

Saphir Guided Session #1



A01 • Initialization

This chapter is an introduction to the basic features of Saphir. It is assumed that you have installed Ecrin workstation or Saphir stand alone to follow this session. The session can be followed in all levels of Saphir except the Saphir reader.

Note: By default, the plot 'Always show scales' option is on. In this guided session, it has been turned off (in Settings – Plot Aspects - Plots tab).

The session will use the following files installed in the example directory during the main installation of Saphir or workstation Ecrin: SapGS01.rat, the rate file and SapGS01.pre, the pressure file. The extension to the files is not important here as any ASCII file can be loaded by the application.

Main options Information Units Comments	
Test type:	Fluid type:
 Standard 	Reference phase:
C Interference	Oil
Well Radius: 0.3 ft Pay Zone: 30 ft Porosity: 0.1	Available rates: ☑ Oil ☐ Gas ☐ Water
Reference time (t=0)	Start with analysis:
12/ 4/1999 V 12:06:45 AM ·	Standard NonLinear shale gas
	C coalbed methane
	C Formation Test
	C Slug-Pulse

Fig. A01.1 • Initialization dialog 1 of 2

This dialog allows you to choose the test type, reference fluid type, the available fluid rates, net drained thickness, well radius and average porosity. Set the reference time to **Dec 4, 1999 at 00:06:45 hours**. Keep all other parameters as the suggested default.

Formation Volume Factor B
Viscosity µ 1 cp Total compressibility ct 3E-6 psi-1
This PVT window does not apply for NL and Rubis sector analyses, where specific PVT settings are accessed from the analysis control panel tab.
Calculate from correlations So 1 Co N/A Sg 0 cg N/A
Sw 0 cw N/A psi-1 v So and Sg from Flash

Fig. A01.2 • Initialization dialog 2 of 2

You input the PVT characteristics, the formation volume factor, the fluid viscosity and the system compressibility. Keep all values at their suggested defaults.

Click Create >>> to create the new project. The Saphir main screen is displayed.

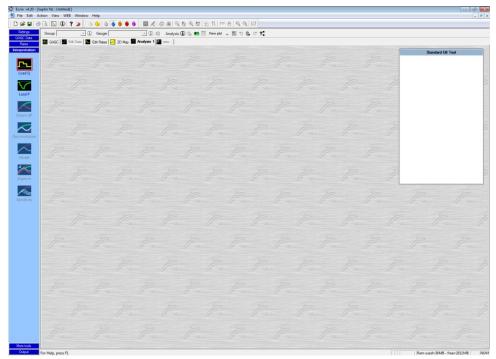


Fig. A01.3 • *Saphir main screen*

The main screen is opened with the 'Interpretation' page active. This page (or panel) contains seven icons and by clicking consecutively on the icons from top to bottom, executing the dialogs and instructions, you will follow exactly the default path of the basic workflow used in pressure transient analysis.

B01 • Loading data

B01.1 • Loading rates

Click . This will initialize the load sequence which is usually a sequence of two dialogs. Specify an ASCII file in the 'Define data source' dialog and click on 🖆 to browse to the file SapGS01.rat in the Example directory. A preview of the file will be shown in the dialog as illustrated in Figure B01.1.

Select type o	of data source						
С	File Database From an oper	Ascii file EcrGS01 Plugin ned Ecrin document	 ✓ ✓ ✓ ✓ 	 C Elipboard C Keyboard - notepad C Keyboard - spreadsheet C Real time 	2 +	columns	
1.40416 0.30905 0.17265 0.16379 0.16379 2.95353 7.60049	- 66667908 88496033 06334350	Time (hr) 43 0 0 264 1600 20.6 71 1300 29.95 751 900 36.09 762 700 40.87 08 840 144.24 06 620 340.59	92298855976 54767778312	∬./at Cumulative Volume (STB)			
Append to				Help	Cance		+ (t >>

Fig. B01.1 • Load step 1 – Define data source

Click Next>>> to go to the Data Format dialog. Saphir has recognized the file as valid and has automatically assigned the first column as 'Decimal Time' and the second as 'Oil Rate'. This is known as 'free format'. The units are correct so no need to change the formatting proposed by Saphir. See Figure B01.2.

More lines Er	nough! 11 lines							
	1111165		lines in file - numbr	er of points in file is 11				
	Time (hr)	Liqu	id Rate STB/D)	Cumulative Vol (ST				
1.4041666667	90843 0 0			(01	- /			
0.3090588496 1.1726506334		0.6039256.95583608						
1637967547	973751 900 36	.09821510	059306					
0.1637967547 2.9535313405		.87562100						
7.6004990000	74506 620 340	.59547677	78312					
3.0869444443	96067 0 340.5	954767778	312					
Field	Туре	Unit	Name	Info	Well	Filter	Window	
1.404167	Decimal time	hr 💌	N/A Production	N/A N/A	N/A	N/A	N/A N/A	
0.000000	Oil rate 💻	STB/D 💌	Production	IWA	Tested well	N/A	IWA	
Lines Format			nat Points Steps : durations		s elapsed time	2/ 4/199	99 - 12:0	16:45 PM 📩
C Column			Steps : time @ star					
-			Steps : time @ end					
C Free format	pressure 💌							
C Free format Separator	Decimal symbol							

Fig. B01.2 • Load step 2 – Data Format

Click on <u>Load</u> to load the flow rate file. A history plot with the loaded flowrate file in steps is displayed. Double click in the title bar of the plot to maximize it and display the scales.

A click on the time button in the time scale will change the scale to real time (ToD) as defined with the reference date and time at startup. Minimize the plot.

History	plot (Pressure [psia], Liquid Rate [STB/D] vs Time [hr])			Ð
0.012					
0.008					
0.004					
1500-					
1000-					
-					
500-					
0					
ToD	00:00:00 12/4/1999	05:00:00	10:00:00	15:00:00	20:00:00

Fig. B01.3 • Loaded flowrates

B01.2 • Loading pressure

Click on the icon \checkmark . This will initialize the pressure load process. Specify an ASCII file in the 'Define data source' dialog and click on \succeq to browse to the file SapGS01.pre in the Example directory. A preview of the file will be shown in the dialog as illustrated in Figure B01.4.

Select type of data sour	ce -				
 File 	Ascii file	- 🖻	C Clipboard		
O Database	EcrGS01 Plugin	- 6	C Keyboard - notepad		
0.000000	,		C Keyboard - spreadsheet	2 🕂 columns	
C From an op	ened Ecrin document		C Real time		
view of file : L:\Program	n Files (x86)\KAPPA\Ecr420 Date	Data			
04/12/1999 00:	06:45 3257.29	(psia)			
	07:00 3351.53	(psia)			
04/12/1999 00: 04/12/1999 00: 04/12/1999 00:	07:00 3351.53 07:15 3390.65 07:30 3414.85	(psia)			
04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00:	07:00 3351.53 07:15 3390.65	(19314)			
04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00:	07:00 3351.53 07:15 3390.65 07:30 3414.85 07:45 3431.96 08:00 3445 08:15 3455.44	(1914)			
04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00:	07:00 3351.53 07:15 3390.65 07:30 3414.85 07:45 3431.96 08:00 3445 08:15 3455.44 08:30 3464.12 08:45 3471.44	(1918)			
04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00: 04/12/1999 00:	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	(1939)			
04/12/1999 00: 04/12/1999 00:	$\begin{array}{cccccccccccccccccccccccccccccccccccc$				
04/12/1999 00 04/12/1999 00	07:00 3351 53 07:15 3390.65 07:30 3414.85 07:45 3431.96 08:00 3445 08:15 3455.44 08:30 3445 08:30 3464.12 08:30 3464.12 08:30 3477.71 09:15 3483.15 09:30 3487.9 09:45 3492.13999				
04/12/1999 00 04/12/1999 00	$\begin{array}{rrrr} 07:00 & 3351, 53 \\ 07:15 & 3390, 65 \\ 07:30 & 3414, 85 \\ 07:45 & 3431, 96 \\ 08:00 & 3445 \\ 08:15 & 3455, 44 \\ 08:30 & 3464, 12 \\ 08:30 & 3464, 12 \\ 08:345 & 3471, 44 \\ 09:00 & 3477, 71 \\ 09:15 & 3483, 15 \\ 09:30 & 3487, 9 \\ 09:45 & 3492, 13999; \\ 10:00 & 3495, 99 \\ 10:15 & 3499, 48 \\ \end{array}$				
04/12/1999 00 04/12/1999 00	$\begin{array}{rrrr} 07:00 & 3351, 53 \\ 07:15 & 3390, 65 \\ 07:30 & 3414, 85 \\ 07:45 & 3431, 96 \\ 08:00 & 3445 \\ 08:15 & 3455, 44 \\ 08:30 & 3464, 12 \\ 08:30 & 3464, 12 \\ 08:345 & 3471, 44 \\ 09:00 & 3477, 71 \\ 09:15 & 3483, 15 \\ 09:30 & 3487, 9 \\ 09:45 & 3492, 13999; \\ 10:00 & 3495, 99 \\ 10:15 & 3499, 48 \\ \end{array}$				

Fig. B01.4 • Load pressure Step 1 – Define data source

Click Next>>> to go to the Data Format dialog. Saphir has automatically recognized the file as valid, but the automatic interpretation of the format is not correct, the first column contains the date, the second column contains the real time (ToD) and the third column is listing the pressure. Thus you need to manually specify the format.

Select the **Field** option in the Lines Format section. A spreadsheet like display is shown containing the data separated in three columns. Under the header **Type** you can define the various field types by choosing from the droplists. The type of the first field is Date **(DD/MM/YYY)**, the second is **ToD - Auto** and the lasts field is the value, **Pressure**. The pressure file is in **Points** mode.

Load - S	Step 2 - D	ata Fo	irmat								— ×-
м	tore lines		Enough! 100 line	es read - end of	file not reached - nur	nber of points in file is	3186				
	Α		в с								*
Date		Data									
(psi											
	2/1999	00:06									
	2/1999 2/1999	00:07:									
	2/1999	00:07:									
	2/1999	00:07									
	2/1999	00:08									
	2/1999	00:08									-
	Fiel	d	Туре	Unit	Name	Info	Well	Filter	Window		
A	04/12/1	999	31 [-] 12 [-] [19]94 💌	N/A	N/A	N/A	N/A	N/A	N/A		
В	00:06:4	5	ToD - Auto	N/A	N/A	N/A	N/A	N/A	N/A		
С	3257.29	00000	Pressure *	psia 💌	SapGS01	Not entered	Tested well				
	C Fr	e Id umn ee form	at pressure 💌	c c	nat Points Steps:durations Steps:time@istart Steps:time@iend	Gauge	s elapsed time preference time 1 line : Absolute 11 Elapsed 0	2/04/1999		6:45 AM	
	Sep	arator	Decimal symbol			Help	Cancel		< Back	Load >>	

Fig. B01.5 • *Load pressure Step 2 – Data format*

Click on <u>Load</u> to load the pressure file. The history plot contains now both the flowrate and the pressure file. Figure B01.6.

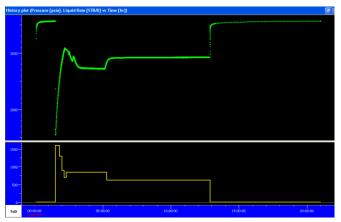


Fig. B01.6 • History plot

The pressure shows that the test is a simple DST, starting with some static pressure followed by a slug as the fluid rises in the well. Then finally flowing at surface, followed by two drawdowns on different choke sizes and a final buildup. The buildup is subject to the pressure transient analysis in this session.

C01 • Extracting delta P

The next natural step is to extract the buildup pressure to the loglog plot, compute the Bourdet derivative to be displayed together with the delta P to aid the interpreter to choose the model that may finally match the data and yield the results.

Click on the icon \frown . The first dialog is to choose the period to be extracted, in this case 'build-up #1'. The second dialog is to set the derivative smoothing, the filtrations (points/log cycle) and the starting pressure (P at dt=0, often also called Pwf), the default value of the pressure has been chosen by Saphir as the nearest pressure point to the change in flowrate (when the flowrate goes to zero for the buildup). Stay with the default values and click OK.

Extract delta-P	Extract dP - extraction parameters
Select gauge(s): <mark>SapGS01 ▼</mark> List Select group(s): build-up #1 ▼ List F	Parameters for gauge <sapgs01> and group <build-up #1=""> Smoothing: 01 Filtration (pts/cycle): 100</build-up></sapgs01>
	P at dt=0: 2924.08 psia
Skip parameters extraction dialog(s)	Initial Pressure: 3566.65
Help Cancel OK	Help Cancel OK

Fig. C01.1 • Extract dialogs

Now the Saphir screen contains two new plots; the loglog and the semilog plot. Figure C01.2.

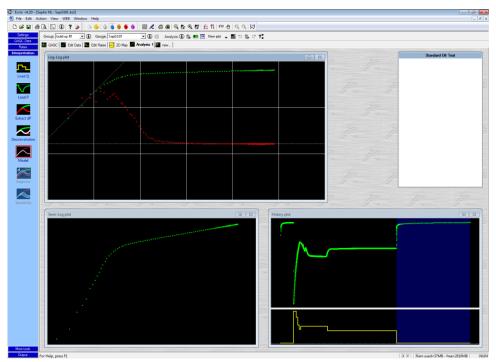


Fig. C01.2 • After extract

The extraction process can also be done automatically, i. e. without the intervention of the two dialogs in Figure C01.1. In that case it is always the last extractable period in the history that is extracted.

To invoke automatic extraction you hold down the shift key while clicking on the icon The red flash on the icon indicates that the extraction is in automatic mode.

At the extraction Saphir makes an automatic match. Stabilization is sought in the derivative, as well as a unit slope straight line at early time in both the derivative and the delta P. This corresponds to the two most common flow regimes seen in pressure transient analysis, namely infinite acting radial flow and wellbore storage. If Saphir can find these regimes it will make the match by setting the white horizontal dotted line on the stabilization of the derivative and the unit slope white dotted line on the early time data as seen in Figure C01.2. The lines are connected and can be moved to any other position by you (click and drag with mouse) in the event that the automatic match is not satisfactory.

D01 • Modeling

Once the match is satisfactory the process changes to diagnostic mode. The diagnostic phase includes the search for all flow regimes that may be present in the response of the extracted period. This allows the interpreter to choose the most appropriate model that includes all the flow regimes identified. Then the next natural process is to run the model and obtain the match which again will yield the results.

The response of this extracted flow period is straight forward with a long period of infinite acting radial flow and a small amount of wellbore storage to start with. Small wellbore storage was expected as this is a DST with downhole shut-in.

The most appropriate model to use in this analysis would be a model that takes this into account, hence the use of the homogeneous model with wellbore storage and skin in an infinite system.

Click on the Model icon . This will open the Model dialog where the combination of wellbore, well, reservoir and boundary models may be selected. The default model parameters are displayed in the dialog and you can modify them manually. The default values of C (wellbore storage coefficient) and kh (permeability thickness product) are deduced from the original automatic match made by Saphir. Keep the default values as seen in Figure D01.1.

Option Standard Model	•				
Wellbore model		Parameter	Value	Unit	Pick
Constant wellbore storage	-		parameters (Teste		FICK
🗖 use well intake 🔲 pseudo time		С	1.20436E-4	bb/psi	
		Skin	0	_	
Well model		Reservoir & Bou	undary parameters		
Vertical	-	Pi	3566.65	psia	
time dependent skin Reservoir model					
Homogeneous	•				
Boundary model					
Infinite	-				
show p-average					

Fig. D01.1. • Model dialog

Click on <u>Generate</u>. The model is generated and immediately it can be seen that there is an important mismatch between the model and the data, see Figure D01.2 left. This mismatch is caused by not having used the correct skin. By calling the Model dialog (Figure D01.1) again (and a few times) and manually changing the skin a good match will be obtained as seen in Figure D01.2 right. There is still a small problem with the match, the wellbore storage coefficient is not exactly right but this problem will be dealt with in the next section.

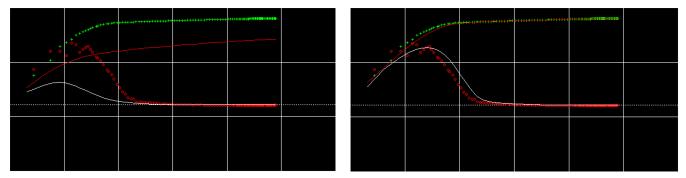


Fig. D01.2 • Loglog matches

It is also possible to run an automatic model.

If you hold down the shift key and click on (the red flash indicates automatic mode) the homogeneous model with wellbore storage and skin in an infinite system will be run without the dialog in Figure D01.1. The skin will be estimated and the match as indicated in Figure D01.2 right would have been immediate. It is also possible in the Settings page (panel) to have Saphir make the automatic skin calculation the first time the model dialog is called.

E01 • Improving

Click on the improve icon. This will allow you to run a non linear regression to improve the match between the model and data. Uncheck the permeability k and run the regression on the wellbore storage constant C and the skin. Click Run

The result after regression is shown in Figure D01.3.

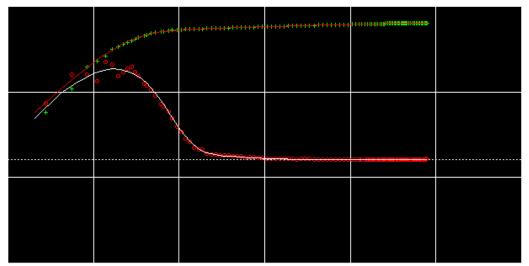


Fig. D01.3 • Match after regression

The Saphir screen now shows the model match on all the plots. Figure D01.4.

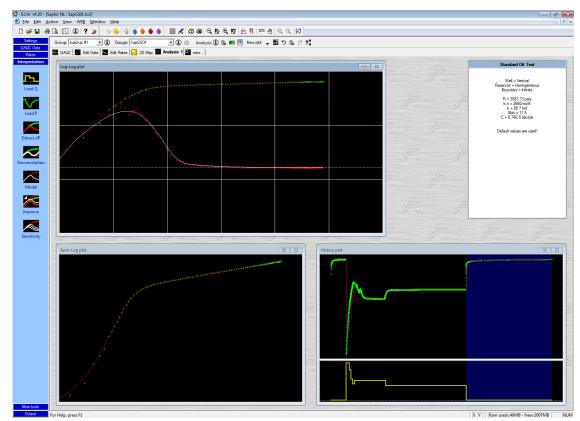


Fig. D01.4 • Saphir screen

F01 • Sensitivity

The final step in the workflow is the sensitivity. Click on the Sensitivity icon A. The dialog that follows (Figure F01.1) will allow you to specify the parameters to run the sensitivity on.

In this case the choice is the skin value. Move the Skin from the parameter selection area to the parameter values by selecting it in the left-hand side list and clicking on \bigcirc . Enter the following sensitivity skin values: 1, 2, 4, 6, 8, 10, 14, 20.

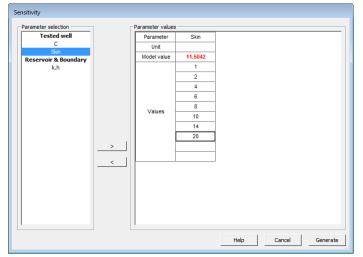
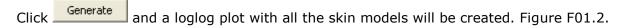


Fig. F01.1 • Sensitivity



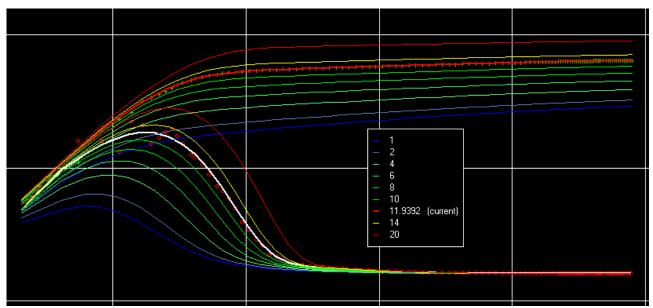


Fig. F01.2 • Skin sensitivity

G01 • Horner plot

The Horner plot is strictly only valid for a buildup following one single constant rate drawdown. However, when you want to use such an analysis method it is possible, and it is just necessary to confirm the previous production time which is calculated within Saphir as the cumulative production divided by the last rate. The access to specialized or flexible plots is through the page (panel) 'More tools' More tools'

Click on **1**. This will access the Flexible plot dialog, choose the Horner plot in the drop list (Figure G01.1) and accept the default previous production time.

Flexible type	
Type: Horner	Fastest
Time function	Pressure function
CΔt	(• P
	C P2
$ \sqrt{\Delta t} $	C M(P)
⊂ ∜ <u>∆</u> ±	C P/Z
○ 1/√∆t	
	- Normalization
Superposition	ΦP
C Drawdown	C dP
Build-up	
tp: 13.1843 hr 💌	Scale
C Multi-rate	Linear
C Agarwal	C Log
Help	Cancel OK

Fig. G01.1 • Flexible plots

Click OK and the Horner plot is displayed. Right click on the plot and select 'Show Derivative' and unselect 'Show Model'.

To regress or draw a semilog straight line on the plot use the button so or the plot popup menu (right click in the plot). Use the regression method and click the beginning and the end of the line, the line will be displayed and the line results are accessible by clicking on the Results icon. Figure G01.2.

The derivative curve (red markers) can be used as an indication of the best possible straight line by selecting the interval where the derivative is constant.

The method of drawing a straight-line on the semilog plot in the main Saphir screen is identical.

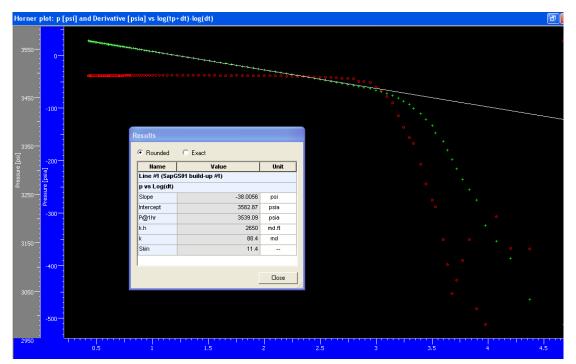


Fig. G01.2 • Horner plot