February – 2011 Progress Report

**Highlights and Accomplishments**

**Reservoir characterization and modeling** has been completed. Graduate student, Akapak Srichumsin successfully defended his thesis, *Reservoir Characterization and Simulation to Assess the Waterflood Potential of The Round Tank Queen Reservoir, Chaves County, New Mexico*, in February. Conclusions from his work are listed below.

1. Successful characterization of the Round Tank Queen reservoir with limited and poor quality data was made with the assistance of modern logs and core analysis.

2. Normalization of old neutron logs and calibration of old sonic logs were two techniques applied to acquire valuable information.

3. The study of mineralogy indicates that quartz is the main mineral of the formation with other minor minerals present a combination of potassium feldspar, anhydrite, micas and illite.

4. A newly discovered friable sand bed was identified and has implications on reservoir performance.

5. The results from history matching show satisfactory outcomes; a minor adjustment was made for the porosity distribution, and reservoir boundary was identified.

6. The large permeability reduction from history matching indicates that permeability of the Round Tank Queen formation is significantly lower than the other Queen sands.

7. The prediction results of the proposed flooding pattern show poor performance: low oil production and water injection rates, slow flood front movement and unable to fill-up reservoir pressure.

8. Many factors contribute to the poor performance including low permeability, high oil viscosity, depleted gas-cap and low differential pressure between bottomhole and reservoir.

**Stimulation evaluation** continues with the comparison of possible fracture scenarios; the first case assumes that the fracture is vertical, while the second case assumes that the fracture is horizontal. The results of these models are then compared with that of the tracer surveys and the net fracture pressure plot.

As an example, the treating pressure match for the horizontal model is shown in figure 1. To obtain a pressure match for the horizontal model the in situ subsurface stresses for the layers had to be increased above that of the vertical model to a value close to the overburden (0.9-1 psi/ft). Also the ellipsoidal aspect ratio (ratio between the length of the major and minor ellipse axes) was increased to 8 to achieve a good pressure match. The significance of this ratio is that if it is 1, then the fracture would be a standard radial or penny shaped geometry (Meyer user’s guide).
Figure 1: Comparison of actual treating pressure and model predicted pressure for the horizontal fracture model.

As was the case with the vertical model, the pressure match had some dissimilarity between the model-predicted pressure and the observed treatment pressure occurred during the early time of treatment and the reasons are the same as those of the vertical model.

Apart from the early treatment stage and the untimely shut-in period the model predicted pressures were within 100 psi of the observed data for the fracture treatment, thus achieving a good match.

COMPARISON OF VERTICAL AND HORIZONTAL MODELS WITH TRACER SURVEY

As was indicated earlier on, the radioactive tracer is more reliable than the temperature survey because it has fewer limitations, therefore only the gamma ray results were compared with the vertical and horizontal models.

The fracture height from the radioactive tracer is about 1 ft, while the height from the vertical model results was excessive at 179 ft and that of the horizontal model was about 0.03 ft. From these results, it can be concluded that the fracture is horizontal in an area within 4 to 5 ft away from the well bore. Therefore the horizontal model is adopted as the fracture geometry. But it is unknown if at greater lengths into the formation, the fracture changes to a vertical geometry or it simply continues as a horizontal fracture. Also from the radioactive tracer, the horizontal fracture is located at a depth of 1592 ft. This depth is the lower part of the pay zone, which has the highly porous, highly permeable friable sand bed. Thus the horizontal fracture is believed to be located within this friable sand zone.
The horizontal model is adopted because the rock stresses were closer to the fracture gradient (1.06 psi/ft) than those of the vertical model. Stress gradients are always close to the fracture gradients, because the fracture is initiated at the point at which the fracturing pressure exceeds the rock stress.

Generally, horizontal fractures in a vertical well (pan cake fractures) are not as efficient as vertical fractures on a vertical well. In this study, the horizontal fracture efficiency was 25%, while the vertical fracture efficiency was about 44%. Since the injectivity of the reservoir was not improved (operator reported several problems such as sharp pressure increase during waterflooding) after the well was fractured, it is safe to say that the fracture treatment was not successful, therefore it is likely that the fracture remained horizontal throughout the reservoir, rather than change geometry to a vertical fracture with higher fracture efficiency and a higher chance of success. The success of any fracture treatment depends to a great extent on the fracture-well intersection.