference. Water is a basic necessity and also a valuable resource on earth.

In the last three decades, growing water shortage and water pollution in both the developed and developing countries have plunged the world into a water crisis. The world's finite supply of fresh water is being threatened by increasing population, rising standard of living and pollution. Already there are millions of people without access to drinking water and proper sanitation. This would lead to commodification of water which would not serve the purpose.

1 WATERQUALITY STANDARDS AND ORGANISATIONS
Polluted water hardly of any use for most purpose it cannot be utilized for drinking because of its inherent health risk .Water with high salt content is not suitable for agriculture and for most industries. The water which is not suitable for drinking may be good for irrigation or water unsuitable for irrigation may be quite suitable for industrial cooling or fish growth .Thus it can be seen that each use of water has its own limits on the degree of pollution it can accept. Water quality standards or criteria are not a set of static values but are subject to modification as the scientific data get updated and more and more knowledge is gathered.

Characteristics	World Health Organization(WHO)		Ministry of Work and Housing(1975)	
Physico-chemical	Highest desirable	Maximum permissible	Acceptable	Cause of rejection
Turbidity(JTU)	5.0	25.0	2.5	10
Color(pt-scale)	5.0	50.0	5.0	25.0
Taste and odour	nothing	disagreeable	unobjectionable	unobjectionable
pH	7.0-8.5	6.5-9.2	7.0-8.5	6.5-9.2
Total solids	500	1500	500	1500
Total hardness	100	500	200	600

Chlorides	200	600	200	1000
Sulphates (as SO4)	200	400	200	400
Nitrates(as NO3)	45	45	45	45
Detergents(anionic)	0.2	1.0	0.2	1.0
Mineral oil	0.01	0.30	0.01	0.30

To attain the desired water quality objectives, the standards can be applied in two ways. One type, called 'effluent standards', are applicable to the quality of the municipal, agriculture or industrial waste discharge into the water resources and on the land. The other type is 'stream standards' concerned with the water receiving or being affected by the effluents.(Ref.1)

DRINKING WATER STANDARDS

In view of the direct consumption of water by human beings, the domestic water supply is considered to be most critical use of water. In India, agencies like Indian council of Medical Research (ICMR), Bureau of Indian Standards and Ministry of works and Housing have formulated certain drinking water standards which are being followed by different authorities. World Health Organization (WHO) has also laid down drinking water standards which are considered international standards

Bacteriological Standards

W.H.O	Ministry of Works and Housing
(a) Water entering distribution system: if disinfected, coliform count in any sample of 100 ml should be zero (b) Water in the distribution system should meet the requirements below (1) Throughout any year, 95% of the samples examined should not have any coliform organisms . (2) *E.coli* count in 100ml of any sample should be zero (3) Coliform organisms not more than 10 per 100ml shall be present in any sample.	(a) coliform count in any sample of 100ml should be zero (b) water in the distribution system shall satisfy all the three below (1) *E.coli* count in 100ml of any sample should be zero (2) Coliform not more than 10/100 ml shall be present in any sample (3) Coliform organisms should not be detectable in 100ml of any two consecutive samples of more than 50% of the sample collected for the year.

STREAM STANDARDS

Water quality objectives for fresh waters take into account several major uses to which water is put like irrigation, drinking, industry, power generation, recreation and even for discharging waste waters together with the fact that all water bodies or stretches are not necessarily required to meet all potential uses.

The water resources can be classified or zoned depending upon the designated best use of the water. The central pollution control board along with state pollution control boards has adopted a scheme of classification of water bodies. The water quality criteria for this classification is given below

WATER QUALITY CRITERIA FOR FRESH WATER CLASSIFICATION (CPCB 1979)

Classes	Criteria
Class A	Dissolved oxygen(minimum 6mg/L),BOD(maximum 2mg/L),MPN of coliforms per 100 mL(maximum 50) ,PH (6.5-8.5)
Class B	DO(minimum 5mg/L), BOD (maximum3mg/L), MPN of coliform per 100mL(maximum 500),PH(6.5-8.5)
Class C	DO(minimum4mg/L),BOD(maximum3mg/L),MPN of coliform per 100Ml(maximum 5000),PH(6.0-9.0)
	SIMILARLY DIFFERENT CLASSES ARE THERE

EFFLUENT STANDARDS

The effluent standards pertain to the quality of waste waters originating from community, agricultural operations and industries. In general they restrict the quantity of pollutants in that water.

For ex: BOD level should be 30 for inland surface water ,350 for public sewers,100 for land for irrigation &100 for Marine coastal areas

COD level should be 250 for inland surface water& 250 for marine coastal areas. All these are in mg/l.

MINIMAL NATIONAL STANDARDS(MINAS) is applicable to lndustrial effluents . This envisages the treatment of all waste waters to certain minimum standards irrespective of type and location.

2 IMPACT OF WATER QUALITY PARAMETERS

1) **DISSOLVED OXYGEN**

Dissolved oxygen is oxygen that is dissolved in water. Fish and aquatic animals cannot split oxygen from water (H2O) or other oxygen-containing compounds. Only green plants and some bacteria can do that through photosynthesis and similar processes. If water is too warm, there may not be enough oxygen in it. When there are too many bacteria or aquatic animal in the area, they may overpopulate, using DO in great amounts. Oxygen levels also can be reduced through over fertilization of water plants by run-off from farm fields containing phosphates and nitrates. How much DO an aquatic organism needs depends upon its species, its physical state, water temperature, pollutants present, and more. Consequently, it's impossible to accurately predict minimum DO levels for specific fish and aquatic animals. Numerous scientific studies suggest that 4-5 parts per million (ppm) of DO is the minimum amount that will support a large, diverse fish population. The DO level in good fishing waters generally averages about 9.0 parts per million.

IMPACTS OF DISSOLVED OXYGEN

A high DO level in a community water supply is good because it makes drinking water taste better. However, high DO levels speed up corrosion in water pipes. For this reason, industries use water with the least possible amount of dissolved oxygen. Water used in very low pressure boilers have no more than 2.0 ppm of DO, but most boiler plant operators try to keep oxygen levels to 0.007 ppm or less.

2)PH

The balance of positive hydrogen ions (H^+) and negative hydroxide ions (OH^-) in water determines how acidic or basic the water is. In a lake or pond, the water's pH is affected by its age and the chemicals discharged by communities and industries.

Synergistic Effects of pH

Synergy is the process whereby two or more substances combine and produce effects greater than their sum. When acid waters (waters with low pH values) come into contact with certain chemicals and metals, they often make them more toxic than normal. The pH of sea (salt) water is not as vulnerable as fresh water's pH to acid wastes. This is because the different salts in sea water tend to buffer the water with Alka-Seltzer-like ingredients. . Many shellfish and algae are more sensitive than fish to large changes in pH, so they need the sea's relatively stable pH environment to survive.

3)TEMPERATURE

1. The color of the water. Most heat warming surface waters comes from the sun, so waterways with dark-colored water, or those with dark muddy bottoms, absorb heat best.
2. The depth of the water. Deep waters usually are colder than shallow waters simply because they require more time to warm up.
3. The latitude of the waterway. Lakes and rivers in cold climates are naturally colder than those in warm climates.

   Fish and most aquatic organisms are cold-blooded. Consequently, their metabolism increases as the water warms and decreases as it cools. Each species of aquatic organism has its own optimum (best) water temperature. If the water temperature shifts too far from the optimum, the organism suffers. Cold-blooded animals can't survive temperatures below 0 ^oC (32 ^oF), and only rough fish like carp can tolerate temperatures much warmer than about

36^{o}C (97 ^{o}F). Fish can regulate their environment somewhat by swimming into water where temperatures are close to their requirements. Fish usually are attracted to warm water during the fall, winter and spring and to cool water in the summer.

4) TURBIDITY

Light's ability to pass through water depends on how much suspended material is present. Turbidity may be caused when light is blocked by large amounts of silt, microorganisms, plant fibers, sawdust, wood ashes, chemicals and coal dust. Any substance that makes water cloudy will cause turbidity. The most frequent causes of turbidity in lakes and rivers are plankton and soil erosion from logging, mining, and dredging operations.

Turbidity effects fish and aquatic life by:

Interference with sunlight penetration. Water plants need light for photosynthesis. If suspended particles block out light, photosynthesis—and the production of oxygen for fish and aquatic life—will be reduced. If light levels get too low, photosynthesis may stop altogether and algae will die. It's important to realize conditions that reduce photosynthesis in plant result in lower oxygen concentrations and large carbon dioxide concentrations. Respiration is the opposite of photosynthesis. Fish can't see very well in turbid water and so may have difficulty finding food. On the other hand, turbid water may make it easier for fish to hide from predators.

5) BOD

The Biological Oxygen Demand, or BOD, is the amount of oxygen consumed by bacteria in the decomposition of organic material. It also includes the oxygen required for the oxidation of various chemical in the water, such as sulfides, ferrous iron and ammonia. While a dissolved oxygen test tells us how much oxygen is available, a BOD test tells us how much oxygen is being consumed.

BOD is determined by measuring the dissolved oxygen level in a freshly collected sample and comparing it to the dissolved oxygen level in a sample that was collected at the same time but comparing it to the dissolved oxygen level in a sample that was collected at the same time but incubated under specific conditions for a certain number of days. The difference in the oxygen readings between the two samples in the BOD is recorded in units of mg/L. Unpolluted, natural waters should have a BOD of 5 mg/L or less. Raw sewage may have BOD levels ranging from 150 – 300 mg/L.

6) COD

The chemical oxygen demand, or COD, is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. For samples from a specific source, COD can be related empirically to BOD, organic carbon, or organic matter. The test is useful for monitoring and control after correlation has been established. Oxidation of most organic compounds is 95 to 100 percent of the theoretical value. Ammonia, present either in the waste or liberated from nitrogen-containing organic matter, is not oxidized in the absence of significant concentration of free chloride ions.

7) ALKALINITY

Alkalinity is not a pollutant. It is a total measure of the substances in water that have "acid-neutralizing" ability. Alkalinity is important for fish and aquatic life because it protects or buffers

against pH changes (keeps the pH fairly constant) and makes water less vulnerable to acid rain. The main sources of natural alkalinity are rocks, which contain carbonate, bicarbonate, and hydroxide compounds. Borates, silicates, and phosphates may also contribute to alkalinity.

Limestone is rich in carbonates, so waters flowing through limestone regions generally high alkalinity — hence its good buffering capacity. Conversely, granite does not have minerals that contribute to alkalinity. Therefore, areas rich in granite have low alkalinity and poor buffering capacity.

Chloride, fluoride, Iron and manganese, sulfate, phosphorus and phosphate etc are the other major parameters that have to be determined.

3 WATER QUALITY TESTING

Water quality testing consist of different areas like sampling, laboratory apparatus and reagents, different type of equipments, various type of analysis etc.

(a)SAMPLING

It is an axiom that analytical results obtained in the laboratory can never be reliable than the sample upon which the tests are performed. The subject of sample collection and care of samples is treated quite adequately in "Standard Methods" but additional emphasis is felt to be useful on the subject of *grab* verses *composited* samples.

Grab samples are those taken more or less instantaneously and analyzed separately. The most of the sampling is of grab variety. The number of samples vary from one to over a hundred per day depending upon the nature of the material to be sampled.

Composited samples are used mainly in evaluating the efficiency of waste water treatment facilities, where average treatments are adequate. Such samples are collected at regular intervals, and pooled into one large sample over a 24-h period.

(b)LABORATORY APPARATUS AND REAGENTS

A good grade of laboratory apparatus is adequate for all practical uses. Pyrex or a similar glassware of low coefficient of expansion is highly recommended. Reagents should be of analytical-reagent grade or known to meet the specifications of purity established by the American Chemical Society.

(c) DIFFERENT PROSES OF ANALYSIS

Precipitation: some analytical methods depend upon precipitation of an ion to allow its separation and measurement by actual weighing of the precipitated material

Filtration: filtration of precipitates or solids is accomplished by means of paper, membrane, or glass fiber filters.

Drying or Ignition: There are two standard temperatures used for drying residues and solids; one is 103 degree C and the other is 180 degree C.

Desiccation: following drying or ignition operations, the residues and their containers (crucibles, evaporating dishes, or filters) must be cooled to room temperatures before weighing on the analytical balance. If such cooling where allow to take place in the open air, moisture would be picked up from the residue and the container.

(d) INSTUMENTS

Analytical Balance

The care of such instruments cannot be stressed too much. It is important to recognize that analytical balances fall into the realm of *delicate* instruments and that great care and scrupulous cleanliness must be maintained with respect to both the balance and weights used .Automatic analytical balance is the most practical device for modern laboratories.

PH meter

A ph meter is a scientific instrument that measures hydrogen ion concentration (or PH) in a solution, indicating its acidity or alkalinity. The ph meter measures the difference in electrical potential between a ph electrode and a reference electrode , usually it is glass electrode plus a calomel electrode .(Ref.4)

(e) WATER QUALITY TESTS

Physical tests

Colour in water may be caused by the presence of minerals such as iron and manganese or by substances of vegetable origin such as algae and weeds. Colour tests indicate the efficacy of the water treatment system.

Turbidity in water is because of suspended solids and colloidal matter. It may be due to eroded soil caused by dredging or due to the growth of micro-organisms. High turbidity makes filtration expensive. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection.

Odour and taste are associated with the presence of living microscopic organisms; or decaying organic matter including weeds, algae; or industrial wastes containing ammonia, phenols, halogens, hydrocarbons. This taste is imparted to fish, rendering them unpalatable. While chlorination dilutes odour and taste caused by some contaminants, it generates a foul odour itself when added to waters polluted with detergents, algae and some other wastes.

Chemical tests

pH is a measure of hydrogen ion concentration. It is an indicator of relative acidity or alkalinity of water. Values of 9.5 and above indicate high alkalinity while values of 3 and below indicate acidity. Low pH values help in effective chlorination but cause problems with corrosion. Values below 4 generally do not support living organisms in the marine environment. Drinking water should have a pH between 6.5 and 8.5. Harbour basin water can vary between 6 and 9.

B.O.D.: It denotes the amount of oxygen needed by micro-organisms for stabilization of decomposable organic matter under aerobic conditions. High B.O.D. means that there is less of oxygen to support life and indicates organic pollution.

Bacteriological tests

It generally check for indicator bacteria(for ex: total coliform, *Escherichia coli*,) and can indicate the presence or absence of disease-causing bacteria. there are many type of bacteriological tests that cover a variety of bacteria.

Mineral tests

It can determine if the mineral content of water is high enough to affect either health or the aesthetic and cleaning capacities of water. A mineral test may include calcium, magnesium, manganese, iron, copper etc

(F) WATER QUALITY ANALYSIS

Different types of analysis are

1) Gravimetric analysis
2) Volumetric analysis
3) Colorimetry
4) Optical methods of analysis

   (a) absorption methods

   Ultraviolet spectroscopy, Infrared spectroscopy

   (b)Emission methods

   Atomic emission spectroscopy, Atomic absorption spectroscopy, Inductively coupled plasma spectroscopy.

5) Electrical methods of analysis

   Potentiometric analysis, gas electrode, metel electrode, glass electrode, membrane electrode etc are come under this category.

6) Chromatographic methods of analysis

   Gas chromatography, High- performance liquid chromatography, Ion chromatography etc come under this category.

7) Other instrumental methods

   Mass spectroscopy, x-ray analysis, NMR spectroscopy, radioactivity measurements etc included in this.

   By acquiring this knowledge, we can test the water quality and go for its remedies (Ref.4)

X. REFERENCES

1. P.K. Goel (1997).*Water pollution-Causes, Effects and control, New* Age International Publishers, New Delhi.

2. Kerala water authority. *Jhalam*, CCDU Publishers.

3. *PPTs,Papers* from Prof.S.Rathish, Prof.M.G.Cyriac

4. Sawyer,C.N and M.C. Carty (1978).*Chemistry for environmental engineering*,M.C.Graw,Hill book company,Tokyo

5. https://www.youtube.com/watch?v=LU6Mwmi49eo – *Water quality-Sampling and analysis*

6. https://www.youtube.com/watch?v=h7uyi_NrR1Y- *How do we test water quality?*

7. https://www.youtube.com/watch?v=h3DvCCifdr0- *An introduction to water quality testing*