Determining Water Vapour Phase Equilibrium Coefficients at Different Temperatures for Gas Wells

LIVIU DUMITRACHE[1]*, IULIAN NISTOR[1], SILVIAN SUDITU[2], ANA MARIA BADEA[1]

[1] Petroleum Gas University of Ploiesti, Petroleum Geology and Reservoir Engineering Department, 39 Bucharest Blvd., 100680, Ploiesti, Romania

[2] Petroleum Gas University of Ploiesti, Drilling, Extraction and Transport of Hydrocarbons Department, 39 Bucharest Blvd., 100680, Ploiesti, Romania

In the course of gas production from reservoirs across the world, salt precipitation from the reservoir water is observed to an increasing extent as recovery progresses. This phenomenon, likewise, occurs during the injection of dry gas into porous aquifers. Salt deposits can form in the production string, in the perforation zone as well as in the area of the reservoir surrounding the well [1]. A better understanding of salt precipitation phenomena along with the conditions under which this takes place is needed for a better productivity control [2]. Simulating the process and taking actions as necessary may reduce or even eliminate the necessity for down-hole fresh water washes and, in turn, minimize the overall production losses. Input for this simulation are also the Water-Vapour Phase Equilibrium Coefficients. This article presents a methodology on how to obtain these coefficients for different temperatures using commercial simulators.

Keywords: Soreide, Whitson mature gas reservoirs, reservoir simulation, grid, ECLIPSE, Petrel, PVTi, Water-Vapour Phase Equilibrium Coefficients, GASWAT, E300

The Thermal CO2STORE simulation is being used in order to model the, often seen in dry gas reservoirs, salt deposition phenomenon [3]. Moreover, with the help of K values or phase equilibrium coefficients tables, the gas phase/aqueous phase equilibrium is modelled. A simple GASWAT dataset can be used in order generate values for these tables. The methodology is described in the following lines.

As the pressure declines at constant temperature, water is vaporised given the increase of the molar water content in the gaseous phase [4]. This process can be simulated in ECLIPSE by using the GASWAT option. The consequence of producing this vaporised water by the gas stream is the gradual increase of the concentration of dissolved salts in water, which, at some time, will cause, when the solubility limit will be reached, solid salt precipitation. This process is not covered by the GASWAT add-on and, in order to take it into account, we will have to make use of the Thermal CO2STORE option tuned with SOLID. In this case, in order to control water-vapor phase equilibrium at the reservoir temperature, specified by the KWTEMP keyword, the KWTABTn keywords will have to be defined.

After researching the domain literature, it has been found that a paper which deals with the gas phase/aqueous phase equilibrium for different salt concentrations is *Peng-Robinson predictions for hydrocarbons, CO2, N2, and H2S with pure water and NaCl brine* written by Ingolf Soreide and Curtis H.Whitson [5[.

The abstract of the paper states that attempts at predicting mutual solubilities with a conventional cubic equation of state EOS including the effect of salts in the aqueous phase have so far been limited. The main purpose of this work is to provide a simple and novel approach for predicting mutual solubilities of brine/hydrocarbon mixtures with an EOS at high pressures and temperatures, including the effect of salinity in the aqueous phase. The Peng-Robinson EOS has been applied in this study with two modifications: (1) an alpha-term in the EOS constant a has been developed specifically for the water/brine component as a function of sodium chloride NaCl brine salinity and pure water reduced temperature, Tr, and (2) two sets of binary interaction parameters BIP in the classical mixing rule for mixture EOS constant a have been determined as a function of acentric factor, temperature, and salinity. Experimental data of vapor pressures and mutual solubilities provide the basis for the proposed methods. Applications of the methods described include phase behavior prediction of reservoir gas-oil/brine systems at high pressures, including (1) gas solubility in water/brine and (2) water solubility in hydrocarbon reservoir fluids [6].

At the moment, PVTi, fluid mixture modelling software using equations of state, is not the best tool to model water – hydrocarbons interactions and the above mentioned equation is not implemented there.

Among the GASWAT features in the ECLIPSE Technical Description we can find the following statement: The GASWAT option in ECLIPSE 300 provides a method of modeling gas phase/aqueous phase equilibria using an equation of state. The Peng Robinson equation of state is modified following the suggestions of Soreide and Whitson to obtain accurate gas solubilities in the aqueous phase [7].

Therefore, in order to obtain the required input for the KWTABTn, ECLIPSE keyword required to input the phase equilibrium coefficients, a simple one cell GASWAT dry gas model can be used.

This cell is characterised by a rock volume which is in fact a geometric volume. This rock volume is multiplied with the porosity in order to obtain a pore volume. The saturation of a phase is defined as the volume of that phase divided by the pore volume. Implicitly, the SGAS, or gas saturation of the cell is the volume of gas from the cell divided by the pore volume. If gas will be the only phase present, the saturation will be 1, or if expressed in percentages, 100%. If water is present, the water saturation, SWAT, is defined as the volume of water divided to the pore volume. As the pore volume is occupied with

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* *email: dumitrache.liviu@gmail.com; Phone: (+40)729816089*

fluid, the phase saturations, in this case SGAS and SWAT should add up to 1 or 100%. \

Experimental part

Proposed Methodology

The steps taken in achieving the above described are the following:

1.Create a simple GASWAT (1 cell) model (current case two models: Equilibration initialization +NEI non equilibrium initialization);

2.Populate it with the required fluid mixture in order to obtain the necessary interactions;

3.Make sure that the first value of the reservoir temperature fixed in the KVTEMP keyword is specified in this deck;

4.Assign the correct salinity value of the reservoir water using the SALINITY keyword;

5.Run the equilibration initialization;

6.Adjust the required NEI dataset with required values for water saturation, SWAT, and gas saturation, SGAS;

7.Deplete the model as required for the different pressures which will populate the KWTABT keyword;

8.Visualize results in Petrel and create calculated results in order to easily export the K values;

9.Generate the keyword input using Excel;

10.Repeat for the other temperature values specified in KVTEMP ECLIPSE keyword.

The above steps are exemplified and more detailed instructions are given below. All the models used are attached to the current content for further use and analysis.

Results and discussions

Determining Water-Vapour Phase Equilibrium Coefficients

The mixture for which the KWTABT is required consists of a mixture of water and dry gas characterized with the following components CO_2, H_2O, CH_4, NaCl. The required initial SWAT=0.46 and an initial SGAS=0.54. For the GASWAT dataset we will adjust the existing fluid (C1, C2, CO_2, H_2O – COMPVD) to contain only C1 and H_2O. The salinity of the water (110,000.00 ppms = 2.115 gm-M/kg) is introduced using the SALINITY keyword.

The required pressure range is between 330 and 10 bar. The temperatures imposed in the KWTEMP keyword are 50 and 70 degrees Celsius.

The following presents an implementation of the above proposed methodology:

1.Create the simple GASWAT models;

2.Populate it with the required fluid mixture in order to obtain the necessary interactions:

Initially, we consider the mole fractions to be different than 0 for the components required (C1 and H2O) and attribute them values that will add up to 1.

This case is initialized and initial pressure is saved into a restart file that will be input for the second simulation case in which non equilibrium initialization is being used to respect the initial values for water and gas saturations.

3.Set the RTEMP keyword to 50 deg Celsius;

4.Insert the salinity of the water to be 2.115 gm-M/kg;

5.Run the equilibration;

6.Adjust the required NEI dataset with required values for SWAT and SGAS (SWAT=0.46, SGAS=0.54). When the NEI keyword is being used, ECLIPSE will obey the saturation values imposed by SWAT and SGAS in the SOLUTION section and will overwrite the mole fractions specified in the NEI keyword;

7.Deplete the model as required for the different pressures which will populate the KWTABT keyword;

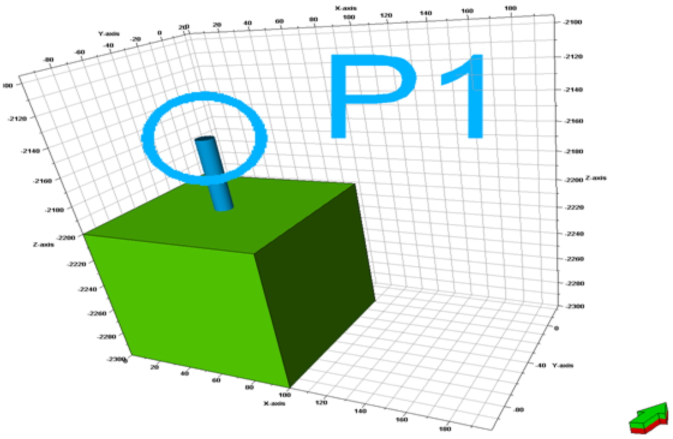


Fig. 1 Cell water saturation, SWAT - confirmation of the requested value of 0.46

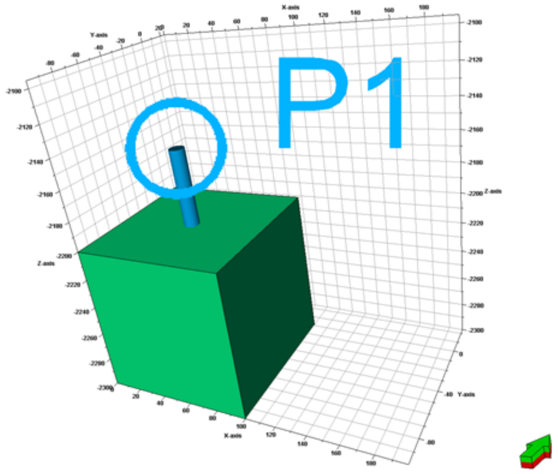


Fig. 2 Cell gas saturation, SGAS -confirmation of the requested value of 0.54

8.Visualize results in Petrel and create calculated results in order to easily export the K values;

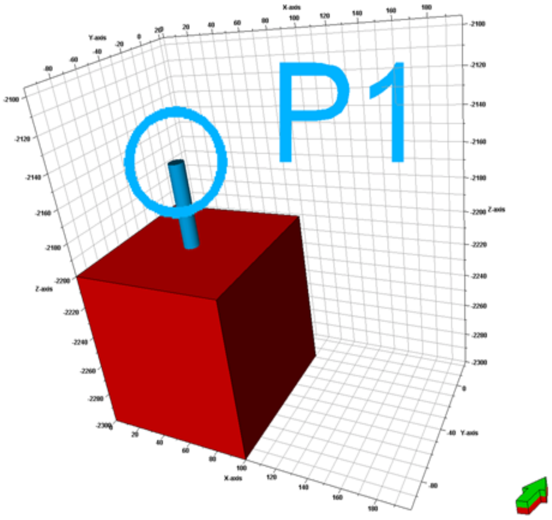


Fig. 3 Cell initial pressure, SGAS - confirmation of the requested value of 330 bar

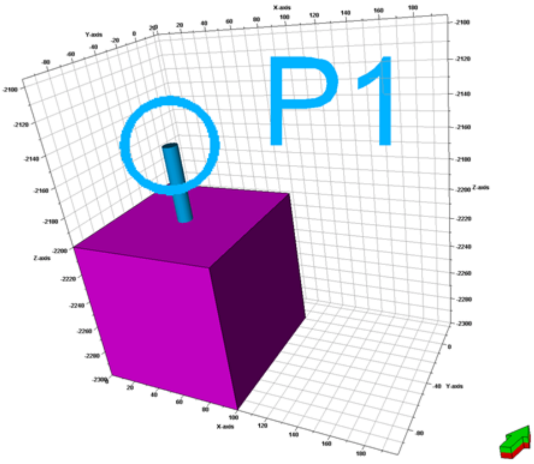
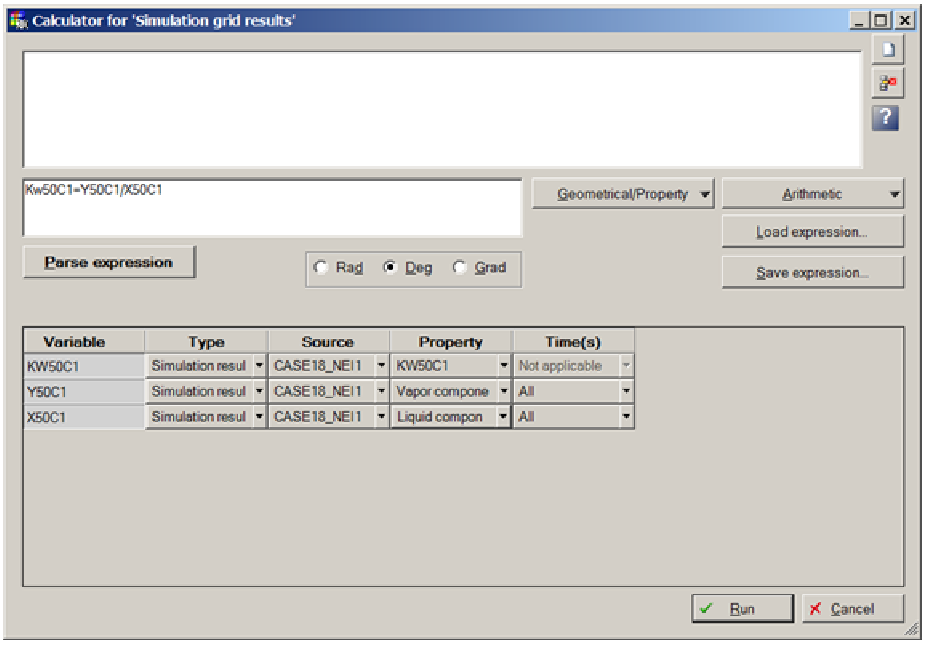


Fig. 4 Cell final pressure, SGAS - confirmation of the requested value of 10 bar

a.Are required saturations obeyed? As suggested by figures 1 & 2 the gas and water saturations are obeyed.

b.Is the required pressure range covered? As suggested by figures 3 & 4 the pressure range is covered.

c.Create Calculated Results to determine the Kw values as presented in figures 5 and 6. By definition, the K value, or the equilibrium coefficient for a certain component is defined by the ratio between the molar fraction under vapor phase (Y) and molar fraction under liquid phase (X).

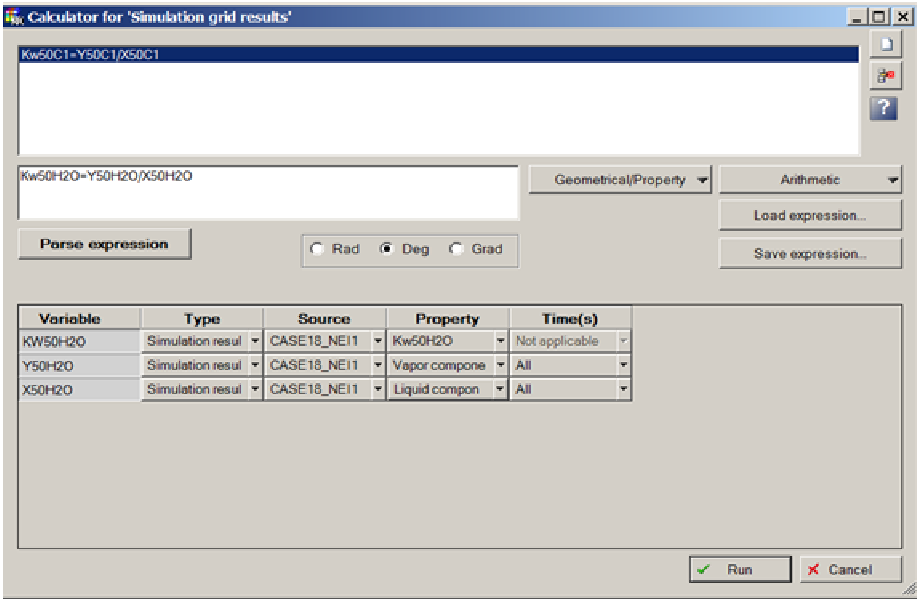


Kw50C1=Y50C1/X50C1

○ Rad ● Deg ○ Grad

Variable	Type	Source	Property	Time(s)
KW50C1	Simulation resul	CASE18_NEI1	KW50C1	Not applicable
Y50C1	Simulation resul	CASE18_NEI1	Vapor compone	All
X50C1	Simulation resul	CASE18_NEI1	Liquid compon	All

Fig. 5 K value calculation in Petrel for C1, CH_4, component at 50°C



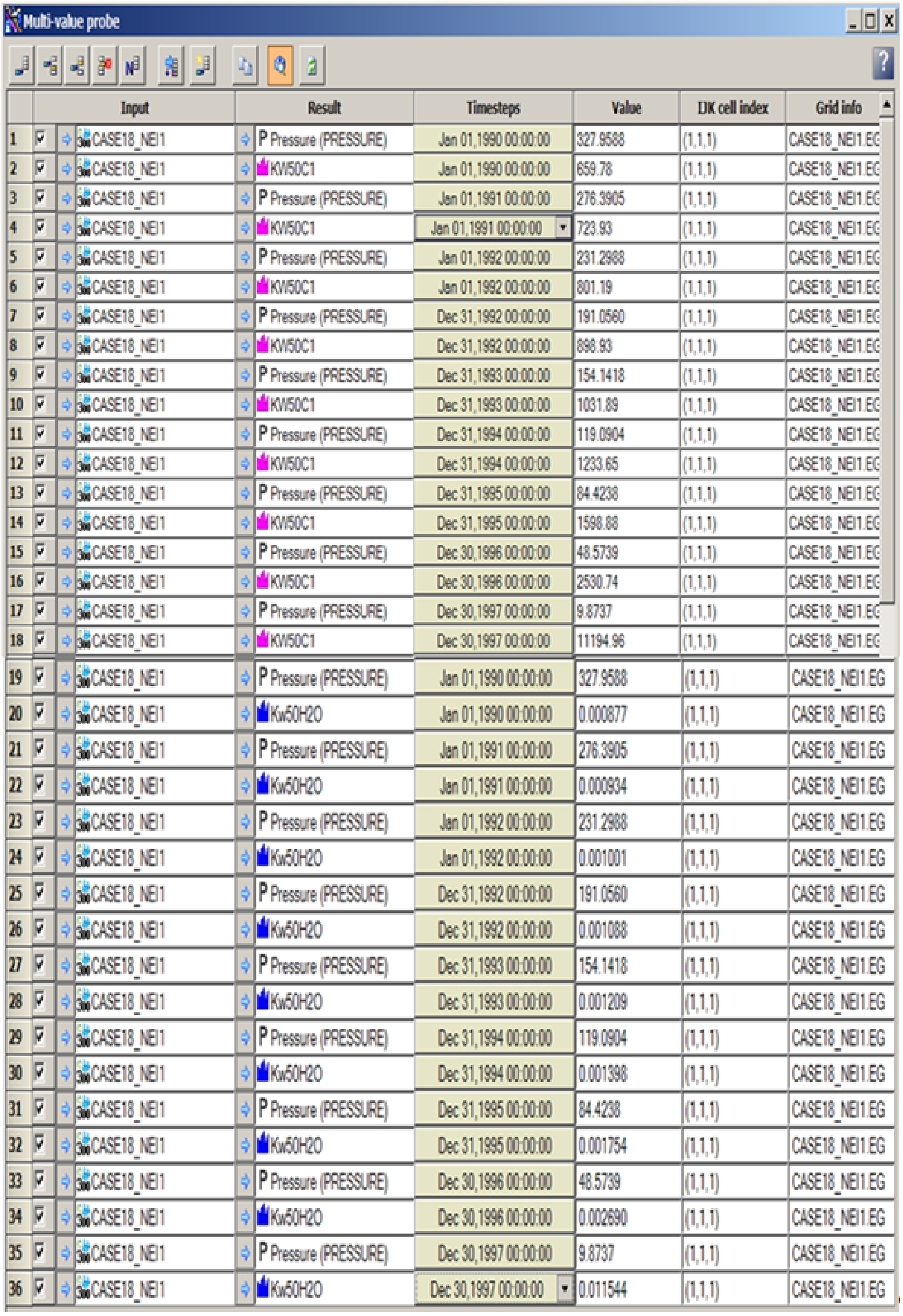
Kw50C1=Y50C1/X50C1

Kw50H2O=Y50H2O/X50H2O

○ Rad ● Deg ○ Grad

Variable	Type	Source	Property	Time(s)
KW50H2O	Simulation resul	CASE18_NEI1	Kw50H2O	Not applicable
Y50H2O	Simulation resul	CASE18_NEI1	Vapor compone	All
X50H2O	Simulation resul	CASE18_NEI1	Liquid compon	All

Fig. 6 K value calculation in Petrel for H_2O component at 50°C



		Input	Result	Timesteps	Value	IJK cell index	Grid info
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2	☑	CASE18_NEI1	KW50C1	Jan 01,1990 00:00:00	659.78	(1,1,1)	CASE18_NEI1.EG
3	☑	CASE18_NEI1	P Pressure (PRESSURE)	Jan 01,1991 00:00:00	276.3905	(1,1,1)	CASE18_NEI1.EG
4	☑	CASE18_NEI1	KW50C1	Jan 01,1991 00:00:00	723.93	(1,1,1)	CASE18_NEI1.EG
5	☑	CASE18_NEI1	P Pressure (PRESSURE)	Jan 01,1992 00:00:00	231.2988	(1,1,1)	CASE18_NEI1.EG
6	☑	CASE18_NEI1	KW50C1	Jan 01,1992 00:00:00	801.19	(1,1,1)	CASE18_NEI1.EG
7	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1992 00:00:00	191.0560	(1,1,1)	CASE18_NEI1.EG
8	☑	CASE18_NEI1	KW50C1	Dec 31,1992 00:00:00	898.93	(1,1,1)	CASE18_NEI1.EG
9	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1993 00:00:00	154.1418	(1,1,1)	CASE18_NEI1.EG
10	☑	CASE18_NEI1	KW50C1	Dec 31,1993 00:00:00	1031.89	(1,1,1)	CASE18_NEI1.EG
11	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1994 00:00:00	119.0904	(1,1,1)	CASE18_NEI1.EG
12	☑	CASE18_NEI1	KW50C1	Dec 31,1994 00:00:00	1233.65	(1,1,1)	CASE18_NEI1.EG
13	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1995 00:00:00	84.4238	(1,1,1)	CASE18_NEI1.EG
14	☑	CASE18_NEI1	KW50C1	Dec 31,1995 00:00:00	1598.88	(1,1,1)	CASE18_NEI1.EG
15	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 30,1996 00:00:00	48.5739	(1,1,1)	CASE18_NEI1.EG
16	☑	CASE18_NEI1	KW50C1	Dec 30,1996 00:00:00	2530.74	(1,1,1)	CASE18_NEI1.EG
17	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 30,1997 00:00:00	9.8737	(1,1,1)	CASE18_NEI1.EG
18	☑	CASE18_NEI1	KW50C1	Dec 30,1997 00:00:00	11194.96	(1,1,1)	CASE18_NEI1.EG
19	☑	CASE18_NEI1	P Pressure (PRESSURE)	Jan 01,1990 00:00:00	327.9588	(1,1,1)	CASE18_NEI1.EG
20	☑	CASE18_NEI1	Kw50H2O	Jan 01,1990 00:00:00	0.000877	(1,1,1)	CASE18_NEI1.EG
21	☑	CASE18_NEI1	P Pressure (PRESSURE)	Jan 01,1991 00:00:00	276.3905	(1,1,1)	CASE18_NEI1.EG
22	☑	CASE18_NEI1	Kw50H2O	Jan 01,1991 00:00:00	0.000934	(1,1,1)	CASE18_NEI1.EG
23	☑	CASE18_NEI1	P Pressure (PRESSURE)	Jan 01,1992 00:00:00	231.2988	(1,1,1)	CASE18_NEI1.EG
24	☑	CASE18_NEI1	Kw50H2O	Jan 01,1992 00:00:00	0.001001	(1,1,1)	CASE18_NEI1.EG
25	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1992 00:00:00	191.0560	(1,1,1)	CASE18_NEI1.EG
26	☑	CASE18_NEI1	Kw50H2O	Dec 31,1992 00:00:00	0.001088	(1,1,1)	CASE18_NEI1.EG
27	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1993 00:00:00	154.1418	(1,1,1)	CASE18_NEI1.EG
28	☑	CASE18_NEI1	Kw50H2O	Dec 31,1993 00:00:00	0.001209	(1,1,1)	CASE18_NEI1.EG
29	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1994 00:00:00	119.0904	(1,1,1)	CASE18_NEI1.EG
30	☑	CASE18_NEI1	Kw50H2O	Dec 31,1994 00:00:00	0.001398	(1,1,1)	CASE18_NEI1.EG
31	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 31,1995 00:00:00	84.4238	(1,1,1)	CASE18_NEI1.EG
32	☑	CASE18_NEI1	Kw50H2O	Dec 31,1995 00:00:00	0.001754	(1,1,1)	CASE18_NEI1.EG
33	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 30,1996 00:00:00	48.5739	(1,1,1)	CASE18_NEI1.EG
34	☑	CASE18_NEI1	Kw50H2O	Dec 30,1996 00:00:00	0.002690	(1,1,1)	CASE18_NEI1.EG
35	☑	CASE18_NEI1	P Pressure (PRESSURE)	Dec 30,1997 00:00:00	9.8737	(1,1,1)	CASE18_NEI1.EG
36	☑	CASE18_NEI1	Kw50H2O	Dec 30,1997 00:00:00	0.011544	(1,1,1)	CASE18_NEI1.EG

Fig. 7 K values vartion in time for different pressures

d.Using the multi-value probe in Petrel, investigate the variation of the recently created calculated results through time with pressure. In figure 7, we notice that in time pressure decreases between the ranges we are specifying.

9. Generate the keyword input using Excel – Paste in an excel spreadsheet the above results and arrange them so that input for the KWTABT will be obtained as presented in table 1.

Table 1

VALUES VARTION IN TIME FOR DIFFERENT PRESSURES

Property	Date	Value	Cell	Pressure, bar	KW50C1, ratio
Pressure	Jan 01,1990	327.9588	(1,1,1)	9.8737	11194.96191
KW50C1	Jan 01,1990	659.781616	(1,1,1)	48.5739	2530.739746
Pressure	Jan 01,1991	276.3905	(1,1,1)	84.4238	1598.884155
KW50C1	Jan 01,1991	723.93158	(1,1,1)	119.0904	1233.654297
Pressure	Jan 01,1992	231.2988	(1,1,1)	154.1418	1031.893188
KW50C1	Jan 01,1992	801.194824	(1,1,1)	191.056	898.930908
Pressure	Dec 31,1992	191.056	(1,1,1)	231.2988	801.194824
KW50C1		898.930908	(1,1,1)	276.3905	723.93158
Pressure	Dec 31,1993	154.1418	(1,1,1)	327.9588	659.781616

KW50C1	Dec 31,1993	1031.893188	(1,1,1)	Rearranged/Increasing	
Pressure	Dec 31,1994	119.0904	(1,1,1)		
KW50C1	Dec 31,1994	1233.654297	(1,1,1)		
Pressure	Dec 31,1995	84.4238	(1,1,1)		
KW50C1	Dec 31,1995	1598.884155	(1,1,1)		
Pressure	Dec 30,1996	48.5739	(1,1,1)		
KW50C1	Dec 30,1996	2530.739746	(1,1,1)		
Pressure	Dec 30,1997	9.8737	(1,1,1)		
KW50C1	Dec 30,1997	11194.96191	(1,1,1)		
				Pressure, bar	KW50H2O, ratio
Pressure	Jan 01,1990	327.9588	(1,1,1)	9.8737	0.011544
Kw50H2O	Jan 01,1990	0.000877	(1,1,1)	48.5739	0.00269
Pressure	Jan 01,1991	276.3905	(1,1,1)	84.4238	0.001754
Kw50H2O	Jan 01,1991	0.000934	(1,1,1)	119.0904	0.001398
Pressure	Jan 01,1992	231.2988	(1,1,1)	154.1418	0.001209
Kw50H2O	Jan 01,1992	0.001001	(1,1,1)	191.056	0.001088
Pressure)	Dec 31,1992	191.056	(1,1,1)	231.2988	0.001001
Kw50H2O	Dec 31,1992	0.001088	(1,1,1)	276.3905	0.000934
Pressure	Dec 31,1993	154.1418	(1,1,1)	327.9588	0.000877
Kw50H2O	Dec 31,1993	0.001209	(1,1,1)	Rearranged/Increasing	
Pressure	Dec 31,1994	119.0904	(1,1,1)		
Kw50H2O	Dec 31,1994	0.001398	(1,1,1)		
Pressure	Dec 31,1995	84.4238	(1,1,1)		
Kw50H2O	Dec 31,1995	0.001754	(1,1,1)		
Pressure	Dec 30,1996	48.5739	(1,1,1)		
Kw50H2O	Dec 30,1996	0.00269	(1,1,1)		
Pressure	Dec 30,1997	9.8737	(1,1,1)		
Kw50H2O	Dec 30,1997	0.011544	(1,1,1)		

Considering the mentioned components, in the order specified by the CNAMES (CO_2, H_2O, CH_4, NaCl) keyword and arranging the above as required, the KWTABT1 keyword for 50 deg Celsius will look as per table 2:

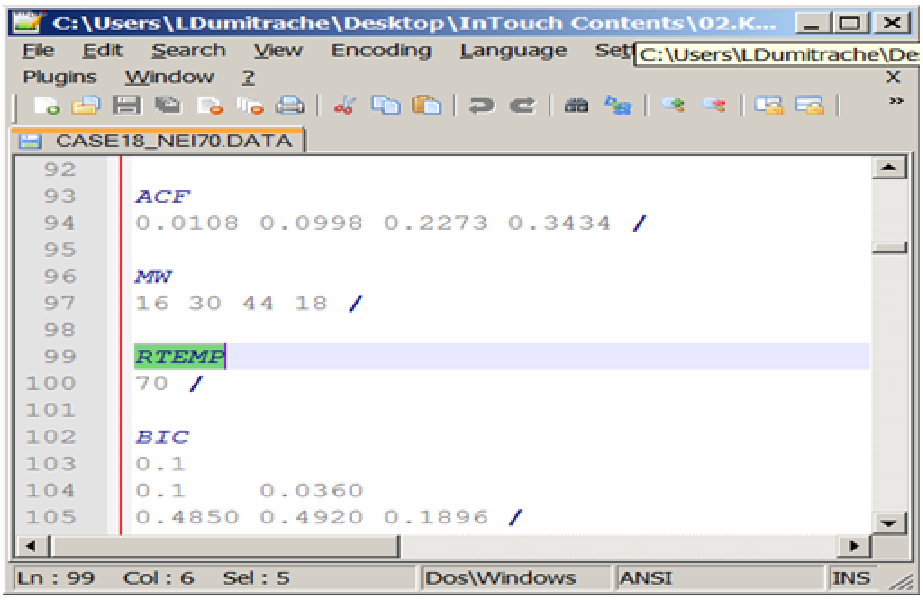
Table 2

KEYWORD AS REQUESTED TO BE INSERTED FOR SIMULATION

KWTABT1				
Pressure	**KW50CO2**	**KW50H2O**	**KW50C1**	**KW50NaCl**
9.8737	0.000001	0.011544	11194.96191	0.000001
48.5739	0.000001	0.00269	2530.739746	0.000001
84.4238	0.000001	0.001754	1598.884155	0.000001
119.0904	0.000001	0.001398	1233.654297	0.000001
154.1418	0.000001	0.001209	1031.893188	0.000001
191.056	0.000001	0.001088	898.930908	0.000001
231.2988	0.000001	0.001001	801.194824	0.000001
276.3905	0.000001	0.000934	723.93158	0.000001
327.9588	0.000001	0.000877	659.781616	0.000001

CO_2 and NaCl, in this case, will not go into the vapor phase very low K values have been attributed to them.

10. Repeat for the other temperature values specified in KVTEMP – in our case RTEMP=70 deg Celsius as per figures 8,9,10 and table 3 to obtain the necessary input.



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ACF
0.0108 0.0998 0.2273 0.3434 /

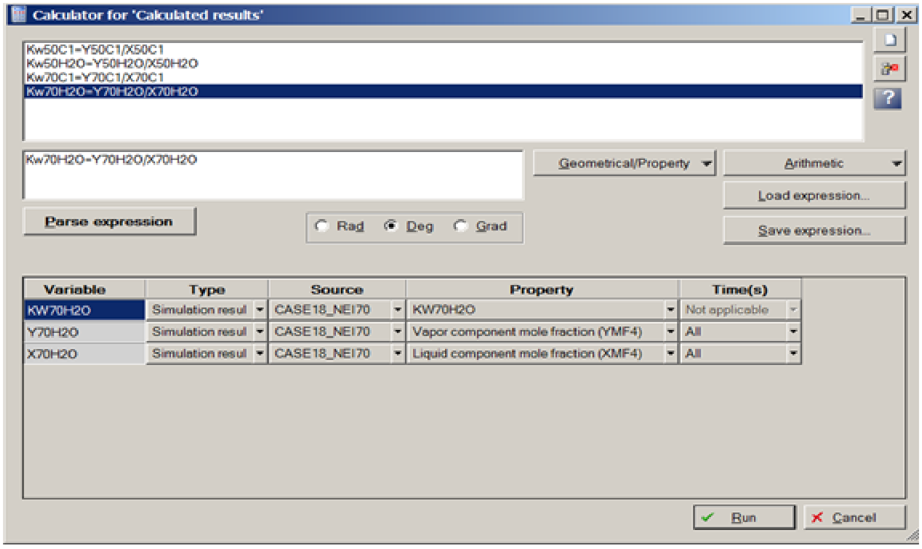
MW
16 30 44 18 /

RTEMP
70 /

BIC
0.1
0.1      0.0360
0.4850 0.4920 0.1896 /
```

Ln : 99 Col : 6 Sel : 5 Dos\Windows ANSI INS

Fig. 8. Reservoir temperature update in the ECLIPSE dataset



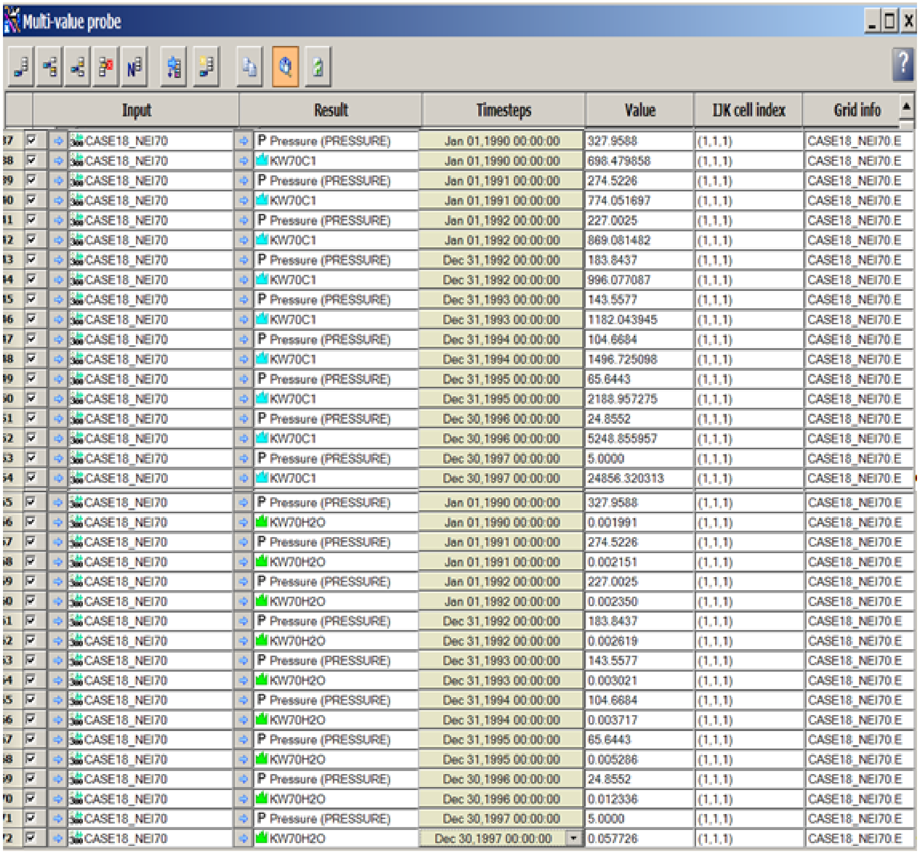
Kw50C1=Y50C1/X50C1
Kw50H2O=Y50H2O/X50H2O
Kw70C1=Y70C1/X70C1
Kw70H2O=Y70H2O/X70H2O

Kw70H2O=Y70H2O/X70H2O

○ Rad ● Deg ○ Grad

Variable	Type	Source	Property	Time(s)
KW70H2O	Simulation resul	CASE18_NEI70	KW70H2O	Not applicable
Y70H2O	Simulation resul	CASE18_NEI70	Vapor component mole fraction (YMF4)	All
X70H2O	Simulation resul	CASE18_NEI70	Liquid component mole fraction (XMF4)	All

Fig. 9. K value calculation in Petrel for H_2O component at 70 °C



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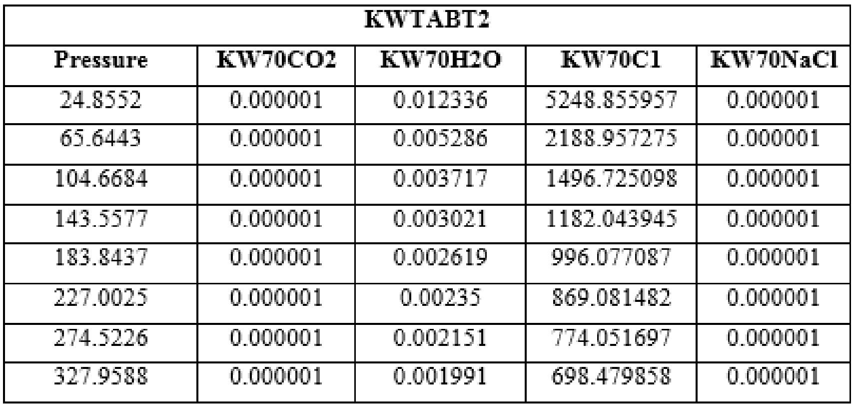
☑	CASE18_NEI70	P Pressure (PRESSURE)	Jan 01,1991 00:00:00	274.5226	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Jan 01,1991 00:00:00	774.051697	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Jan 01,1992 00:00:00	227.0025	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Jan 01,1992 00:00:00	869.081482	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1992 00:00:00	183.8437	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 31,1992 00:00:00	996.077087	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1993 00:00:00	143.5577	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 31,1993 00:00:00	1182.043945	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1994 00:00:00	104.6684	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 31,1994 00:00:00	1496.725098	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1995 00:00:00	65.6443	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 31,1995 00:00:00	2188.957275	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 30,1996 00:00:00	24.8552	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 30,1996 00:00:00	5248.855957	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 30,1997 00:00:00	5.0000	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70C1	Dec 30,1997 00:00:00	24856.320313	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Jan 01,1990 00:00:00	327.9588	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Jan 01,1990 00:00:00	0.001991	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Jan 01,1991 00:00:00	274.5226	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Jan 01,1991 00:00:00	0.002151	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Jan 01,1992 00:00:00	227.0025	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Jan 01,1992 00:00:00	0.002350	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1992 00:00:00	183.8437	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 31,1992 00:00:00	0.002619	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1993 00:00:00	143.5577	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 31,1993 00:00:00	0.003021	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1994 00:00:00	104.6684	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 31,1994 00:00:00	0.003717	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 31,1995 00:00:00	65.6443	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 31,1995 00:00:00	0.005286	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 30,1996 00:00:00	24.8552	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 30,1996 00:00:00	0.012336	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	P Pressure (PRESSURE)	Dec 30,1997 00:00:00	5.0000	(1,1,1)	CASE18_NEI70.E
☑	CASE18_NEI70	KW70H2O	Dec 30,1997 00:00:00	0.057726	(1,1,1)	CASE18_NEI70.E

Fig. 10. K values vartion in time for different pressures



KWTABT2				
Pressure	KW70CO2	KW70H2O	KW70C1	KW70NaCl
24.8552	0.000001	0.012336	5248.855957	0.000001
65.6443	0.000001	0.005286	2188.957275	0.000001
104.6684	0.000001	0.003717	1496.725098	0.000001
143.5577	0.000001	0.003021	1182.043945	0.000001
183.8437	0.000001	0.002619	996.077087	0.000001
227.0025	0.000001	0.00235	869.081482	0.000001
274.5226	0.000001	0.002151	774.051697	0.000001
327.9588	0.000001	0.001991	698.479858	0.000001

Table 3
KEYWORD AS REQUESTED
TO BE INSERTED FOR
SIMULATION

Conclusions

So far, with the help of comercial fluid modfeling packages obtaining equilibrium coefficients for components dissolved in water is an almost impossible task due to the fact that not all of them have implemented a modified equation of state which models the interactions between these components.

Following the above workflow, the modified, as per the suggestions of Soreide and Whitson, Peng Robinson equation of state is used in ECLIPSE with the help of the GASWAT option in order to obtain accurate water solubilities in the gas phase.

Sensitivity analyses done on reservoir water salinity using ECLIPSE GASWAT, confirm the increase of water vaporization the lower its salinity will be.One observation that is worth mentioned is the one related to water density. This value has abnormal low values which have been reported in the past.

Moreover, the use of the SALINITY keyword will increase the density of the water, but will not bring it to an expected value for relevant reservoir conditions.

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