

CHAPTER III

TECHNICAL CONSIDERATION

For a certain hydrocarbon reservoir, only single ultimate recovery of hydrocarbon produced from that particular reservoir under a certain production process is obtained. This is because the reservoir can be produced only one time. Therefore, ultimate recovery can be exactly determined only when the reservoir ceases to economically produce petroleum. The figure obtained during the producing period of the reservoir is an estimated figure. The accuracy of estimated value compared with actual value depends on several factors.

Several approaches have been utilized to estimate ultimate recovery. Most of those approaches require that reservoir and fluid properties as well as reservoir behavior be determined. Although most of the parameters and variables are available, a number of assumptions have to be made for those approaches in order to justify the conditions used to select the appropriate method.

Currently, four different approaches¹⁶ are acceptable for estimating ultimate recovery. These approaches include the use of empirical correlation, the application of material balance equations, the production decline analysis, and the application of numerical reservoir simulation study. Selection each of these methods depends on several factors, for example, the amount of information available and reliability of the information obtained. One of the most important factors is the attitude to these four approaches of the person who performs an estimation.

Notice that the four approaches require subsurface information in combination with information obtained at the surface. It is agreed that uncertainty of subsurface information is high in comparison with the information obtained at the surface. Furthermore, additional expenditure is required in order to obtain subsurface information. Not only additional cost, extra time is also needed in order to interpret and verify subsurface information. In addition, if the condition of the well does not allow subsurface operation, such as static bottom hole pressure survey, to be performed, chance to obtain subsurface information becomes drastically low.

Out of the four approaches, the application of numerical reservoir simulation study is the only approach that can be used to estimate ultimate recovery in a what-if manner. The other three approaches give the ultimate recovery which can be obtained from that particular reservoir as it has been produced under certain production scheme. A numerical reservoir simulator can be considered as a useful tool for reservoir engineers. At present, it has been widely used although not as conventional tools. As mentioned earlier, however, numerical reservoir simulation study requires subsurface information. Therefore, the results from numerical reservoir simulation study are highly dependent on the quality of the information available.

A petroleum production process includes reservoir and production system . It can be considered as another type of production process systems. It has the outputs which can be read at the surface. Because the concept of process control can be applied to any production system, it is highly possible that the process control concept could be applied to the petroleum production process as well.

However, the petroleum production process has one unique behavior. It has a limited resource. The limited resource includes both volume of fluid initially in place

and energy to drive the fluid. The limitation of resource probably makes the petroleum production process different from other production processes which have unlimited inputs.

As constraints of petroleum production process were realized, other mathematical approaches for which have been used in engineering field were searched. A concept of derivative plot which has been widely used in engineering fields is considered possibly applicable for this purpose. It will be applied to surface information including oil production rate, GOR, and flowing tubing head pressure.

The major tool for investigations is a commercial black oil reservoir simulator. It will be used to generate data. The generated data will be used for the investigations of the effects of various parameters. This study begins with the investigations on effects of the maximum allowable oil production rate on the ultimate recovery of oil produced from a close reservoir having solution gas drive mechanism under natural depletion. In addition, time to reach ultimate oil recovery of each case will be investigated. The investigations will be made at sand face. This type of investigations will ensure that a capacity of reservoir can be solely observed. This is because the effects of multiphase flow in tubing which in turn has effect on ultimate recovery are excluded. As there is vertical multiphase flow phenomena in tubing, the effect of fluid density as well as the effect of fluid viscosity will reduce ability of liquid to flow. The investigations made at the sand face will, therefore, results in the volume of oil which can be produced from the reservoir under a certain production scheme.

The investigations will then be extended to cover the effect of various parameters, including heterogeneity of reservoir and PVT properties, on the

relationship between maximum allowable oil rate and ultimate oil recovery. Hence, the investigations are also made at the sand face.

As the conclusions at the sand face are obtained, further investigations will cover the cases where tubing is included in the model. Detailed investigations will be made to surface information, i.e., oil production rate, producing gas oil ratio, and flowing tubing head pressure. This simulates the actual production system which surface information is obtained. For studying purpose, however, subsurface information will probably be used as additional information required for explaining some phenomena that might occur. Most of the information obtained are plotted versus time. The investigations will be made accordingly to the conclusions of the effects of maximum allowable oil rate on ultimate oil recovery and on time to reach ultimate recovery.



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