Q1) Define the quality of Irrigation Water and, what are categories to describe the irrigation water effects on crop production and soil quality?

Q2) What is aquatic chemistry, describe chemical properties, and what are the goals of aquatic chemistry?

Q3) What are the factors affecting the chemical composition of water aquifer minerals, and water-bearing rocks? explain briefly.

Q4) Explain two (2) of the following questions

A- What is the ion hydration?

B- Why water is an excellent solvent?

C- pH + pOH = pKw = 14 at $25^{O}C$ if you know the concentration of pure water is 55.5 moles/L and $K_a = 1.8 \times 10^{-16}$ *at* $25^{o}C$

D- What are the salinity hazard and boron toxicity

Q5) The following data represent the chemical analysis of water sample classify this water using:-

Concentration of ions	$meq.L^{-1}$
Ca^{2+}	5
Mg^{2+}	4
Na^{+}	0.5
CO_3^{2-}	0.0
HCO_3^{1-}	2
Cl^{-}	4
$(pk_2 - pk_c)$	2.4
p (Ca + Mg)	2.7
p (Alk)	2.5

where pHc = (pk2 - pkc) + p (Ca + Mg) + p (Alk)

Calculate the :

1-USA classification

2-Wilcox classification

3-Adjuste Sodium Adsorption Ratio (adj SAR)

TYPICAL ANSWER

Q1) quality of Irrigation Water

The concentration and composition of soluble salts in water will determine its quality for various purposes (human and livestock drinking, irrigation of crops, etc.). The quality of water is, thus, an important component with regard to sustainable use of water for irrigated agriculture, especially when salinity development is expected to be a problem in an irrigated agricultural area.

1-Salinity Hazard

Excess salt increases the osmotic pressure of the soil solution, a situation that can result in a physiological drought condition. Thus, even though the soil in the field appears to have plenty of moisture, the plants will wilt. This occurs because the plant roots are unable to take up soil-water due to its high osmotic potential. Thus, water lost from the plant shoot via transpiration cannot be replenished, and wilting occurs

2-Sodium Hazard

The sodium hazard of irrigation water is expressed as the 'sodium adsorption ratio (SAR)'. Although sodium contributes directly to the total salinity and may also be toxic to sensitive crops, such as fruit trees, the main problem with a high sodium concentration is its effect on the physical properties of soil (soil structure degradation). It is, thus, recommended to avoid using water with an SAR value greater than 10 $(\text{mmoles } l^{-1})^{0.5}$, if the water will be the only source of irrigation for long periods.

3-Carbonates and Bicarbonates Concentration

Waters high in carbonates (CO_3^{2-}) and bicarbonates (HCO_3^{-}) will tend to precipitate calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$), when the soil solution becomes concentrated through evapotranspiration

4 Specific Ion Effects (Toxic Elements)

In addition to salinity and sodium hazards, certain crops may be sensitive to the presence of moderate to high concentrations of specific ions in the irrigation waters or soil solution. Many trace elements are toxic to plants at very low concentrations. Both soil and water testing can help to discover any constituents that might be toxic.

4- Boron Toxicity

Boron is essential to the normal growth of all plants, but the amount required is low. If it exceeds a certain level of tolerance depending on the crop, then boron may cause injury. The range between deficiency and toxicity of boron for many crops is narrow.

Q2)

Aquatic chemistry is a branch of environmental chemistry which deal with studding the chemical properties of water,

chemical properties of water

1. Temperature
2. Water quality (chemical composition, pH, oxidation–reduction potential, alkalinity, hardness, turbidity, dissolved oxygen, biological oxygen
3. demand, fecal coliforms, etc.) .
4. Flow rate and flow pattern
5. Water is an excellent solvent because of its polarity and high dielectric constant. Polar and ionic substances dissolve well in water, including acids, alcohols, and many salts.

Goals of studying of water chemistry

1. Classification of water for different purposes like :irrigation, drinking industrial, food technology. Swimming and culturing.
2. Studding the role of water quality in limiting plant growth, yield and quality.
3. Effect of water no soil chemical, physical and biological characters.
4. Role of water quality in fertilization recommendation.
5. Limiting water family.
6. Studying salt composition of water.
7. Studding chemical properties of water.
8. Studding the amount of and type of ion pairs in water and their role in water classification .
9. Studding chemical pollution of water.
10. Studding the relation between water quality and method of irrigation management.
11. Studding the relation between water quality and irrigation management.
12. Studding the seasonal fluctuation (changes) in water quality.
13. Studding the factors affecting chemical composition of water.
14. Mixing between saline and fresh water.
15. Desalination of saline water 16-Purification of water.

Q3) Factors affecting chemical composition of water aquifer mineral of water bearing rocks.

1-Mineral composition ship of water bearing rocks.

There is relationship between the chemical composition of rocks and chemical composition of water. The solid rocks, which are in contact with ground water, which is the primary sources of salt in irrigation water. It was found that the relatively low levels of K^+ in ground water a consequence of it is tendency to fixed clay minerals and high concentration $Ca2^+$ and Mg^{2+} in ground water due to the rocks (dolomite, calcite, calcite etc.

2-Ioinic composition of aquifer

Water formation have a high EC value, or concentration of cations and anions, for this reason the water in upper

4-Climate.

The main climate change consequences related to water resources are increases in temperature, shifts in precipitation patterns and snow cover, and a likely increase in the frequency of flooding and droughts

4-The fluctuation of groundwater level

Groundwater-level fluctuation is an effect related to aquifer type, recharge, abstraction and regional circulation of **groundwater** in the area. High rainfalls above the mean are the most prominent sources of water that reach deep into the aquifers through recharge either locally or through regional circulation. In different seasons of year depending on amount of rain fall. Fluctuation of ground water level of some wells caused increase in salinity of ground water.

5-Deep percolation.

Small variation in the ionic composition and electrical conductivity values of water in deep wells in comparison with shallow wells was noticed.

7-pumping time

Time of pumping has great effect on the chemical composition of water in addition to the effect of pumping in hydrodynamic changes of aquifer system.

8-water cycle in nature between ground water and surface water

Q4/

a- The negative (oxygen) side of a dipolar water molecule attracts and is attracted by any positive ion in solution. Because of this **ion-dipole force**, water molecules cluster around positive ions, as shown in Figure below *a*. Similarly, the positive (hydrogen) ends of water molecules are attracted to negative ions. This process, in which either a positive or a negative ion attracts water molecules to its immediate vicinity, is called **hydration**.

b- because the polar end of the molecule are attracted to (and pulled apart by) the charged end of the H_2O molecule

-i.e salt (NaCl) dissolves easily in water to become Na^+ and Cl^-

c- **The concentration of pure water**

The concentration of pure water is 55.5 moles/L

$Keq=(H^+)*(OH^-)/(H_2O)$

$1.8 * 10^{-16}=(H^+)*(OH^-)/(H_2O)/55.5$

$(H^+)*(OH^-)=55.5*1.8 * 10^{-16} =1.01*10^{-14}$

Replace $K_a *[H_2O] = K_w = 10^{-14}$

Where K_w *= the ion product of water*

$$[H^+]\,[OH^-] = K_w = 10^{-14} \text{ at } 25^{O}C$$

$$-\log_{10}([H^+][OH^-]) = -\log_{10}(K_w) = -\log_{10}(10^{-14})$$

$$pH + pOH = pK_w = 14$$

Note the introduction of the term 'pH defined as:

$$pH = -\log_{10}[H^+]$$

d- Excess salt increases the osmotic pressure of the soil solution, a situation that can result in a physiological drought condition. Thus, even though the soil in the field appears to have plenty of moisture, the plants will wilt. This occurs because the plant roots are unable to take up soil-water due to its high osmotic potential. Thus, water lost from the plant shoot via transpiration cannot be replenished, and wilting occurs.

Q5)

EC= 10/10 =1

SAR= Na^+/ (Ca^{+2} + Mg^{+2})/2(0.5) 0.5/ (5+4/2)0.5 = 0.5/ 2.12 =0.23dS/m

RSC = { HCO_3^- +CO_3^{-2}} - {Ca^{+2} + Mg^{+2}} ={2}- {9} = -7

ppm = EC * 640 = 1*640 =640 ppm

640/1000 = 0.064 g/L

g/L =1000ppm mg/L= ppm

g= 1000 mg (g/L)/1000 = ppm

Q5)

1-SAR=0.5/((6+5)^2)$^{1/2}$ =0.14

2- adj SAR = SAR [1 + (8.4 - pHc)]

adj SAR = 0.14 [1 + (8.4 – 7.6)] =0.252

3- RSC (meq l^{-1})=(CO_3^{2-}+$HCO3^-$)−(Ca^{2+}+Mg^{2+})

RSC (meq l^{-1})=(0+6.78)−(6+5) = 17.78

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