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Effects of The Groundwater Hypothetical Salts on Electrical Conductivity and Total Dissolved Solids

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Abstract

The Electrical conductivity [EC] relationship to total dissolved solids TDS were investigated for solutions of same salinity levels with respect to different prime hypothetical salts and their combinations.

The obtained results show remarkable jump in the order of the hypothetical salt sequence and specially that of the magnesium type.

A computer model is then built with an input of EC and TDS. The output will be the possible prevailing hypothetical salts. The accuracy of the model were tested (using groundwater data of Safwan-Zubair -S. Iraq)and its proved to be significant at 95% matching. The 5% unmatched results is due to possible of more than one type of prevailing salt.

Introduction

The electrical conductivity and total dissolved solids relationship is not new [Mackereth et al. 1978]. The relationship as for groundwater and surface water at different localities show different approaches [Hem 1970 ,Todd 1980] and different results. Also Richards [1954] present some factor affecting the prime salt relationships.

The aim of this paper is to present a model clearing the effect of the prime salt at same salinity level on the values of the electrical conductivity. Also the effects of the presence of difference hypothetical salts (at same salinity level) on the electrical conductivity. Finally this model is programmed with input of electrical conductivity and total dissolved solids to predict the type of the hypothetical salt.

Materials and Methods

Preparation of different hypothetical salts at same level of salinity in five replicates were carried out. The salinity levels are taken from 500 ppm with 500 ppm increment to 3000 ppm. Then the salinity levels is increased by 1000 ppm from 3000 ppm to

7000 ppm. The electrical conductivity where measured at 25ºC for prime salts and their combinations.

The statistical tests (F ,t) are applied for the predicted TDS and the input TDS [Meddis 1975] .

Results and Discussions

The obtained results for prime salt of chloride type started from top NaCl to KCl to bottom $CaCl_2$ (fig. 1) . At same TDS salinity Level the EC values increase from bottom to top of the sequence. That is means at same EC value the TDS increase from top to bottom. All of the prime salts are below the mixed water type no. 4. The $MgCl_2$ is jumped out of the sequence.

The $MgCl_2$ hypothetical prime salt jump from the chloride sequence to the sulphate sequence (fig. 2). The position is at the end of the sulphate replacing the $MgSO_4$ position of the second jump type.

Here the value of the TDS at same level of EC will be from top to bottom increase. The sulphate sequence is of higher TDS than the chloride sequence at given level of EC.

The bicarbonate sequence (fig.3) is characterizes by the $KHCO_3$ top passes toward $Ca(HCO_3)_2$ and than a jumping to $NaHCO_3$Will be then followed the $Ca(HCO_3)_2$. The $MgSo_4$ is

jumped from the sulphate to the bicarbonate sequence following the $NaHCO_3$ and replacing the $Mg(HCO_3)_2$. The bottom of the sequence will Be the $Mg(HCO_3)_2$.

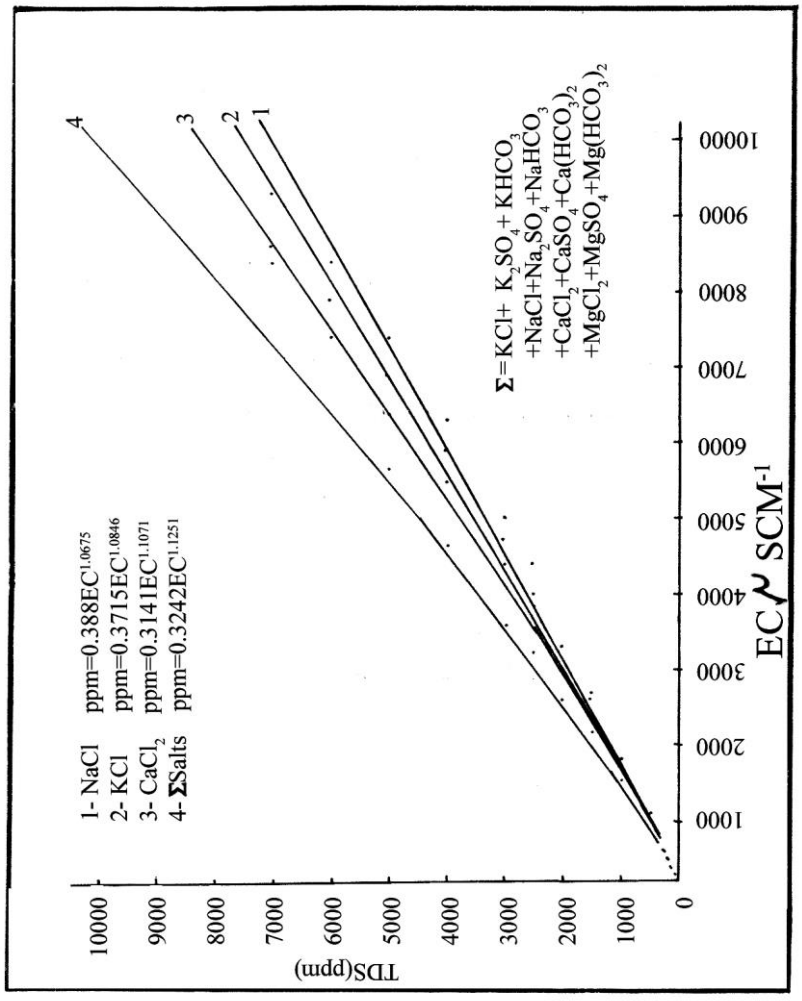

Fig: 1 Prime salts EC and TSS (1,2,3) firststage , mixed salts (4) EC and TSS

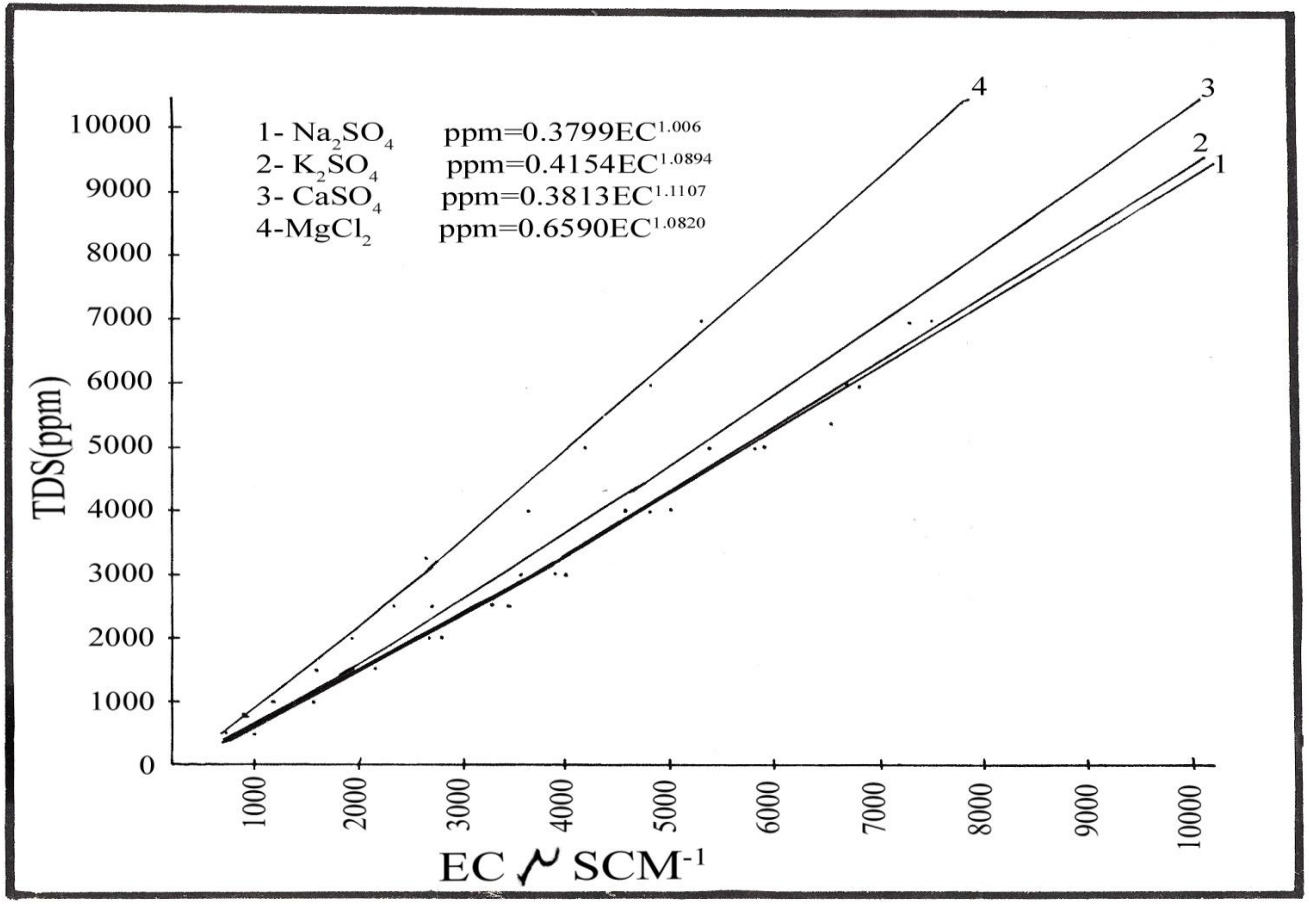

Fig: 2 Prime salts EC and TDS second stage

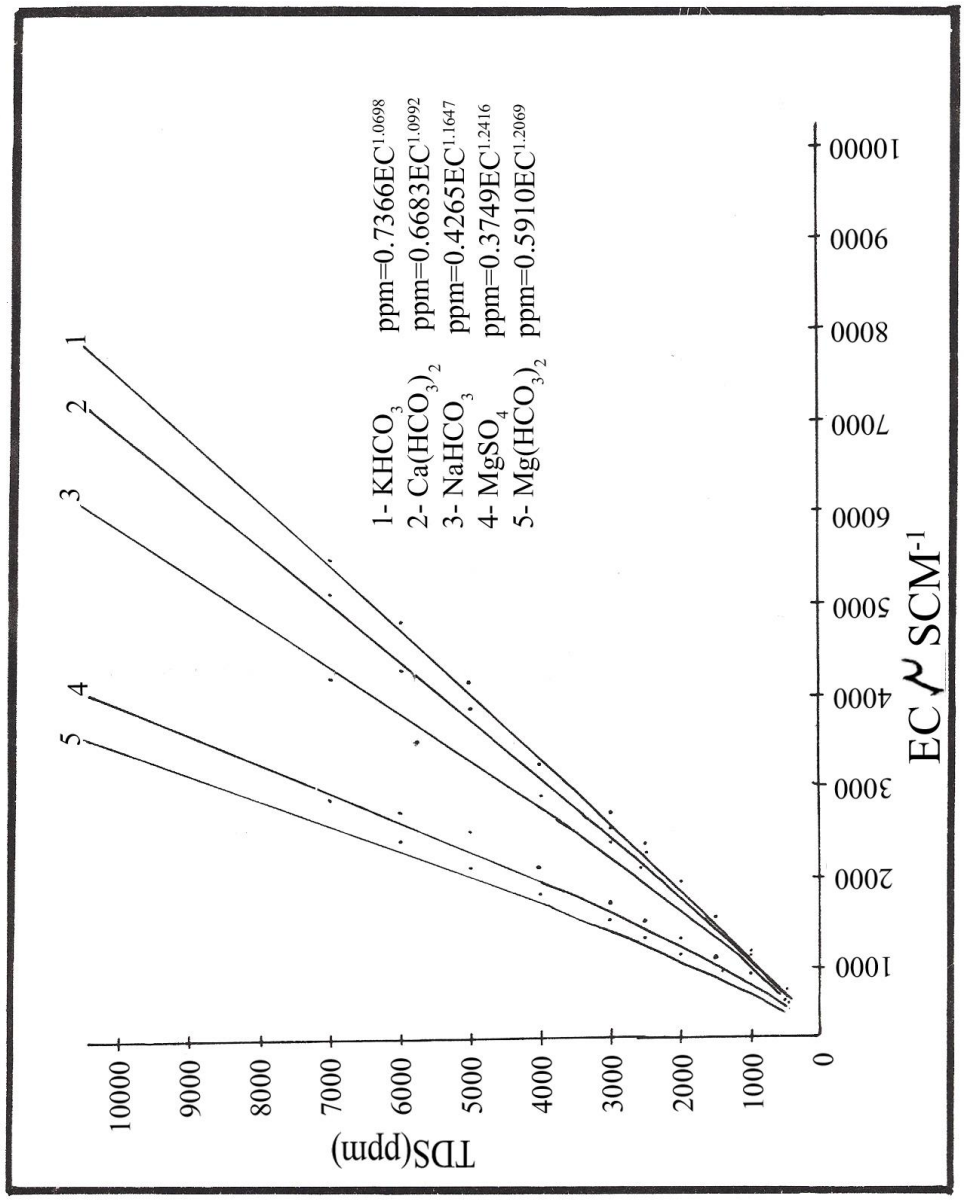

Fig: 3 Prime salts EC and TDS last stage

The flow chart of such jump in sequence of salts is shown in figure (4). Also all the hypothetical salts of the chloride type [Na ,K ,Ca ,Mg] were mixed with the sulphate and bicarbonate hypothetical salts combination. The obtained results shown that the EC value decrease from the mixing of Na_2SO_4 to K_2SO_4 passed to $NaHCO_3$,$KHCO_3$ and ending by $MgSO_4$. This is the same result of the obtained individual sequence.

The TDS will increase from top to bottom and all of the sequence is higher in TDS values than the sulphate at same level of EC. There is an overlap between the $KHCO_3$ and the $MgCl_2$ in position (fig. 5).

Computer Model

The mixed salt relationship presented in figures (1-5), and type curve no. 4 is the first point considered in the model. The calculated electrical conductivity [ECC] by this type curve will be compared with the actual one [EC]. There will be three conditions:

1.ECC<EC:

This is the condition of chorded hypothetical salt combination. Then **Chloride Water Type** will be in action.

2.ECC>EC:

This is the condition of sulphate and bicarbonate hypothetical salts. The [SOCH] subroutine will be in action.

3.ECC=EC:

This is the ideal case of more than one prevailing hypothetical salt combination. The limits are taken for ±5% relative difference. This mean matching of 95% .

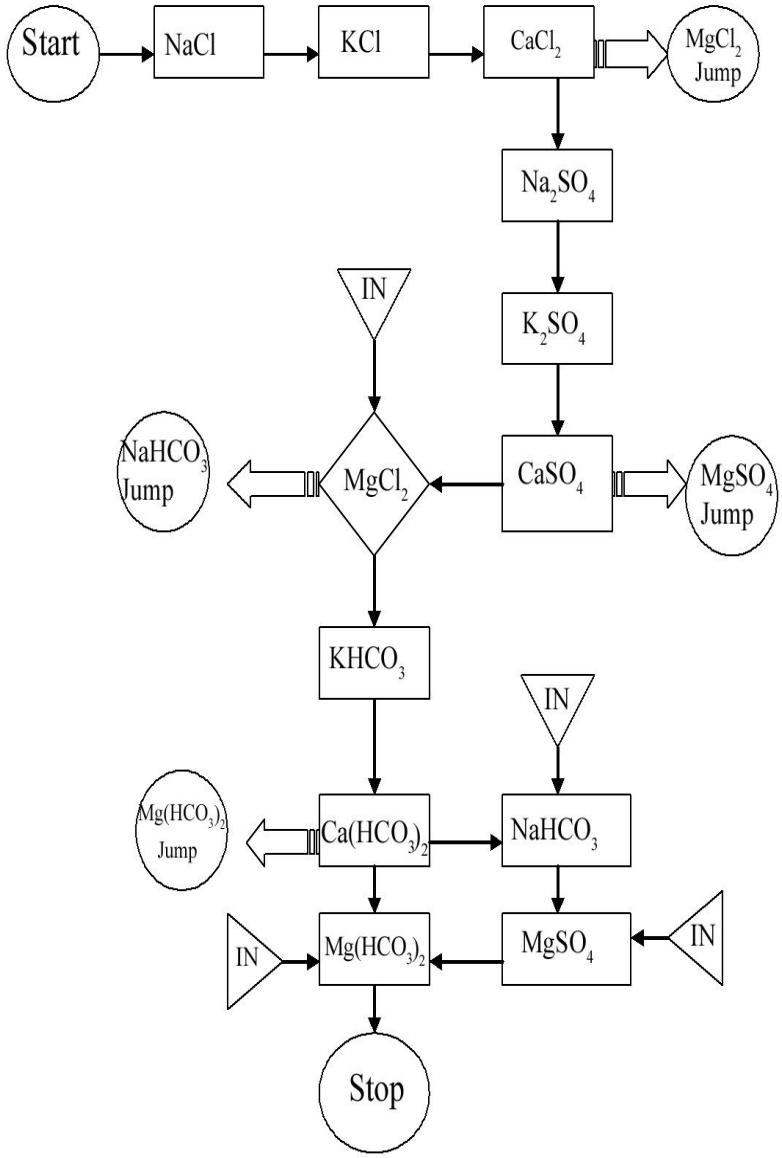
Start
NaCl
KCl
$CaCl_2$
$MgCl_2$ Jump
Na_2SO_4
IN
K_2SO_4
$NaHCO_3$ Jump
$MgCl_2$
$CaSO_4$
$MgSO_4$ Jump
$KHCO_3$
IN
$Mg(HCO_3)_2$ Jump
$Ca(HCO_3)_2$
$NaHCO_3$
IN
$Mg(HCO_3)_2$
$MgSO_4$
IN
Stop

Fig : 4 Flow chart of the Jump of EC at same salinity TDS with different water type .

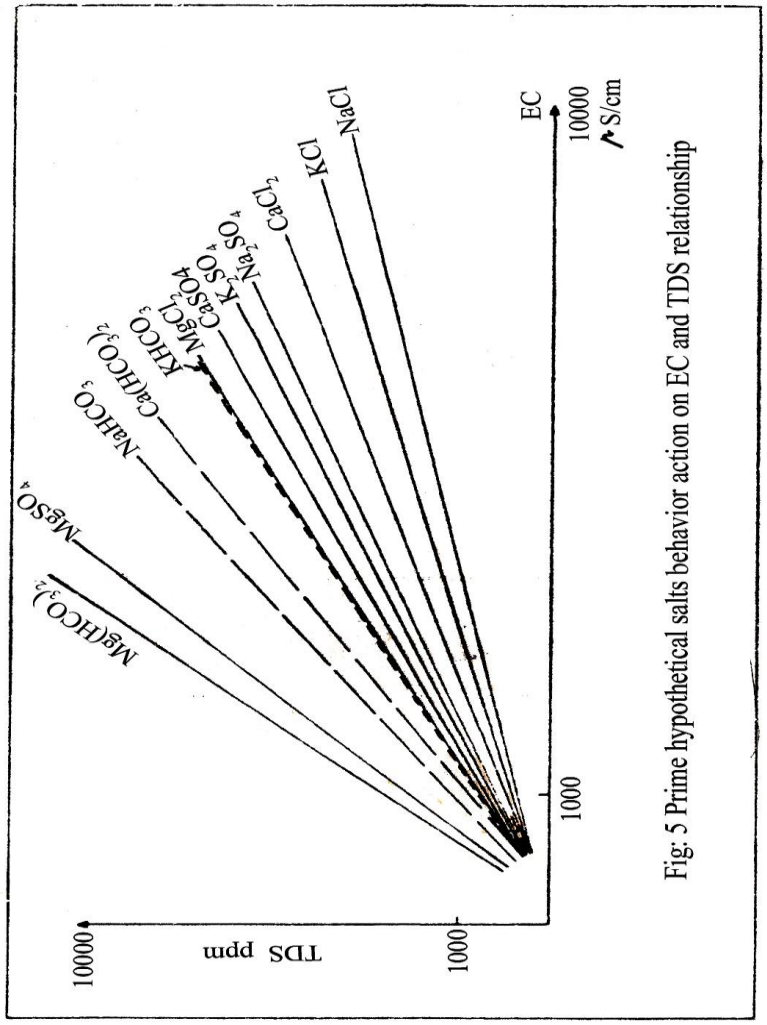

Fig: 5 Prime hypothetical salts behavior action on EC and TDS relationship

Conclusions

1. The prime salt of chloride group is of higher EC value than the sulphate water group followed by the bicarbonate of same salinity. This sequence is changed when salt combinations are considered . for chloride and sulphate groups the EC value decreases from sodium to potassium and to calcium in a solution of same salinity. This order is changed for bicarbonate group as the sodium bicarbonate salt will be at the end of the sequence . The presence of the magnesium-anion salts decreases the EC rapidly . The $MgCl_2$ follows the $CaSO_4$ and the $MgSO_4$ follows the $NaHCO_3$ and this sequence ended by the $Mg(HCO_3)_2$. For the case that the magnesium is the prevailing caution , then the EC value will be less than the expected .

   There is significant differences in the EC values of the prime salts in a solution of same salinity in the mixed state . This fact is due to the behavior of the prime salts in a solution related to their stages of development and interaction . The mixed stat position is between the chloride and the sulphate water groups, while the bicarbonate is still far away from the mixed condition . Thus it is not possible to use any relation of a given basin to another basin without taken in consideration the prevailing water type and salinity level.
2. A computer model built for the prediction of the type of the hypothetical salt. The input data is the EC and TDS. The calculated electrical conductivity ECC is according to the mixed condition of no prevailing salt. The relation between the actual and the calculated electrical conductivity will determine the type of prevailing salt.

References

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