

### 2.3.3 Reservoir Volumetrics

A volumetric study for the Schaben Field demonstration area was completed on a grid-by-grid basis prior to the start of simulation. The volumetric calculations were performed to check if the different reservoir parameters such as effective porosity, net pay thickness, and water saturation in the effective porosity were able to support the observed historic production data.

Review of the production data indicates that most of the wells produce less than 15% water for a 1 to 4 year period after initial production. Average water saturation derived from the well logs show values ranging between 65 to 75%. Analysis of the NMR data from core plugs indicates a significant difference between the total porosity (obtained from well logs) and the effective porosity under reservoir pressures. The total water saturations obtained from the logs show high values especially given the fact that most of the wells show a low water cut during the initial production years. Thus, it was inferred that perhaps not all of the total water saturation is mobile. It was assumed that the reservoir was made up of micro- and macro-pores. The micro-pores are believed saturated with water that is immobile under reservoir pressure. In order to determine effective porosity the correlation between the effective porosity and total porosity developed from the NMR data was used to adjust total porosity determined from logs. The adjusted effective porosity for each grid cell is believed to better represent the pore volume where fluid-flow can occur under reservoir conditions.

Effective oil saturation in each grid cell was obtained using total water saturation from 1, calculated total porosity and calculated effective porosity. Total volume of oil present in each grid cell was obtained by multiplying the grid volume with the total porosity and the oil saturation. The macro-pore volume of each grid was obtained by multiplying the grid volume with the effective porosity. Oil saturation located in the effective porosity was obtained by dividing the total volume of oil present in the grid by the macro pore volume of the grid. Oil saturation in the effective porosity was used in the volumetric calculations.

Mobile water saturation was obtained by subtracting the oil saturation in the effective pores from 1. Thus, the water saturation used in the volumetric calculations represents the water saturation in the effective pore volume of the reservoir (i.e., in the macro pores).

A map of the original oil in place (Figure 2.36) was generated by using the effective porosity, effective water saturation and grid volume. Production data available on a lease basis for 33 years, includes the total volume of oil produced per lease in a year. In addition to annual production data, results of an annual productivity test for each well during its operational history were available. This data included total barrels of oil and water for the one day test and the calculated water-oil-ratio (WOR). Productivity test data were used to allocate annual lease oil production among all the wells on the lease. Individual well water production was obtained by dividing total oil production on a per well basis by the corresponding WOR recorded in the annual one day barrel test. Schaben field is spaced on a relatively uniform 40 acre spacing with each well located near the center of the tract. The grid cell dimension used in the volumetric study was 220 feet by 220 feet. The result is that each 40 acre tract has 36 grid cells. Cumulative oil production at each well was gridded to generate a cumulative production per grid cell map for the whole field. Cumulative production from each grid cell divided by 36 was gridded to generate a map showing the calculated distribution of the cumulative well production among the 36 surrounding grid blocks (Figure 2.37).

Remaining oil in place in each grid cell was generated by subtracting the calculated volume of oil produced in each grid cell from the original oil in place in that grid cell. The remaining oil saturation at each grid cell was multiplied by the pay thickness in the grid cell to obtain a residual oil saturation-thickness map as of 1995 (Figure 2.38). An irreducible oil saturation of 0.25 was assumed to be applicable in Schaben field. Subtracting 0.25 from the remaining oil saturation in each grid cell was used to calculate the residual mobile oil saturation. To highlight the productive potential remaining areas of the Schaben Field, a mobile saturation - thickness map (Figure 2.39) was generated by multiplying the mobile residual oil saturation in each grid cell by the pay thickness at the grid cell.

The residual mobile oil saturation-thickness map identifies areas with significant production potential. Also, absence of negative oil saturation values in any of grid cells in the field indicate that the combination of reservoir parameters such as effective porosity, effective water saturation and pay thickness is consistent with the historical production figures for the Schaben field.