University of Salahaddin Erbil
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Springe Semester
4th year students

Aquatic chemistry

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Aquatic chemistry for 4th year students:

1-Introduction which includes:

-Basic terms in Aquatic chemistry: Aquatic chemistry ,Water chemistry, water quality , ,water suitability , Environmental chemistry.

- main water chemical properties.

-Goals of studying water quality.

2- factors influencing water quality or chemical composition of water.

3-The Relation between water quality and suitability.

4-The most important tools or parameters in studying irrigation water quality and its classification.

5-Classical and modern water classification.

6- Effect of Aquatic chemistry on soil properties (Chemical ,Physical and Biological).

7-The threshold value of ECiw and ECe and their effects on growth and yield of plants.

8-Management of saline water.

9-Others.

Aquatic chemistry:
Introduction: The basic terms in aquatic chemistry are:
- Water quality.
- Water suitability.
- Water chemistry [aquatic chemistry].
- -Environmental chemistry.

Aquatic chemistry is a branch of environmental chemistry which deals with studding the chemical properties of water like:

1-EC. 2-pH.
3-Concentration of cations anions.
4-Total hardness.
5-Concentration of microelements.
6-Concentration of heavy metals.
7-Dissolved gasses. 8-others.

Some important chemical properties of water:

1. It is a general solvent.
2. The K value for H_2O dissociation is equal to $1*10^{-14}$
3. The tendency of water molecules to orient themselves around ions facilitates dissolution of salts:
4. It Has unique thermodynamic properties.
5. Dissociation of water.

$H_2O = H^+ + OH$

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

The concentration of pure water is 55.5 mol/l.

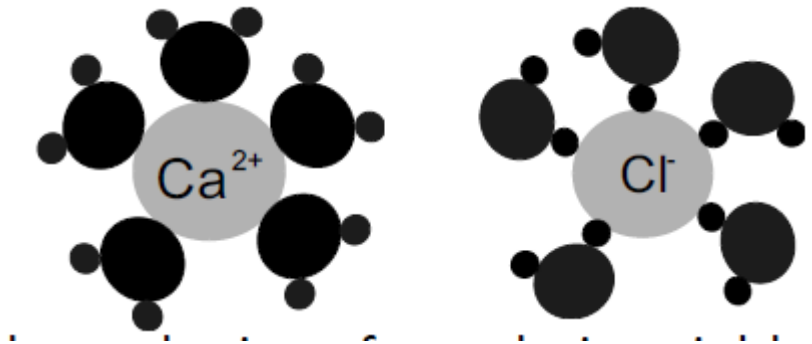
$Keq. = (H^+)* (OH^-)/ (H_2O)$

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

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

Ion hydration :

• Also because of the polar nature of water, ions will be surrounded by water dipoles (hydrated) in solution.



• Hydration isolates the ions from their neighbors and neutralizes the attractive forces that hold minerals together.

Goals of studding aquatic chemistry

1-Classification of water for different purposes:

-irrigation. -Drinking. -Industrial. -Food technology.-Swimming. -Fish culturing.

2-Studying factors affecting water quality.

3-Studying the role of water quality in limiting plant growth ,yield and quality.

4-Effect of water on soil chemical ,physical and biological characters.

5-Role of water quality in fertilization recommendation.

6-Limiting water family. 7-Studding salt composition of water.

8-Studying chemical properties of water.

9-Studying the role of ion pairs in water classification.

10-Studying chemical pollution of water.

11-Studying the relation between water quality and method of irrigation.

12-Studying the relation between water quality and irrigation management.

13-Studying the seasonal changes of water quality.

14-Effect of water quality on soil reclamation.

Factors affecting chemical composition of water

There are different factor affecting chemical composition of water, the most important factors can be summarized as follow:

1. Chemical composition of aquifers.
2. Geological formation of the position site as shown in figure (1 and 2).
3. Time of pumping.
4. Precipitation rate per year.
5. Chemical composition of catchments area.
6. Type and depth of well.
7. Cation exchange between aquifer and water.
8. Environmental factor.
9. Pollution due to human activities like agricultural, industrial ……..

Etc. activity.

10. Seasonal variation due to variation in temperature, humidity ……

Aquatic chemistry and suitability for irrigation:

Water quality for different purposes depends on aquatic chemical, physical and biological (microbial) analysis in laboratory.

While the aquatic suitability for agricultural purpose depends on many factors like:

1- Aquatic chemistry. 2- Type of plant. 3-Type of soil. 4- Climate like temperature, humidity,……etc. 5 Management 6- Others

The relation between water quality and suitability can be expressed as follow:WSI = f (Q, P, S, C, M …)

WSI = Water suitability for irrigation.

f = Function of (depend on). Q = Aquatic chemistry P = Plant type.

S = Soil type. C = Climate. M = Management.

… Other factor will be add in the future

Sodium as a tool for evaluating irrigation water quality or classification:

The following criteria were also considered for expressing the sodium hazard in irrigation water:

1-Sodium Adsorption Ratio (SAR)

SAR is a tool for evaluating sodium hazard. An equation used to predict sodium hazard in irrigation water is the sodium adsorption ratio (SAR). Richards (1954) expressed SAR (Sodium Adsorption Ratio) as follow:

SAR = $Na^{+}/\sqrt{(Ca^{2+}+Mg^{2+}}$)/2

Where:

(Na^{+}, Ca^{2+}, Mg^{2+}) = Sodium, calcium and magnesium concentrations in $mmol_c\ L^{-1}$.

SAR in (mmolc L^{-1}) $^{1/2}$

Adjusted Sodium Adsorption Ratio (Adj.SAR)

Adj.SAR = $Na+/ [(Ca^{2+}+Mg^{2+})/2]^{1/2}$ * (1+ (8.4-pHc)) ……. (2)

Where:

(Na^{+}, Ca^{2+}, Mg^{2+}) = Sodium, calcium and magnesium concentrations in mmolc L^{-1}.

$pHc = (pk_2-pk_c) + p(Ca^{2+}+Mg^{2+}) + p(ALK)$

(pk_2-pk_c) = The tabulated value for sum of concentration of ($Ca^{2+,}$ Mg^{2+}, Na+) in mmolc L-1 (Table 2.1).

pkc = The solubility product of CaCO3.

pk2 = The second dissociation constant of carbonic acid (H2CO3).

p(Ca2++Mg2+) = The tabulated value for sum of the concentrations of (Ca2++Mg)

p(ALK) = The tabulated value for sum of the concentrations of (CO_{32-} + HCO_{3-}) $mmol_c$ L_{-1} (Table 2.1).

If pH_c of the water is greater than 8.4 it will lend to dissolve $CaCO_3$ in the soil solution, but if the pH_c of water is less than 8.4 it causes precipitation of $CaCO_3$ from the soil.

Adjusted Sodium Ratio (Adj.RNa)

Adj.RNa = $Na^{+}/\sqrt{(Ca^{2+}x+Mg^{2+}/2)}$ …….

In which:

Na^{+} = Sodium concentration of irrigation water (mmolc L^{-1}).

$Ca^{2+}x$ = Calcium concentration ($mmol_c$ L^{-1}), modified, according to table adapted by Suarez (1981), which depends on ECiw and HCO_3^{-}/Ca^{2+} ratio (Table 2.2).

Mg^{2+} = magnesium concentration in irrigation water ($mmol_c$ L^{-1}).

Carbonate and bicarbonate as a tool for evaluating irrigation water quality:

Residual Sodium Carbonate (RSC)

The RSC value is defined by the following equation:

RSC = $(CO_3^{2-}+HCO_3^{-})-(Ca^{2+}+Mg^{2+})$ ……. ions expressed in ($mmol_c\ L^{-1}$).

The role of chloride and sulphate in evaluating of irrigation water quality

They are playing an important role in water classification because salinity potential (SP) of irrigation water depends on them in mmolc L^{-1} as shown below:

SP = $(Cl^{-}+½\ SO_4^{2-})$ …….

Soluble Sodium Percentage (SSP)

Eaton (1950) expressed SSP (soluble sodium percentage) as follow:

SSP = $[Na^{+}/ (Ca^{2+} + Mg^{2+} + Na^{+})] * 100$ …….

Ionic concentrations were expressed in mmolc L-1.

2.1.5. Soluble Sodium Percentage Possible (SSPP)

SSPP = $[Na^{+}/(Ca^{2+}+Mg^{2+}+Na^{+})-(CO_3^{2-}+HCO_3^{-})]*100$ …….

Where all ionic concentrations were expressed in $mmol_c\ L^{-1}$.

1. Accuracy of the chemical analysis

Accuracy or systematic errors display systematic deviation due to faulty procedures or interference during analysis. Accuracy can be tested only by analyzing reference samples and by inter laboratory comparison of results. At low concentrations, duplicate analysis may show large variation when the sensitivity of the method is insufficient. The accuracy of the analysis for major ion can be estimated from the Electro Neutrality (Relative Difference U %) condition since the sum of positive and negative charge in the water are balance (Appelo, 1999):

$$\text{Relative difference (U)} = \frac{\Sigma \text{ cations} - \Sigma \text{ anions } (\text{mmolcL}^{-1})}{\Sigma \text{ cations} + \Sigma \text{ anions} (\text{mmolcL}^{-1})} * 100 \ldots\ldots.$$

TDS (Total dissolved salts) mg L^{-1} = EC(dS m^{-1}) * 640

This constant may be change depending on EC value and chemical composition of water.

For determining type of salts the depend factor is dissolving of salts ,the less dissolving salt is forming in the First step the highest dissolving salt forming finally depending on the following information: