Saphir Guided Session # 6

A01 • Requirements

There are no special requirements for this guided session as we will use the test design facility of Saphir.
The objective of this guided session is to illustrate some of Saphir multiphase abilities.
You will be led through some of the Saphir dialogs and screens to enable the simulation of the pressure response of a multiphase producer (oil and water) coupled with a water injector (into oil).
The evolution of the fluid saturations will also be studied.

B01 • Initialization

Run Saphir and start a new project. Keep the well and reservoir characteristics at the default values and specify the reference phase as oil, and in the “available rates”, add water. Specify numerical analysis; this will invoke the non linear multiphase simulator with constant composition. See Fig. B01.1.

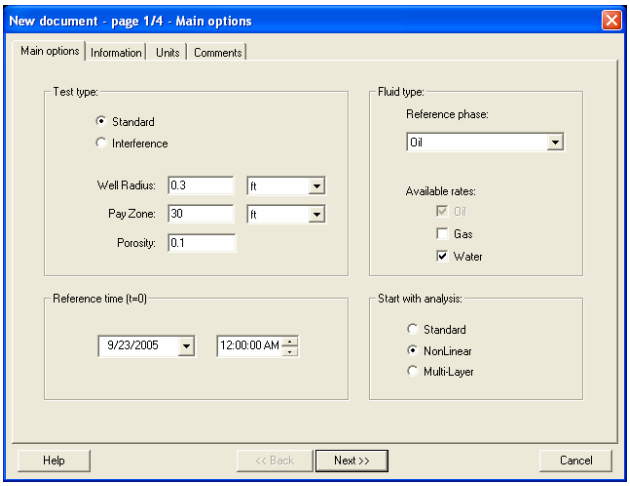


Fig B01.1 Initialization

The next screen is the document or project specific PVT dialog. Automatically “Dead” oil is selected with water. Leave the default PVT characteristics;

Accept the next PVT screen and change Sw to 0.2 in the final PVT dialogue. Click on the button “So and Sg from flash”  to adjust the value of So. The saturations entered here are only used for a constant system compressibility calculation. You will later specify the “Analysis” specific PVT and define initial saturations for model generation and simulation. The next screen shows the PVT characteristics calculated for the reference phase. 

will define the new project.

B01.1• Numerical "Interpretation" panel

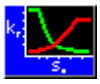
After the creation of the new project, Saphir switches automatically to the "Interpretation" panel and creates 

new analysis tab.

Two new buttons are added to the "Interpretation" panel.



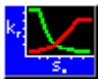
Edit numerical PVT. This PVT is "Analysis" specific.



Edit numerical Kr. The definition is "Analysis" specific.

B01.2 • Analysis specific PVT and Kr

Click on  in the "Interpretation" panel. This accesses the analysis specific PVT dialog and you can here change the parameters. Observe that "Dead Oil" and "Water" has been carried over from the document specific PVT defined during start up. In this guided session keep the default values.

Click on  to define the relative permeability definition for this analysis. In the tab "KrData" enter the following values:

Swr = 0.1, Sorw = 0.2, Krwo = 1, Krow = 1. Use the power law model at power 1.65 and 2 respectively for water and oil with no extrapolation. See Fig B01.2.

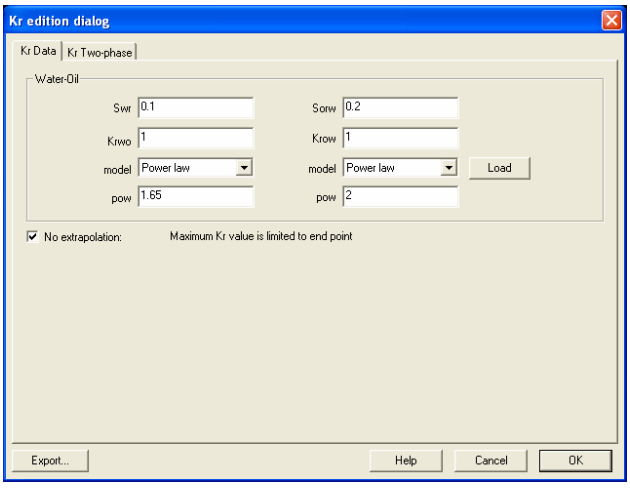


Fig B01.2

You can access the plot of the relative permeabilities versus the water saturation by clicking on the tab "Kr Two-phase". Fig. B01.3.

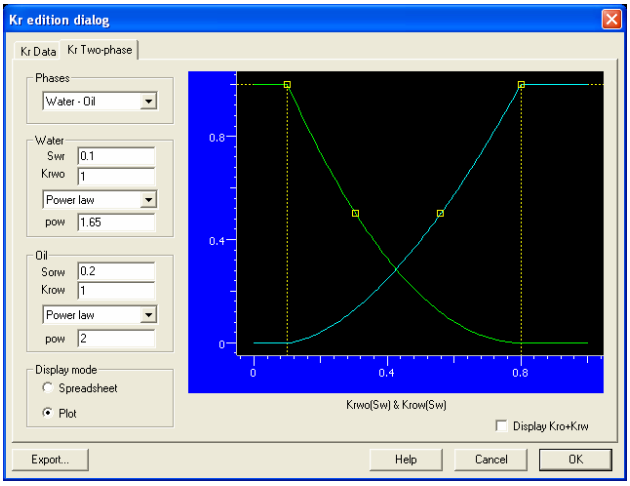
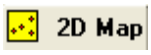


Fig. B01.3

It is possible to interactively change the relative permeability curves at the click of the mouse by dragging the handles (yellow squares) on the curves.

B01.3 • Defining the 2-D Map and the wells

Click on the tab 

to access the 2-D Map.

Now add a vertical well at coordinate (-3000 ft, 0), use the  icon to place the well approximately. Double click on the well and set the coordinates exactly.
Double click on the tested well to define the production history. Click on the tab “Production” and enter 1000 days of Oil rate = 5,000 STB/D and Water rate = 500 STB/D. Fig B01.4 left. Double click on Well# 1 and specify it as an injection well by entering a negative water rate. Enter the same duration as the “Tested well” and a Water rate = -6,000 STB/D and no Oil production Fig B01.4 right.

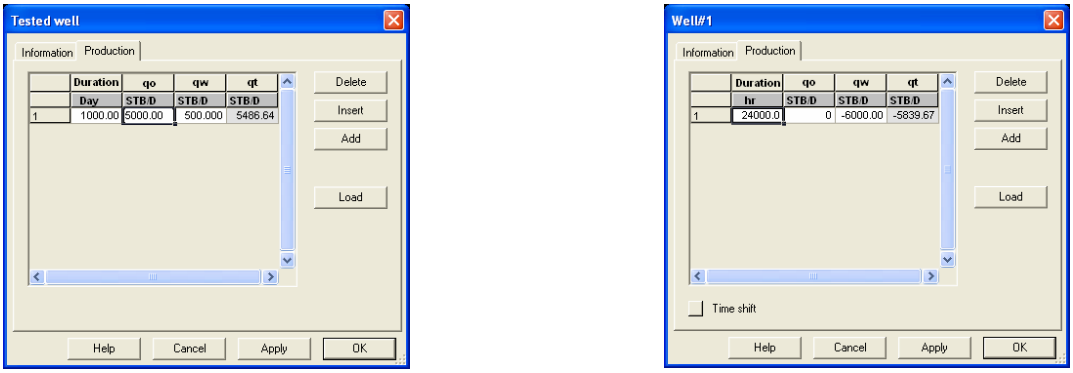


Fig B01.4: Tested well & Well#1 productions

B01.4 • Running the simulation

Click back on the tab NonLinear 1. Choose the option “Test Design” in the More tools panel. Check “add other wells” and “store pressure fields”, run the simulation with initial pressure Pi= 5,000 psia, permeability kh= 1500 mDft and initial water saturation Swi= 0.2. See Fig. B01.5.

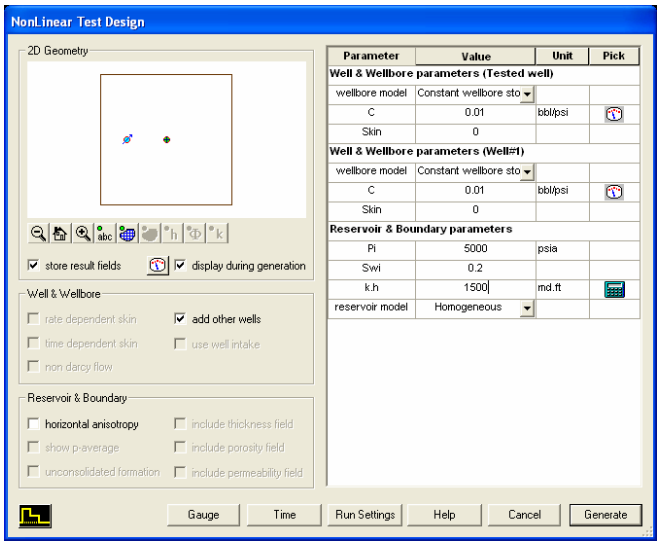


Fig B01.5

The simulated pressure response is illustrated in Fig. B01.6.

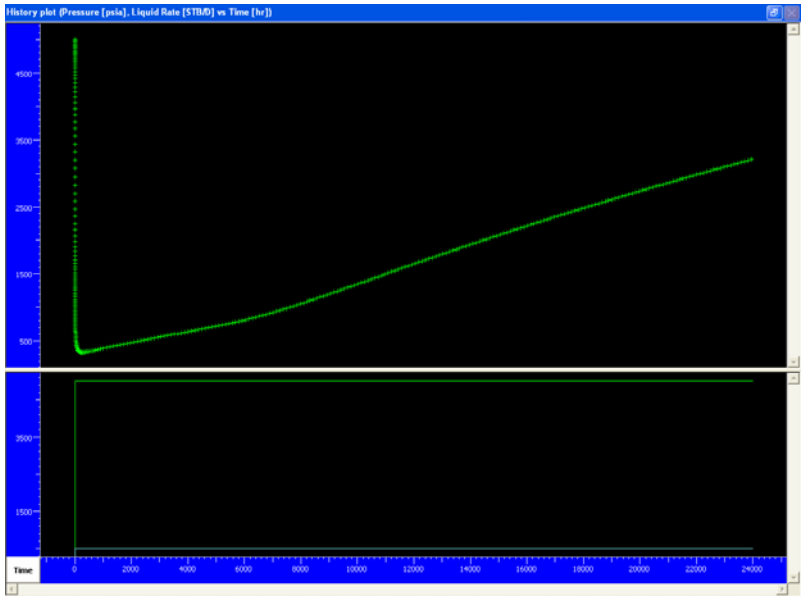


Fig B01.6

Extract dP to see the loglog plot and click on Model to generate the simulation again with the default parameters. Check “display during generation”. The main screen after generation is illustrated in Fig. B01.7.

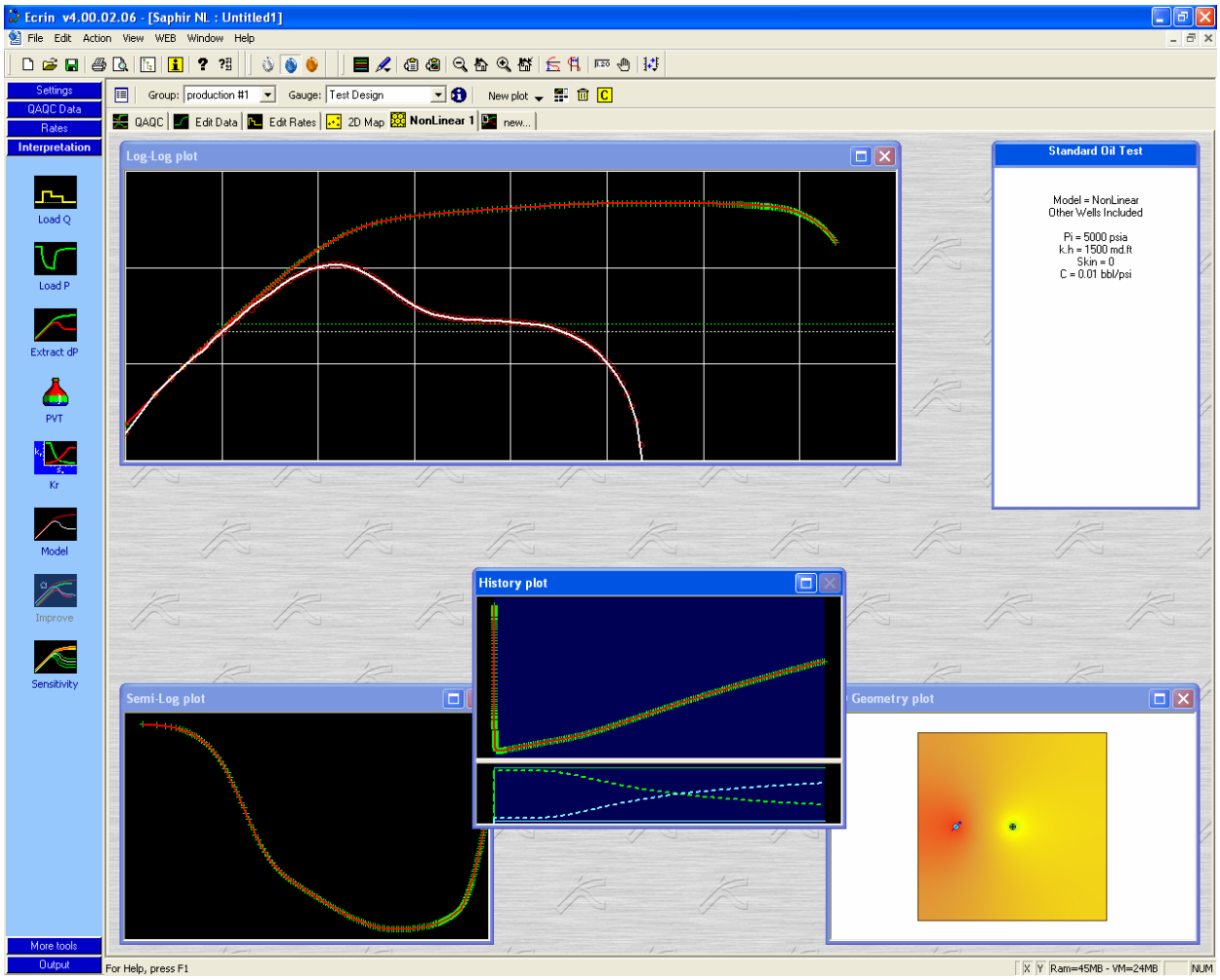


Fig. B01.7

There are now two match lines on the loglog plot. The white dotted line corresponds to the stabilization obtained if only the oil phase is mobile. The green dotted line corresponds to the stabilization at Swi (initial water saturation specified in the model).The results returned are the absolute permeability kh and the effective permeabilities to oil and water at Swi.

You can now display the simulated pressure history and the simulated phase rates in the history plot. You can right click in the rate area of the history plot and select “Show phase rates” – “All” or use the  icon in the toolbar.

The history plot is illustrated in Fig. B01.8. You can observe that water breakthrough happens at about 4000 hrs production.

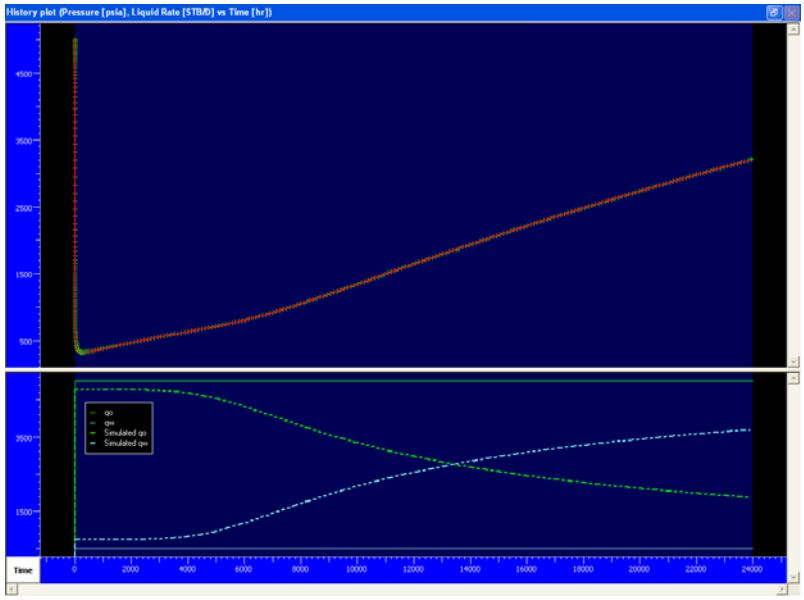


Fig. B01.8

B01.5 • Simulation value fields

The geometry plot is automatically created. Maximize the plot and click on the settings icon to define the settings of the value fields available. The field values “Pressure”, “Sw” and “So” have been generated and can be selected using the droplist under “Gridding and Shading”. Choose the field value Sw (water saturation). Click on the “Color Scale “ tab and check that you have 3 colors as illustrated in Fig. B01.9. Check “the always visible” checkbox which will display the scale of the color coding of the current value field. Then click the button to return to 0, and play back the fields using the button .

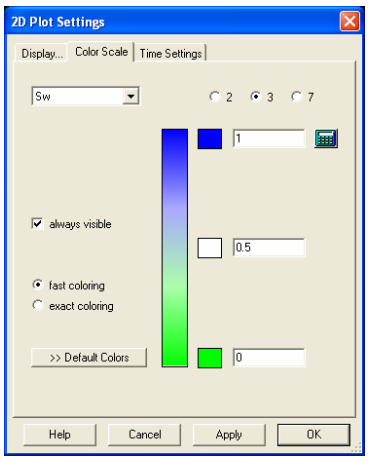


Fig. B01.9

Early in the playback it is clearly observed that water is breaking through, Fig B01.10.

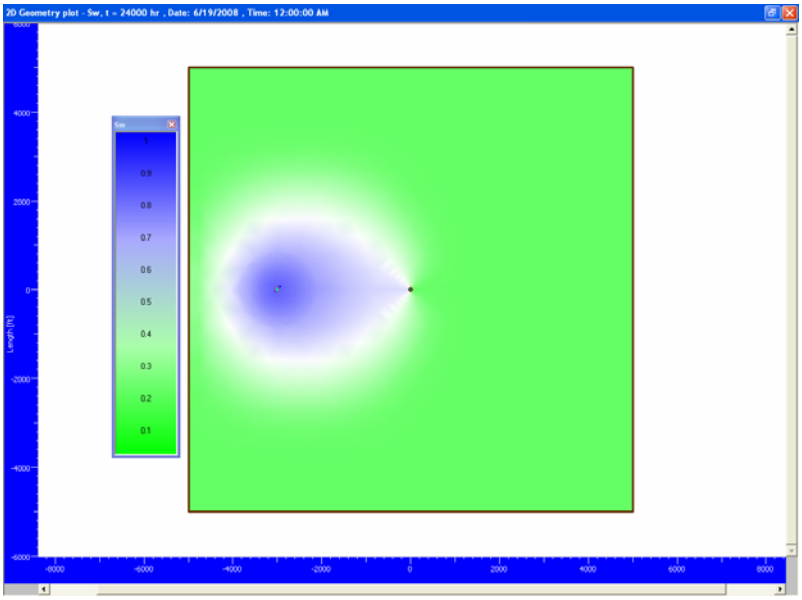


Fig. B01.10

Click on the toolbar button  in the geometry plot to display the pseudo 3-D plot. The shading is Sw and the vertical scale is the pressure.

The 3D plot will look something like Fig. B01.11 depending on the settings and the zoom applied. The pseudo 3-D plot exhibits the pressure variation as the vertical scale, showing clearly the injection and the production well. The color coding is the evolution of Sw (in this case after 1,000 days production). The plot indicates clearly that the injected water is pouring into the producing well.

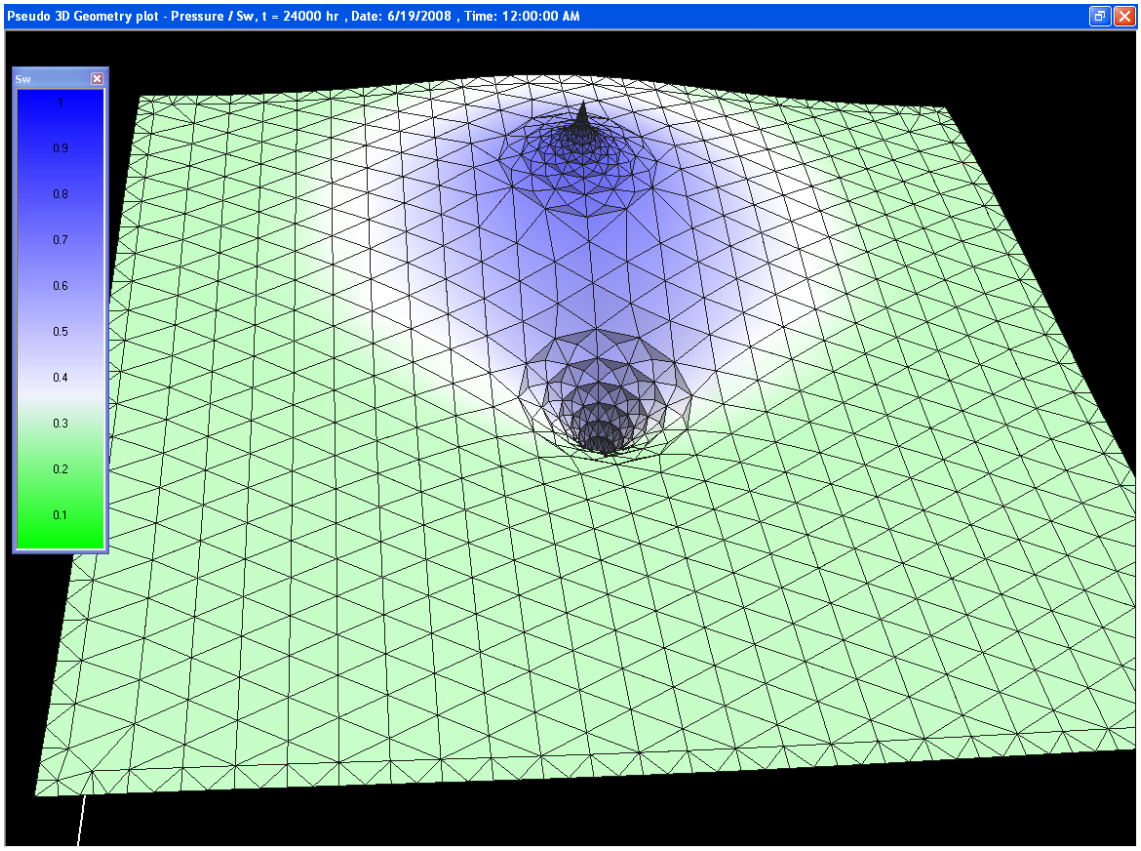

Pseudo 3D Geometry plot - Pressure / Sw, t = 24000 hr , Date: 6/19/2008 , Time: 12:00:00 AM
Sw
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

Fig B01.11