Water drive oil reservoir

A ● Introduction

The scope of the following exercise is to quickly build a reservoir model and get familiarity with the aquifer models available in Rubis. The exercise will consist in:

- ✓ connect the aquifer model to the reservoir;
- ✓ load the available observed pressure data (SBHP and FBHP);
- ✓ match the observed pressure data by selecting an appropriate aquifer model and by calibrating the aquifer parameters;

Since the exercise is strictly focused on the aquifer model, all the other reservoir properties are assumed to be known.

B ● General description

The considered reservoir "evergreen" is oil bearing formation surrounded by an aquifer and intercepted by three producing wells: well1; well2 and well3.
The formation is divided in two geological layers having different thickness and properties. The geometry and all the petrophyical properties are known.
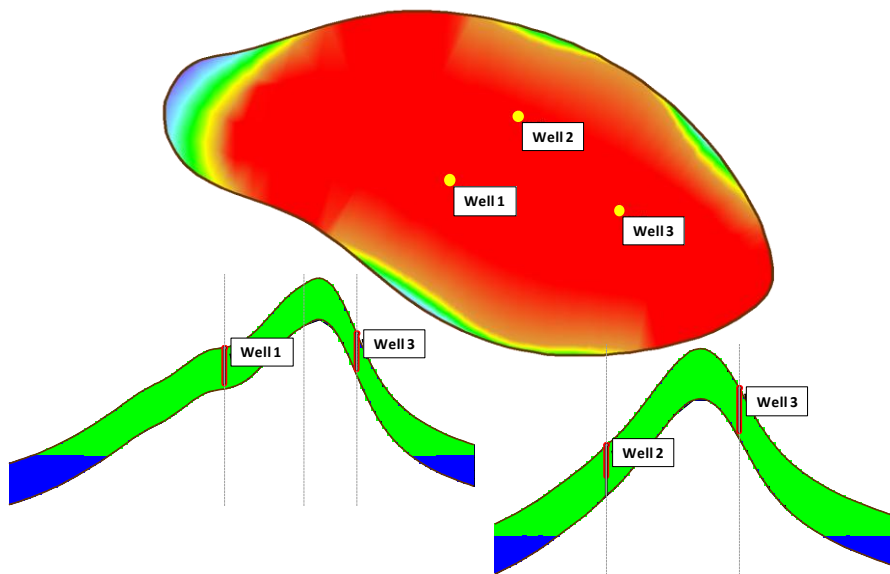
Top and side view and well location for the reservoir model

C • Exercise workflow

The exercise workflow is summarized in the following items. All the necessary information are provided in the following paragraphs and in the attached folders.

> Step 1: build the reservoir model
>   o generate a new Rubis file and save it in your folder.
>   o assign PVT properties for a dead oil (Bo const) plus water system
>   o build the reservoir geometry and assign the properties:
>   ▪ load contour and maps file.
>   ▪ use all the data provided (see next paragraph) to define thickness and properties for the two geological layers.
>   o define the initial state of the reservoir using the information provided in the next paragraph.
>   o connect an aquifer (select your own or use default) to the bottom layer only (layer 2). The aquifer should be connected along the entire reservoir boundary (360°).
>   o define well and completion using the information from the next paragraph. Impose the production history and load for each well the available pressure data (FBHP and/or SBHP).
>   o generate the grid:
>   ▪ use the default values for the horizontal gridding.
>   ▪ set the PV Max / layer coefficient to 0.2 to subdivide the layers into 5 sub-layers.
>   o initialize the model.
>   ▪ check the calculated STOIIP with the provided value (STOIIP $\sim$ 8 MMm^3).

> Step 2: match the aquifer model and parameters
>   o run a simulation for the entire production history (end simulation date 1/1/2011).
>   o compare the simulated pressure response with the observed pressure gauges for each well.
>   o if the match is satisfactory the selected aquifer is ok. Otherwise select a new aquifer model and/or modify the aquifer parameter in order to obtain an acceptable match.

D ● Available data
D1 ● Reference date

Define the reference date as: **01/01/2009**

D2 ● PVT

Consider a dead oil and water reservoir.
Set Bo as constant 1.048m3/stm3. Keep the default values for the other parameters for both dead oil and water.

D3 ● Reservoir geometry

The reservoir evergreen is an anticline having two geological layers characterized by slightly different petrophysical properties.
In order to build the reservoir geometry use the two files (available in the folder "geometry"):

> ➢ "Boundary.dat": containing the x, y coordinates (in m) of the boundary polygon;
> ➢ "TOP-layer1.dat": containing the x, y, z (in m) coordinates for defining the top surface of the first layer. For the top surface map linear interpolation method is suggested.

The thickness of the two geological layers are:

Layer	Thickness (m)
1	**10**
2	**6**

D4 ● Petrophysical properties

For each layer constant value of porosity and permeability are:

Layer	Porosity (-)	Permeability (mD)
1	0.24	120
2	0.18	80

D5 ● Initial state

The data for definition of the initial state are:

Data	Value	Units
Reference depth (datum)	2900	m
Initial pressure	290	bara
Reservoir temperature	90	°C
WOC	2934	m

D6 ● Rock fluid interaction properties

Generate the relative permeability curves by adopting the information provided below:

Parameter	Value
Swr	0.05
Sorw	0.1
krwo	0.3
krow	0.6
exponent	2
exponent	2

Generate the capillary pressure curves by adopting the default values provided in Rubis and changing the max Pc to 0.1 bara.

D7 ● Well definition and data

All the three wells intercepting the formation are vertical. The information necessary to define well geometry are:

Parameter	Well 1	Well 2	Well 3	Units
x	1731.95	2090.61	2633.2	m
y	1942.4	2282.66	1786.06	m
Gauge depth	2892.34	2905.08	2886.82	m
Completed layers	1, 2	1, 2	1, 2	m

For all the not specified parameters use default values.

The production control data are summarized in

Well name	Starting Date	Target surface liquid rate (stbbl/day)	Min THP (bara)
well 1	6/1/2009	400	20
well 1	9/2/2009	150	20
well 2	1/1/2009	250	20
well 2	3/3/2009	180	20
well 2	7/2/2009	0	20
well 3	1/1/2009	550	20
well 3	6/1/2009	380	20
well 3	11/2/2009	150	20

The observed flowing bottom hole pressure (FBHP) data and/or static bottom hole pressure (SBHP) data for each of the well have to be loaded from file (available in the folder "pressure gauges"):

> ➢ Well1_FBHP.txt
> ➢ Well1_SBHP.txt
> ➢ Well2_FBHP.txt
> ➢ Well2_SBHP.txt
> ➢ Well3_FBHP.tx