

Chapter one

Introduction

Introduction

Water quality refers to measurement of some constituents in water. It is directly related to health of people. Evaluation of water quality is done by chemical, physical, microbial and radiological analysis.

In this research two samples were collected from two location Dar Almazeed village in each. Contamination of water with iron in one of the major problem facing water quality specially ground water. Many wells in different area in Sudan have a high iron content some of them the concentration exceed the permissible levels. Other have a high concentration which reach up to 15 ppm.

Although it is known that and according of international standards the maximum permissible level for iron is 0.3 ppm, this reflect importance of having a regular analysis and records for all water wells servicing people.

Chapter two

Literature review

2.1 Introduction:

Water is an odorless ,tasteless and colorless liquid made up of combination of hydrogen and oxygen

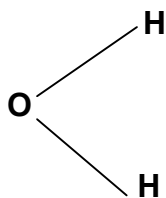
Water which forms rains, moisture, snow, streams, lakes and seas. It occurs in a large quantities in the hydrosphere , atmosphere and lithosphere . And have different states (liquid, solid and gas) and it is natural solvent.

Water is of major importance to all living things and essential raw material for life⁽¹⁾.

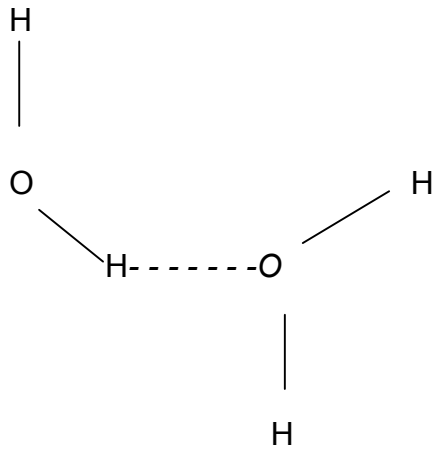
2.2 Chemistry of water:

The structure of water is an important in controlling the chemistry of ground water because it is influence on the solubility of solid and organic liquid.

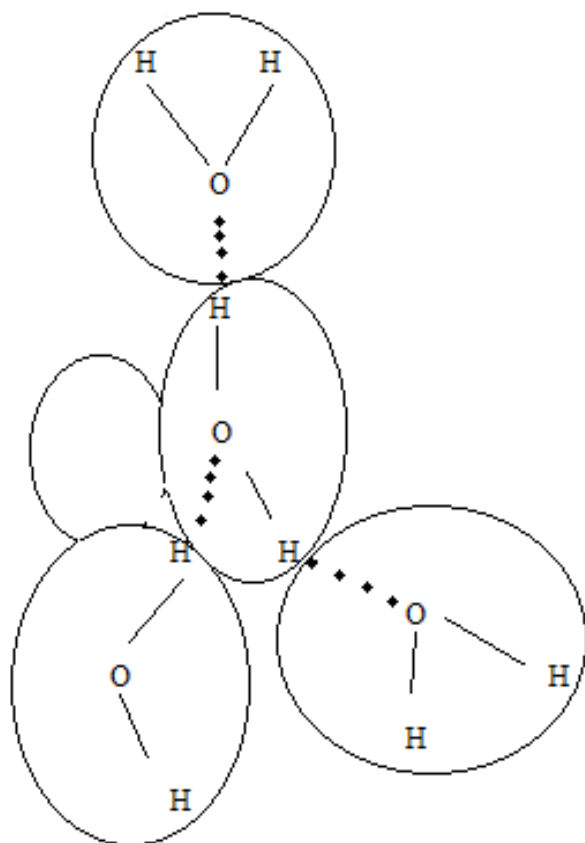
The water molecule is compose of two hydrogen atoms and on oxygen atom, Shared electrons form covalent bond between hydrogen atoms are located symmetrically with respect to the oxygen atom , Because of this structure and covalent bonding ;the electrical center of the negative charges (electrons) have different location than positive charges . This separation make the molecule is Polar I n terms of electrical charge.



The water molecules are joined in a series of hydrogen bonds formed by electrostatic interaction between hydrogen atoms and oxygen atom.

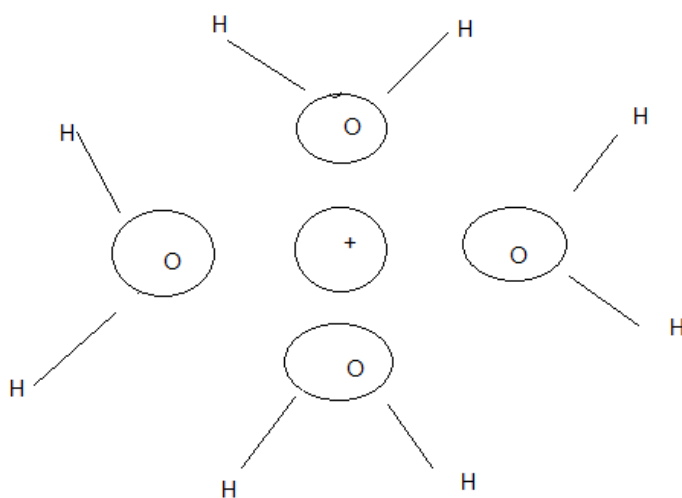


As result of this interaction the water molecules formed octahedral network creating a series of large molecules. And this structure explains some characteristics of water such as freezing point and boiling point.



The structure also contributes to the relative solubility of electrolytes and insolubility of non-electrolytes in aqueous. And the advantages for charges species to be accommodated in water structure overcoming the energy that tends to keep atoms in the solid or another liquid. In water charged species force rearrangement .The water molecules immediately adjacent bind to the charged specie like this

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In the case of non-polar organic molecule energetically more favorable for mass to remain in an organic liquid rather than the aqueous solution⁽¹⁾.

2.3 Anomalous properties of water

The most common physical properties of water that water is a liquid at room temperature, and normal atmospheric pressure. A surprising property of water because almost another compound with similar molar mass to water (18 g/mole) are gases under similar conditions of temperature and pressure like N_2 and O_2 . All these have molar mass lower than water but found in gaseous state.

Solubility (ionic /covalent) (bonding /nonbonding), high surface tension, high latent heat of vaporization, high specific heat and low vapor pressure⁽¹⁾.

2.4 Uses of water

Domestic (drinking, cooking, and sanitation).

Agriculture (plants, animals).

Industry (raw material, dissolution, transport, medium, washing, cooling)⁽²⁾.

2.5 Sources of water

Water that can be made suitable for drinking comes from either surface water or ground water

Surface water ; water from lakes, rivers and reservoirs frequently contains substance that must be removed before it can be used as the drinking water

Ground water ; water pumped from wells that have been drilled into underground aquifers is usually free from harmful contamination⁽²⁾.

2.6 The significance of various substance found in water :

2.6.1 Acidity

Acid water is one which has pH value less than 7. The most causes of acidity are free carbon dioxide in the water ,organic matter , sulphates which occurs when rain falls through polluted industrial atmosphere or when ground water flow through soils having high sulphate content and some contain iron-bearing formation. Sulfuric acid is produce in the water as a result.

Some treatment processes, notably the use aluminum sulphate as coagulate make water acid . For any treatment works the aim should be to correct the acidity of water and make the pH value slightly above 7.

2.6.2 Alkalinity

Alkalinity of water is due to presence of bicarbonates, carbonates, hydroxides of calcium, magnesium, potassium and sodium. The term alkalinity describes the total amount of those substances which are present in water.

Calcium and magnesium bicarbonate cause temporary hardness and when the hardness is greater.

Than alkalinity this make permanent hardness . The alkalinity of many water 100 -200 ppm.

2.6.3 Aluminum

Not found in natural waters in detectable amount but it may be enter a water from the use of aluminum tanks or pipes. And from over dosing of aluminum sulphate in water supply treatment and the effluent should not contain more than 0.15 ppm⁽³⁾.

2.6.4 Ammonia compounds

There are two main compounds (i) free ammonia called ammoniac ammonia. (ii) albuminoidal ammonia.

When the animal and vegetable matter decays ammonia is produce hence most waters contain at least trace of ammonia⁽³⁾.

2.6.5 Arsenic

Is a poison which should not be present to detectable amount in any water supply. It can enter to water from the use of arsenical sprays for weed killing or arsenic solution for sheep dipping⁽³⁾.

2.6.6 Bromine

Sea water contains 50 to 60 ppm ,and some wells contains 2.2ppm. It is not toxic substance in quantities present in water supply⁽³⁾.

2.6.7 calcium

present in water as bicarbonate which is soluble in water and cause water hardness. And also found as sulphate and carbonate⁽³⁾.

2.6.8 carbon dioxide (CO₂)

Free carbon dioxide existing in combination with calcium and magnesium is much important as regarded the corrosive property of water. It is the main causes of acid water. Free CO₂ content up to 10ppm not cause corrosive of water but higher than 20ppm make water corrosive⁽³⁾.

2.6.9 Chlorides

Sodium chloride, calcium chloride and magnesium chloride are present in small quantity in some water but in large quantity in sea water. The amount of sodium chloride present 1.5 times of chloride⁽³⁾.

2.6.10 Chlorine

Is sterilizing gas added to water. The maximum amount of free chlorine which permitted to remain in water depend upon the taste, odor and corrosion that may result. The residual free chlorine content up to 0.20ppm⁽³⁾.

2.6.11 Copper

Copper is rarely found in natural waters. But it may in a water supply from use of copper piping or from the dosing of an impounding reservoir with copper sulphate for reduction of algae growths. Water put in distribution system should not contain more than 0.05ppm⁽³⁾.

2.6.12 Fluorine

It is known that dental decay in children can be reduced by drinking water which contains about 1ppm of fluorine. Excessive quantities of fluorine are toxic⁽³⁾.

2.6.13 Lead

Is accumulation poison and not more than 0.1ppm should exist in a water as drawn from the consumer's tap; preferably none should be detected⁽³⁾.

2.6.14 Iodine

Natural waters contain only trace amount of iodine, but this small amount is beneficial to consumers if their diet is over otherwise deficient iodine. Goiter is believed to be an iodine deficiency disease and addition of iodine in some causes give benefit to goiter sufferers⁽³⁾.

2.6.15 Iron

Is frequently found in raw waters and trace usually found in all waters delivered to the consumers when the water has been in contact with iron pipes. When iron is present above a certain amount it makes water unpalatable, imparting a bitter taste to the water when present in large amounts and makes a precipitate when iron is present with oxygen and causes brown stains upon laundry and sinks. Iron can be picked up from many underground formations and when water contains iron ions it is often corrosive. Treatment for iron removal is likely to be necessary when the amount of iron exceeds 0.3ppm⁽³⁾.

2.6.16 Biochemical oxygen demand (B.O.D)

It is measured because it is used as an indicator to the degree of pollution. When organic matter is broken down by biological organisms, it uses up oxygen from the water; so that the oxygen deficiency when high B.O.D. indicates high pollution and destroys fish and plants⁽³⁾.

2.6.17 Magnesium

Magnesium bicarbonate causes temporary hardness in water. The cause of magnesium compounds is much less than the proportion caused by calcium compounds⁽³⁾.

2.6.18 Manganese

Is often associated with iron in water, have the same behavior except that the deposits are accumulative. High quantities of manganese are toxic. Both in land and well waters can contain troublesome amounts of manganese. In general, less amount of manganese can be correlated than iron because the deposition of manganese is slow. And the limits from 0.2 to 0.3ppm⁽³⁾.

2.6.19 Nitrates and nitrites

Causes when organic matter decays. Nitrites appear less than nitrates in water. A deep well water.

Contain about 5ppm and nitrates derived from soil vegetation. But in surface supply or shallow well contain 20ppm⁽³⁾.

2.6.20 Organic matter

Come from plants and animal life the taste for ammonia or nitrates or nitrite are indicate the present of organic matter in water⁽³⁾.

2.6.21 phenols

Are substances in water which originate from trade wasted and creosoted surfaces. There present even in minute quantities of 0.001ppm can make widespread complaints from consumer⁽³⁾.

2.6.22 phosphate

Come from oxidation of phosphorus originating in vegetable and organic matter or from certain rocks⁽³⁾.

2.6.23 Potassium

Potassium phosphate and potassium sulphate are forms of potassium in water⁽³⁾.

2.6.24 silica

Found up to 40ppm as SiO₂ in hard water and in rivers from d5 to 20 ppm⁽³⁾.

2.6.25 Sodium

sodium chloride is usually taken to be evidence of pollution by sea water if quantities found exceeds the normal amount to be expected. When the water come from non dangerous supply source it may be up to 1400ppm⁽³⁾.

2.6.26 Zinc

Is very rarely present in natural water. But not rare in water when it is drawn at consumers taps because of the use of galvanized iron piping and tanks. Zinc dose not exist in water consumed excess than 15ppm⁽³⁾.

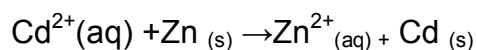
2.7 Chemistry of cadmium

Cadmium is a metallic element with atomic number 48 and relative atomic mass 112.41 . In its pure form it's silver white metal and relatively soft .

Cadmium is most often present in nature as complex oxides, sulphides and carbonate in zinc, lead and copper ores and is very rarely present in the elemental form.

Cadmium is obtained during the distillation of crude zinc. It also present as its ions in the zinc sulphate solution from which zinc is obtain by electrolysis; but since cadmium has less negative electrode potential than zinc, it can be obtained by electrolytic method before any zinc is deposited by careful control of voltage used across the cell⁽⁴⁾.

Or by displaced from the same solution by addition of zinc



2.7.1 properties and uses of cadmium

Cadmium is white lustrous metal ,soft and more malleable and ductile. It is reactive and when exposed to moist air for any length of time protective layer is formed on their surface; and this is the oxide initially but over period of time the basic carbonate is formed.

About 60 percent of total output of cadmium is used for coating iron and steel. And used in the manufacture of cadmium-nickel alkaline storage batteries which is used in alloys⁽⁴⁾.

2.7.2 Compounds of cadmium

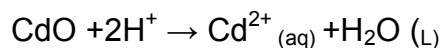
Cadmium exhibit an oxidation state (+2) aqueous solution of it is salts contain $\text{Cd}(\text{H}_2\text{O})_4^{2+}$ ion. And it is colorless since a full complement of d-electrons is present. There is some evidence suggest the existence of (+1) cadmium compounds e.g the Cd^{2+} ion is analogous to the Hg^{2+} ion has been claimed to exist but it is unstable in the present of water⁽⁴⁾.

Cadmium (II) compound

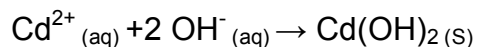
Cadmium oxide (CdO): this oxide obtain by burning the metal in air or by the thermal decomposition of carbonate or nitrate



It is brown solid .this oxide readily react with dilute acid to give salts

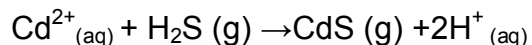


Cadmium hydroxide $\text{Cd}(\text{OH})_2$: obtain as gelatinous white solid when sodium hydroxide solution is add to aqueous solution of cadmium



And this hydroxide is exclusively a basic hydroxide and dissolve in aqueous solution of ammonia with formation of amine complex

Cadmium sulphide (CdS) : precipitated when hydrogen sulphide is passed through aqueous solution of cadmium salt



It is yellow and dissolved when the concentration of acid is increase CdS is used as brilliant and permanent yellow pigment

Cadmium chloride CdCl_2 : obtain by reacting the appropriate oxide, hydroxide or carbonate with the dilute hydrochloric acid; partial evaporation followed by crystallization result in the separation of white hydrated chloride

Cadmium sulphate $\text{CdSO}_4 \cdot 8/3 \text{H}_2\text{O}$: obtain by reacting the appropriate oxide or hydroxide or carbonate with dilute sulphuric acid followed by partial evaporation and crystallization. Isomorphous double salt of this type $\text{K}_2\text{SO}_4 \cdot \text{CdSO}_4 \cdot 6\text{H}_2\text{O}$ are known.

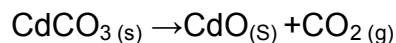
Cadmium nitrate $\text{Cd}(\text{NO}_3)_2 \cdot \text{XH}_2\text{O}$: obtain by reacting oxide or hydroxide or carbonate with dilute nitric acid followed by partial evaporation and crystallization. When heating this nitrate will decompose



Cadmium carbonate CdCO_3 : precipitate when sodium hydroxide solution is add to aqueous solution of the metallic salt



And this readily decompose in to the metallic oxide and carbon dioxide on heating



Some complexes containing cadmium

The majority of the complexes of cadmium have coordination number of 4 and the simple hydrated ions $[\text{Cd}(\text{H}_2\text{O})_4]^{2+}$ and this complex is poisonous to all living matter. Another example $[\text{Cd}(\text{NH}_3)_4]^{2+}$, $[\text{Cd}(\text{CN})_4]^{2-}$, $[\text{CdCl}_4]^{(4)}$.

2.8 effect of cadmium on human health

Cadmium mainly accumulate in the liver and kidney and this make kidney damage. Also cause high blood pressure. Replaces zinc biochemically. Interact with calcium metabolism and can make low calcium level. And distraction of testicular tissue and red blood cell toxicity to aquatic bacota . finally it is carcinogenic⁽¹¹⁾.

2. 9 Iron

2.9.1. Introduction

Iron is the second most abundant metal after aluminum and the fourth most abundant element in the earth's crust. The earth's ore is believed to consist mainly of iron and nickel and occurrence of iron meteorites suggests that it is abundant throughout the solar system. The major iron ore hematite (Fe_2O_3), magnetite (Fe_3O_4), limonite ($\text{FeO}(\text{OH})$) and siderite (FeCO_3).

Because of its high abundance iron is often found as an impurity in other materials. for example corundum (r. Al_2O_3) and its colors are caused by small of Fe^{IV} .

Chemically pure Fe can be prepared by reduction of pure iron oxide (which is obtained by thermal decomposition of iron (II) oxalate or carbonate or nitrate) with H_2 by electrodeposition from aqueous solutions of Fe salts. Or by thermal decomposition of $\text{Fe}(\text{CO})_5^{(4)}$.

2.9.2. Physical properties of Iron:

Boiling point	2887 ⁰ c
Density	7.87
Boiling point	3134 K
Heat of fusion	13.18
Het of vaporization	340
Molar heat capacity	25.10 S/mole
Oxidation stat	{1}2,3,4,5,6,-7,-2
Electro negativity	1.83
Thermal conduction	80.4 V
Crystal structure	low spin 132 ± 3 , 152 ± 6 high spin ⁽⁴⁾ .

2.9.3. properties and uses of Iron:

Pure iron is a silvery colored metal with a melting point of 1540 °c it is easily magnetized when placed inside a coil carrying an electric current but loses its magnetism when the current is switched off. A number of nonmetals combine with it on heating. e.g. Oxygen forming iron (III) oxide Fe₂O₃ but in the passive form iron is coated with a layer of magnetism oxide of iron Fe₂O₃. Pure iron dose not corrode significantly of ordinary temperature when exposed either to action of dry air or air- free water. water result in the formation of rust . At red heat iron is attacked by steam with the formation of magnetic oxide of iron and hydrogen.



Pure iron is soft but is unobtainable by smelting the material is significantly harder and strength by impurities from the smelting process.

Iron chemical compounds , which include ferrous and ferric compounds have many uses iron oxide mixed with aluminum powder can be ignited to create a thermiterc action , used in welding and purifying ores. It forms binary compounds with halogens⁽⁴⁾.

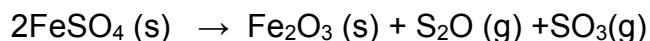
Iron compounds:-

Iron (VI)compounds :

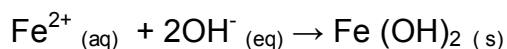
The ferrate (VI) iron FeO_4^{2-} containing iron in the +6 oxidation state potassium ferrate (VI) K₂FeO₄ can be obtained by fusing mixture of iron filing and potassium nitrate (oxidizing agent).

Iron(III)compounds

Iron(III) oxide Fe₂O₃: Occurs naturally as hematite. And by heating Fe(OH₃) or FeSO₄ (s)



Iron (III) hydroxide Fe₂O₃.xH₂O: As a green gelatinous precipitate by adding sodium hydroxide solution to an aqueous solution containing Iron II ions

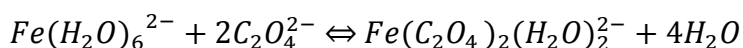


Iron (II) compounds

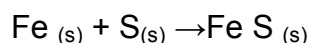
Iron (II) sulphate FeSO_4 : Produced by the action of dilute sulphuric acid on iron .

Iron (II) ammonium sulphate $\text{FeSO}_4(\text{NH}_4)_2 \cdot \text{SO}_4 \cdot 6\text{H}_2\text{O}$: (double Salt) obtained by crystallizing a solution sulphate containing equivalent amounts of iron (II) sulphate and ammonium sulphate.

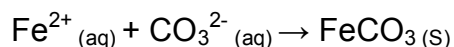
Iron(II) oxalate $\text{Fe C}_2\text{O}_4$: Is a lemon colored. Due to iron (II) oxalate complex the colored by yellow⁽⁴⁾.



Iron II sulphate Fe S : Obtain by heating mixture of iron with sulfur



Iron (II) Carbonate Fe CO_3 : Occurs naturally as the ore siderite



2.9.4 Important role of Iron:

Iron plays an important role in biology forming complexes with molecular oxygen in hemoglobin and myoglobin these two compounds are common oxygen transport proteins in vertebrates .

Iron is also a metal used at the active site of many important redox enzymes dealing with cellular oxidation and reduction in plants and animals⁽⁴⁾.

2.9.5. levels iron in water :

The medium iron concentration in rivers has been reported to be 0.7 mg/L . In anaerobic ground water where iron is in the form of iron II concentration usually be 0.5 – 10 mg/ L but concentration up to 50mg/L sometimes be found . Concentration of iron in

drinking water from WHO must not exceed than 0.3ppm but may be higher in countries use iron salt as coagulation agents in water treatment plants⁽⁵⁾.

2.9.6. Iron problem

Groundwater is of a favored some of potable water supplies in rural areas in developing countries because it is generally regarded as unpolluted and can be safely consumed without the need for treatment .

In many rural condition simple well- hand pump systems are use to water . in such circumstances treatment is avoided wherever possible because of the practicalities and costs involved. However ground water may had other properties which can indirectly affect health of people and water use.

Iron in rural ground water supplies is a common problem (concentration rang 0 – 50 mg/L – WHO recommended < 0.3mg/L). the iron occurs naturally in the aquifer but levels in the ground water can be increased by dissolution of ferrous borehole and hand pump composition.

Iron bearing ground waters are often noticeably orange in color, causing discoloration of laundry and have an unpleasant taste which is apparent in drinking and food preparation⁽⁶⁾.

2.9.7 . the process of biological – enhanced iron removal

Chemical iron removal

Iron is removed from ground water by creating a strongly oxidation environment. this usually achieved by aeration or addition of oxidants such as chlorine or by raising the pH of water using alkaline materials such as limestone. Soluble ferrous ion is oxidized to ferric ion which is subsequently forms a precipitate of ferric hydroxide which may then be removed by filtration .

This technology has been successfully adopted to treated ground waters around the world for many decades .

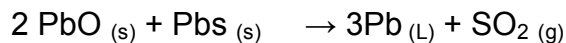
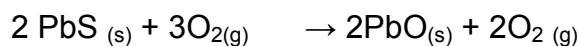
Biological iron removal filters have been promoted an alternative to the traditional chemical approach. Certain bacteria are capable of oxidizing and immobilising iron. the bacteria responsible for the process appear to be natural inhabitants of the well environment and therefore the microorganisms necessary to initial the process are carried with the ground water on to the filters. The active pollution of iron – oxidizers , which requires aeration in order to stimulate its growth , grows on the surface of the filter bed in the form of a slimy orange mat. It is within this zone of bacterial activity that iron removed process appears to occur. Proponents of biological iron removed claim that this biologically enhanced process is more efficient than the chemical process⁽⁶⁾.

2.10 Chemistry of lead:

Lead is oldest metals known , the chemical symbol of the element come from Latin name (plumbum), lead was used in ancient Egypt for glazing pottery (7000 - 5000 Bc), the hanging gardens of Babylon were floored with sheet lead to retain moisture and the Romans used lead extensively for water pipes and plumbing.

Lead is now recognized as a poison heavy metal. Because it complexes with oxo-groups in enzymes.

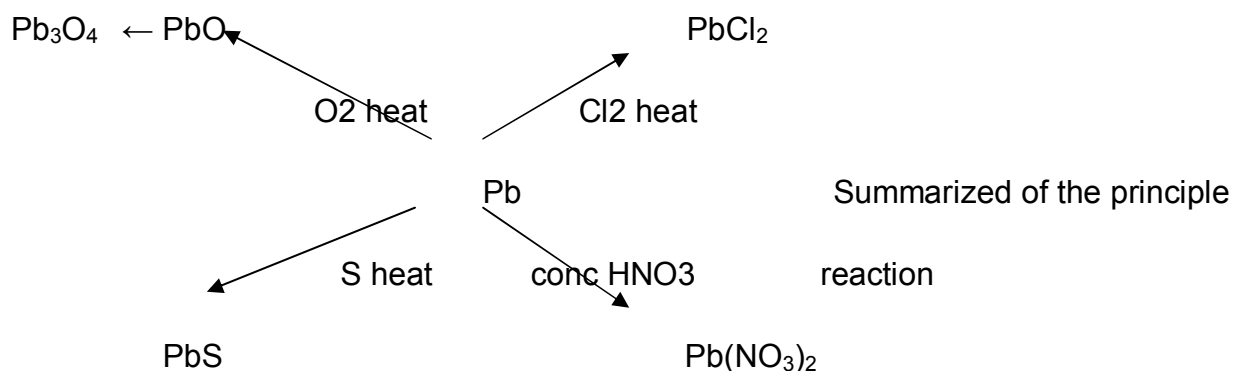
Lead occurs as galena PbS , often in association with zinc blende ZnS in candy and broken hill in Australia which is that reduced to the metal either by further reduction with galena or with coke



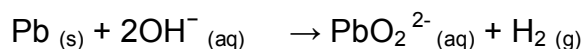
Crude lead is further treated by various processes to remove copper silver , gold, antimony and arsenic⁽⁹⁾.

2.10.1 Properties of lead:

Lead is a very soft metal the principle reaction tends to form covalent compounds since its two electrons are rather inert (the inert pair effect).



The low solubility of PbCl_2 limits the reaction. Hot concentrated alkalis attack the element and form plumbate (II) in which it is covalent⁽⁹⁾.



2.10.2 The structure of lead:

Lead exists in one form which is metallic in nature. The change over from non-metallic to metallic nature with increasing atomic number is thus reflected in the structures of the group 4B element⁽⁹⁾.

2.10.3 Compounds of lead:

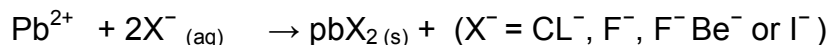
Lead is predominately 2-valent and here the 4-valent state tends to be strongly oxidizing⁽⁹⁾.

The halides of lead

Lead forms a tetra fluoride and tetra chloride the former is a solid and appreciably ionic, $\text{Pb}^{4+}(\text{F}^-)_4$, while the latter is a covalent liquid, PbCl_4 and chlorine.

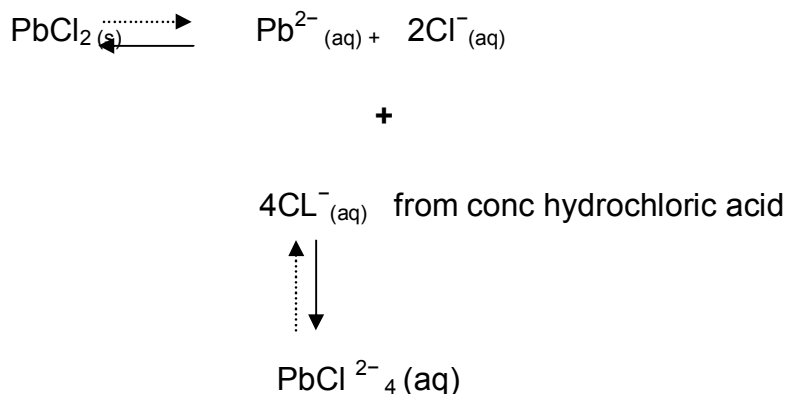
The tetra bromide and tetra iodide do not exist presumably because tetra bromine and tetra iodide do not sufficiently strong oxidizing agents to convert Pb^{II} to Pb^{IV} .

The stable valence state of lead is (II) and all four di halides can be obtained as sparingly soluble solids by adding halide ions to a soluble lead (II) salt e.g the nitrate.



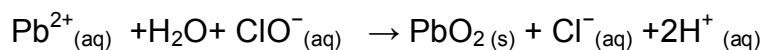
The fluoride is ionic $Pb^{2+} (F^{-})_2$, the chloride, bromide and iodide contain some ionic character which decreases with increasing atomic number of the halogen. Except for the iodide which is yellow, they are white solid.

Lead (II) chloride and lead (II) iodide are of important in qualitative analysis and their formation serves as tests for Pb^{2+} in solution. Both are much more soluble in hot water than in cold and the chloride dissolves in concentrated hydrochloric acid with the formation of the $PbCl_4^{2-}$ complex ion.

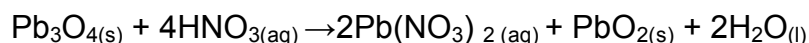


The oxide of lead

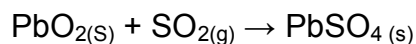
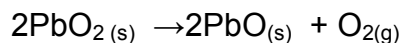
Lead (IV) oxide PbO_2 , is a brown solid obtained when a soluble lead (II) salt warmed with sodium chlorate (I) which oxidizes it



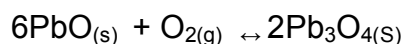
It can also be obtained by treating tri lead tetra oxide Pb_3O_4 , with dilute nitric acid (tri lead tetra oxide behaves as if it were mixture of 2 PbO and PbO_2).



lead (IV) oxide is powerful oxidizing agent ($\text{Pb}^{\text{IV}}_{(\text{s})}$ is unstable with respect to Pb^{II}) for instance, it gives lead (II) oxide and oxygen when heated combine vigorously with sulphur dioxide to give lead(II) sulphate and liberates chlorine from concentrate hydrochloric acid when the mixture is warmed.



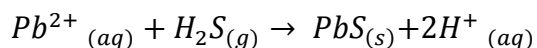
lead (IV) Oxide is considered to be amphoteric , since it reacts with hydrochloric acid at low temperatures to give lead (IV) chloride (this decomposes readily to lead (II) chloride and chlorine at normal temperatures). And with alkalis to give plumbates (IV) the plumbate (III) Ion is usually written as PbO_3^{2-} but is in fact $\text{Pb}(\text{OH})_6^{2-}$.lead II oxide , PbO_2 exists in two forms one of which is a red solid and the other yellow solid, it can be made by the thermal decomposition of lead (II) carbonate, or lead (II) nitrate. Although it is amphoteric , reacting with acids to form lead(II) salt and with alkalis to form plumbates(II) (the plumbate(II) ion is PbO_2^{2-} or $\text{Pb}(\text{OH})_4^{2-}$, tri lead tetra oxide Pb_3O_4 can be prepared by heating lead(II) oxide in air at 400c°



It decomposes if heat to 500c° into lead (II) oxide and oxygen . X ray - examination shows it has a layer structure , each layer of PbO_2 being sandwiched two layers having the PbO structure. It thus behaves as a mixture of PbO_2 and PbO . It is used in the production of lead(IV) oxide for use in lead accumulators and in the manufacture of red lead paint.

The sulphides of lead

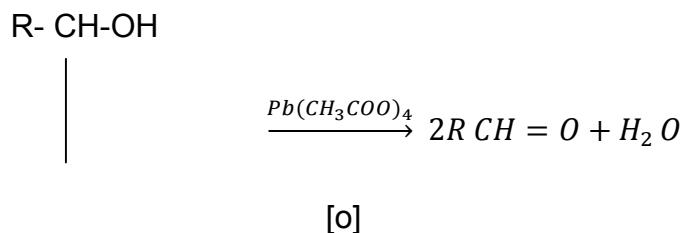
Lead(II) sulphide PbS can be may by passing hydrogen sulphide through a solution containing lead (II) ions



It is a black solid and is insoluble in ammonium poly sulphide.

The oxo salts of lead

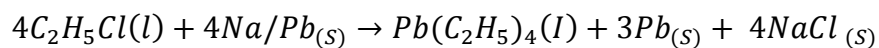
Only the oxy salts of lead are of any importance. Most of the lead II salts are insoluble in water e.g $PbSO_4$ (white) , $PbCrO_4$ (yellow) , lead (II) nitrate and lead (II) ethanoate $Pb(CH_3COO)_2 \cdot 3H_2O$ are however freely soluble. The only stable lead (IV) oxy salt is lead ethanoate $Pb(CH_3COO)_4$, which is obtained as a white solid when treating tri lead tetroxide with hot ethanoic acid. As expected it is an oxidizing agent and used in organic chemistry for oxidizing 1,2 diols to aldehydes or ketones.



R-CH-OH

Lead tetra ethyl $Pb(C_2H_5)_4$

Lead tetra ethyl poisonous covalent liquid produced by reacting chloromethane vapor with sodium –lead alloy



It is an antiknock used in petrol

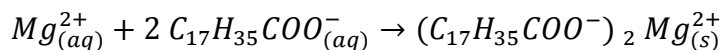
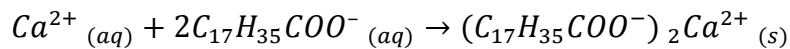
2.11 lead health effects

Lead is now recognized as a poison heavy metal, because it complexes with ox-groups in enzymes and effects virtually all steps in process of human synthesis and metabolism it also inhibits acetyl chloride – esterase , acid phosphate ATP use carbonic anhydrate etc. It inhibits protein synthesis probably by modifying transfer- RNA .

Pb¹¹ also inhibit SH enzymes specially by interaction with cytosine residues in proteins, typical symptoms of lead poisoning are colic , an amine headaches, convulsions, chronic nephritis of the kidneys brain damage and control nevus – system disorder⁽⁷⁾.

2.12 Hardness of water

Water is described as being hard if it forms an insoluble scum(precipitate) before it forms a lather with soap . the hardness of natural water is generally caused by the hydrogen carbonates and sulphate of calcium and magnesium but in fact any soluble salts that form as a scum (precipitate):

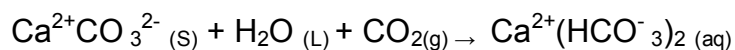


soap will not produce a lather with water until all the calcium and magnesium ions have been precipitated as octadecanoates, hard water therefore wastes soap.

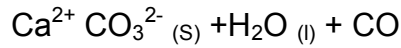
Water is described as being temporally hard if it contains calcium and magnesium hydrogen carbonates , since this type of hardness is easily removed and permanently hard if it contains calcium and magnesium sulphates . Both type of hardness frequently occur together in hard water⁽⁸⁾.

2.12.1 Temporary hardness in water

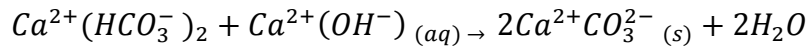
Rain water dissolves small quantities of carbon dioxide from the atmosphere and is thus a very dilute solution of carbonic acid. This water attacks calcium and magnesium carbonates in any rocks over which flows and the soluble hydrogen carbonates are formed



The temporary hardness in water is easily removed by boiling as the hydrogen carbonates decompose readily and insoluble carbonate is precipitate.



It can also be removed by Clark's process, which involves the addition of slaked lime $\text{Ca}^{2+}(\text{OH}^-)$



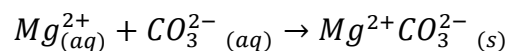
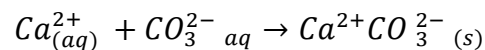
It is essential to add only the correct amount of slaked lime because any excess will cause artificial hardness⁽⁷⁾.

2.12.2 Permanent hardness water:

Permanent hardness is introduced when water passes over rocks containing the sulphates of calcium and magnesium. Neither boiling nor the addition of slaked lime will remove this type of hardness; it can however be removed together with temporary hardness by the addition of washing soda (Na^+)₂CO₃²⁻ or by the permuted process⁽⁷⁾.

a) Addition of washing soda (sodium carbonate)

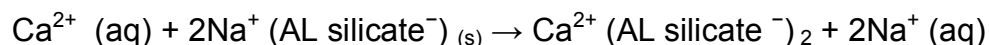
The calcium and magnesium ions in the water react with the ions from the sodium carbonate and a precipitate results:

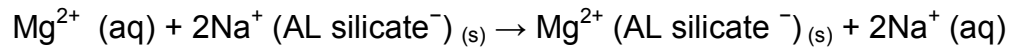


The water now contains dissolved sodium salts but these have no effect upon the soap.

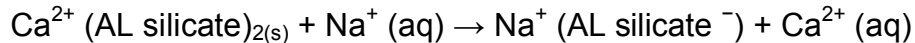
b) the ion exchange process

Permutite is a compound called sodium aluminum silicate (abbreviated here to Na⁺ Al silicate) is insoluble in water when a slow stream of hard water is passed through this material, the calcium and magnesium ions exchange with the sodium ions in the permutite thus.





Eventually the permuted is converted into a mixture of calcium and magnesium aluminum silicates and has to be regenerated this is achieved by passing a concentrated solution of sodium chloride through it:



The calcium chloride is then completely washed of the permuted before- use

C) the calgon process

the sodium salt of chain polyphosphate (v) are able to complex with calcium and magnesium ions and so prevent them reaction with soap to form a scum which complexes with calcium and magnesium ions in hard water at the same time releasing an equivalent amount of sodium ions into the water

2.13 Hardness health effects:

No health based guideline is proposed for hardness in drinking water (WHO 2004).

Much research has been done on the relationship between water hardness and cardiovascular disease mortality.

Numerous studies suggest correlation between hard water and lower cardiovascular disease mortality. (Herman et.al 1996).

Research on heart disease and cancer shows healthy water is hard water and moderately high in TDS.

Experimental evidence shows hard water actually contributes to the prevention of certain type of calculi kidney stones or water belly formation (Sara 2007)⁽¹⁰⁾.

2.14. sampling water:

The sample collection process should be co-ordinate with laboratory so that analyst know many samples will be arriving and the approximate time of their arrival and the analysis that are be carried out , and can thus have appropriate quantities of reagent chemical prepared.

Sample containers that use to vary the sample which contain iron is poly ethylene (500 – 1000 ml)⁽¹⁰⁾.

Washing procedure:

Rinse three times with tap water . once with chromic acid three time with water. Once with 1:1 nitric acid and then three times with ultrapure distilled water.

Samples from ground water:

Can be obtained at the point of discharge. The water should flow for several minutes before sampling until it has reached constant conductivity and temperature in order to avoid any water resident in the system piping being taken as sample. The water should be allowed to flow into the bottle for sufficient time to displace the constants of bottle at least three times. Care should be taken to insure that no bubbles are introduce to the sample.

Chapter three

Materials and methods

3.1 MATERIAL:

water samples were collected from two wells in Dar- Almazeed village.

3.1.1 Collection of water samples:

The bottles were washed three times with water then one time with nitric acid And three time with distilled water.

The outside nozzle of the tap was cleaned carefully. The tap was turned on full, and the water was allowed to run to waste for 10 minutes. Sample bottle was filled with water and close immediately. Contamination was avoided by not allowing any surface to touch the screw thread of bottle neck or inside of the tap.

3.2 apparatus and instruments:

- ✓ Conical flask (50 ML ,250 ML)
- ✓ Beakers
- ✓ Burette
- ✓ Pipette
- ✓ Measuring cylinder
- ✓ Spectrophotometer (DR 5000 HACH LANGE)
- ✓ Atomic absorption spectrophotometer (AA.6800,SHIMDZU)

3.3 Chemicals:

- ✓ Ferrous iron reagent (1.10 phenanthroline)
- ✓ EDTA solution (0.01M)
- ✓ Buffer solution (pH=10)
- ✓ Eiroichrome black T(EBT indicator)
- ✓ Deionized water
- ✓ Stock solution for lead and cadmium (1000ppm)

3.4 Preparation of reagents and standards:

3.4.1 Buffer solution:-

16.9 g of ammonium chloride was weighed and dissolved in 143 ml of ammonium hydroxide solution. Then 1.25 g of sodium salt of EDTA was weighed and added to this mixture to obtain sharp change in colour of indicator and then was diluted to 250 ml of distilled water

3.4.2 Eriochrome black T indicator:-

0.5 g of dye and 100g of sodium chloride were weighed and dissolved in distilled water, Then the solution was transferred to 100 ml volumetric flask and completed to mark.

3.4.3 Standard magnesium solution:-

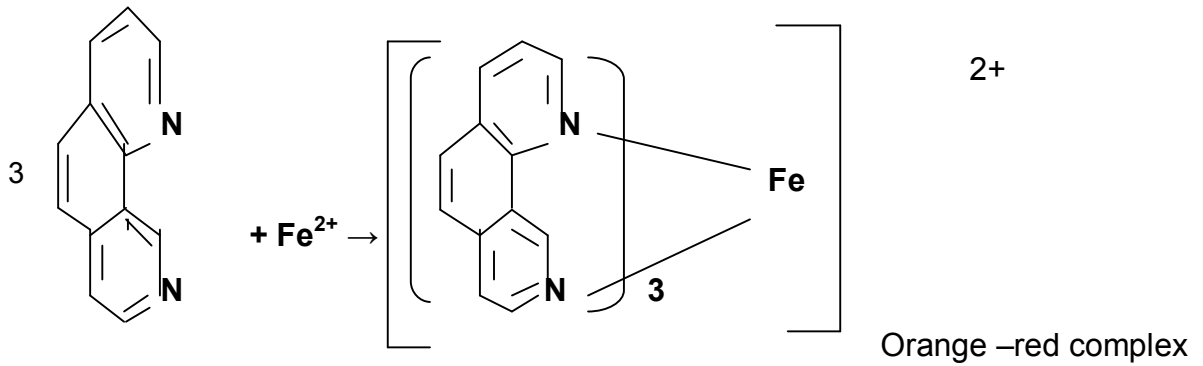
1 g of magnesium sulphate was weighed in 250 ml beaker and dissolved in Hydrochloric acid (1+1). 200ml of distilled water were added and boil for 20-30 minutes. Then cooled and few drops of methyl red indicator were added .Ammonium hydroxide solution was added drop wise till intermediate orange color develops .Then the mixture was diluted to 1000ml to obtain 1ml = 1mg $MgSO_4$.

Methods of analysis

3.5 spectrophotometric determination of iron content by using 1.10 phenanthroline :

Principle

1.10 phenanthroline will react with iron in water to form an orange complex . This complex can be detected at wavelength 510nm.



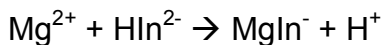
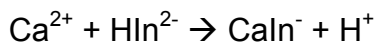
Method

10 ml of water sample were placed in 50ml conical flask and 0.28 g of 1.10-phenanthroline reagent were added to the flask. The content was mixed for three minutes. The absorbance of 10 ml mixture was determined by using 1cm glass cell at wavelength 510nm in the presence of a blank. The result was recorded in table No(1)

3.6 Determination of total hardness (complex metric titration)

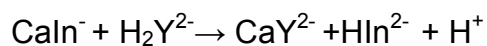
Principle:-

sample is buffered to pH = 10, then the EBT indicator is added to solution containing Calcium or Magnesium ion the color will change to wine red .

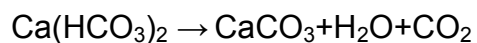


Blue wine red

EDTA, complexes with Magnesium and Calcium ions, remove them from association with the indicator. When all Mg and Ca ions reacted with EDTA the indicator will turn to blue. This is the end point of titration



Wine red blue



3.6.1 Standardization of EDTA :

10 ml of Magnesium sulphate solution (1mg \ml) were transferred to a clean conical flask. 5ml of buffer solution (pH=10) and 2 drops of EBT indicator were added. The solution was titrated against standard EDTA solution (0.01M) solution until the color changed from red to blue. The volume (v_1) was recorded in table No (2).

3.6.2 Determination of total hardness:-

50ml of water sample were transferred to a clean conical flask .5ml of Buffer solution (pH=10) and 2 drops of EBT indicator were added. The mixture was titrated against standard EDTA solution (0.01M) until the color changed from red to blue. The volume (v_2) was recorded in table No (2*).

3.6.3 Determination of permanent hardness:-

250ml of water sample were transferred to a clean beaker and heated to boiling for 30 minutes. Then cooled and filtered off. The filtrate was transferred to 250 ml volumetric flask and filled up to the mark with distilled water .Then 50ml of filtrate were transferred to a clean conical flask , 5ml of buffer solution (pH=10) and 2 drops of EBT were added. The mixture was titrated against standard EDTA solution (0.01M) until the color changed from red to blue (2**).

3.7 Determination of Cadmium and lead content by Atomic Absorption spectrophotometer:

3.7.1 Preparation of standard stock solutions for Cd and Pb:-

Stock solution for Cd and Pb :

10 ppm of standard solution of Cd were prepared by diluting 100 μ l of 1000 ppm stock solution to 10 ml in volumetric flask with deionized water. The same method was repeated For lead.

Standard solution of Cadmium :

(0.2 , 0.4 , 0.6 , 0.8,1.0) ppm of standard Cadmium solution was prepared by diluting 100, 400, 600 and 1000 μ l of 10ppm concentration to 10ml in volumetric flask with deionized water.

Standard solutions of lead :

(0.1, 0.7, 1.0, 2.0) ppm of standard solution of lead were prepared by diluting 100, 700, 1000, 2000 μ l of 10 ppm concentration to 10 ml in volumetric flask with deionized water

Method :

Atomic absorption spectrophotometer is calibrated using standard solution for each element.

Each element concentration was measured in water samples. The AAS specific lamp wave change for measuring each ion concentration.

The outmizatio tube was rinsed with deionized water after each sample reading the result was recorded in tube No (3) for cadmium and table No (4) for lead.

3.8 Determination of Cadmium and Lead in water samples :**3.8.1 Standard calibration curve :**

calibration curves show in page No (37) for Cd, and page No (39) for Pb.

Chapter four

Results and discussions

4.1 Determination of iron content :

Table No (1)

Note:-

Sample (1) collected from Dar Almazeed well .

Sample (2) collected from pant well.

Concentration of iron:-

Sample No	Concentration of total iron(mg/l)
1	1.05
2	0.87

The results show higher value of iron in sample No(1) compare with sample No(2). These two values are more higher than WHO standard (1983)0.3 mg/l

4.2 Determination of total hardness

Standardization of EDTA

Table No (2)

Initial volume(ml)	Final volume(ml)	Used volume(ml)
0.00	10.40	10.40
10.40	20.80	10.40
20.80	31.50	10.70

Table No (2*):

Total hardness:-

Sample No	Initial volume(ml)	Final volume (ml)	Used volume (ml)
1	0.00	5.90	5.90
	5.90	11.20	5.30
	11.30	16.60	5.30
2	0.00	6.30	6.30
	6.30	12.50	6.20
	12.50	19.90	7.40

Table No (2):-**

Permanent hardness:-

Sample No	Initial volume(ml)	Final volume (ml)	Used volume (ml)
1	0.00	5.90	4.80
	4.80	11.20	5.00
	9.80	16.60	4.80
	14.60	19.40	4.80
2	0.00	4.00	4.00
	4.00	8.10	4.10
	8.10	12.30	4.20

Calculations:-

- From table No (2) $\rightarrow v_1 = 10.40$ ml
- Number of mgs of $MgSO_4$ equivalent to 1ml of EDTA
- (x mg of $MgSO_4 \rightarrow 1$ ml of EDTA)

10 mg of $MgSO_4 \rightarrow 10.40$ ml EDTA



X mg of $MgSO_4 \rightarrow 1$ ml EDTA

$$\rightarrow X \text{ mg of } MgSO_4 = \frac{10 \times 1}{10.40} = \underline{.961} \text{ mg}$$

*Total Hardness:-

From table No (2*)

V_2^* for sample No (1) = 5.30 ml

V_2^{\setminus} for sample No (2) = $(6.20 + 6.30)/2 = 6.25$ ml

-Sample No (1):-

0.961 mg $MgSO_4 \rightarrow 1$ ml EDTA
Y mg $\rightarrow 5.30$ ml EDTA

Y mg = $.961 \times 5.30 = \underline{5.0933}$ mg $MgSO_4$ in 50 ml water sample

No of mgs of $MgSO_4$ in 1000 ml $y^* = (y \times 1000)/50$

For sample (2):-

0.961 mg $MgSO_4 \rightarrow 1$ ml EDTA
Y mg $MgSO_4 \rightarrow 6.25$ ml

Y = $0.961 \times 6.25 = 6.006$ mg $MgSO_4$ /50ml (water sample)

$$Y^{\lambda} = (6.008 * 1000)/50 = \underline{120.24} \text{ mg/l}$$

***Permanent Hardness:-**

From table No (2**):-

$$V_3^* \text{ for sample No (1)} = 4.80 \text{ ml}$$

$$V_3^{\lambda} \text{ for sample No (2)} = (4.10 + 4.2)/2 = 4.15 \text{ ml}$$

For sample No (1):-

$$0.961 \text{ mg MgSO}_4 \rightarrow 1 \text{ ml EDTA}$$

$$Z \text{ mg MgSO}_4 \rightarrow 4.80 \text{ ml}$$

$$Z = 0.961 * 4.80 = 4.61 \text{ mgs of MgSO}_4$$

Number of mgs MgSO_4 in 50 ml = 4.61 mgs

$$\rightarrow \text{Number of mgs in 1000 ml } z^* = (4.61 * 1000)/50 = \underline{92.2} \text{ mg/l}$$

For sample No (2):-

$$0.961 \text{ mgs MgSO}_4 \rightarrow 1 \text{ ml EDTA}$$

$$Z \text{ mgs MgSO}_4 \rightarrow 4.15 \text{ ml}$$

$$Z \text{ mgs} = 4.15 * 0.961 = \underline{3.98} \text{ mgs}$$

Number of mgs of MgSO_4 in 1000 ml $Z^{\lambda} = (Z * 1000)/50$

$$Z^{\lambda} = (3.98 * 1000)/50 = 79.7 \text{ mg/l}$$

*Temporary water hardness = Total – Permanent

For sample No (1):-

$$\text{Temporary hardness} = 101.86 - 92.2 = \underline{9.66} \text{ mg/l}$$

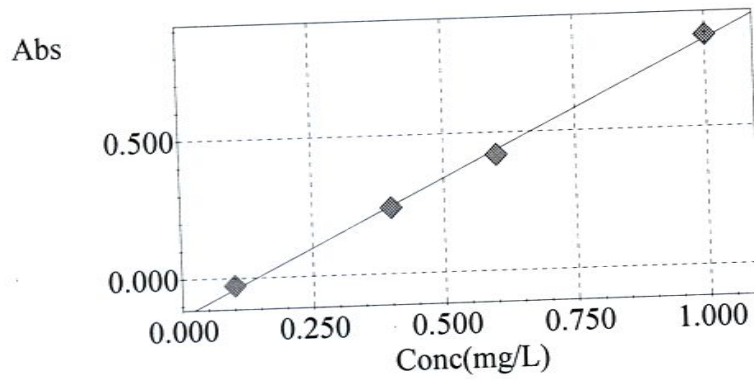
For sample No (2):-

Temporary hardness = 40.54 mg/l

This studied show the water is slightly hard (100-150) mg/l

Calibration curve of Cd (228.8 nm)

Calibration Curve (C# : 01)



Conc (mg/L)	Abs
0.6000	0.4178
0.1000	-0.0282
0.4000	0.2395
1.0000	0.8335

$$\text{Abs} = 0.957415 \text{Conc} - 0.136993$$
$$r = 0.9990$$

Table No (3):-

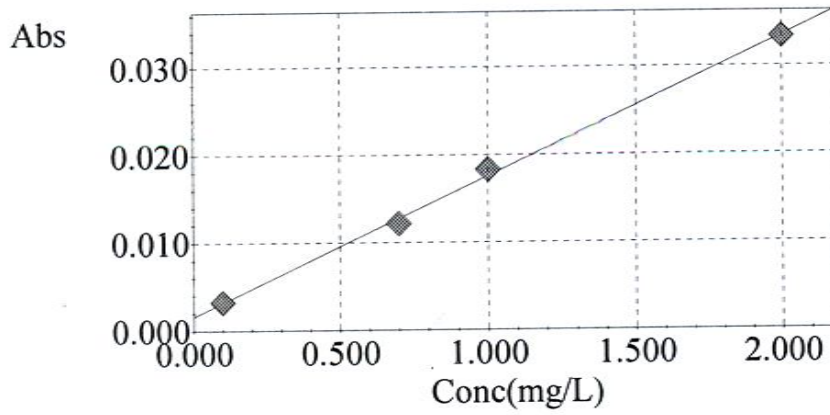
***Concentration of Cadmium by AAs:**

Sample No	Concentration of Cadmium (ppm)
1	0.1432
2	0.1435

The studied samples show maximum value of Cadmium than value of 0.003 mg/l Cd Water containing high concentration of Cadmium is more effect on health because Cadmium is carcinogenic.

Calibration curve of Pb (217.0 nm)

Calibration Curve (C# : 01)



Conc (mg/L)	Abs
0.1000	0.0032
0.7000	0.0122
1.0000	0.0183
2.0000	0.0334

$$\text{Abs} = 0.0159868 \text{Conc} + 0.00158757$$

$$r = 0.9991$$

Table No (4):-

***Concentration of Lead :- (by AAS)**

Sample No	Concentration of Lead (ppm)
1	0.00
2	0.00

In this studied all samples show zero values of Lead.

The WHO (2011) recorded that concentration of Lead is 0.05 mg/l.

When water is free of Lead can be considered good because Lead is poisonous.

Chapter five

Conclusion

Conclusion

According to this analysis these two water samples are not suitable for drinking because there is high concentration of cadmium and iron in the two water samples. The hardness is acceptable and no lead detected.

Suggestions and Recommendation

- 1- Further research may be need to determine other elements such as arsenic (As), mercury (Hg) and iodine (I₂).
- 2- The area may be further studied to include other neighboring village for determination of heavy metals and trace element concentration.
- 3- Further studies can be carried to tend a suitable technique for removing iron and cadmium from water.

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Chapter six

Appendix

The Location of Dar Almazeed Village





