ABSTRACT

Information of residual oil saturation of reservoir is important to estimate remaining hydrocarbon resources of Brown field. Residual oil saturation is commonly measured from core by Water/Oil Relative Permeability (Kr) Unsteady State. This measurement is costly and time consuming, and further coring is more the exception then the rule. Therefore, an alternative technique of residual oil saturation computation by using log data is required since log data are generally available covering most of the pay zones.

Residual oil saturation was computed by comparing computed water saturation in well with virgin oil zone, water rise zone, and virgin water zone. The result shows good matching between the residual oil saturation computed from resistivity and residual oil saturation data from relative permeability measurement.

Residual oil saturation computed from resistivity result by using dual water equation can be used to estimate displacement sweep efficiency of the reservoir with no core data. Displacement sweep efficiency can be estimated using the Welge procedure from fractional flow curve analysis by inputting water saturation in waterise zone and water saturation in virgin oil zone. The result is reasonably acceptable compared with microscopic recovery factor from core data and megascopic recovery factor from simulation by considering reservoir heterogeneity.

The details of methodology and examples in Brown field from the Mahakam PSC, East Kalimantan, Indonesia will be explained in this paper.

INTRODUCTION

A large discrepancy (~25%) was observed between recovery factor (RF) calculated from field simulation and oil recovery measured from core of Brown field in the Mahakam PSC. To better apprehend, a study was carried out to evaluate residual oil saturation and displacement sweep efficiency of the reservoir using openhole log data. For sweep efficiency, it was computed from residual oil saturation subsequently compared with recovery factor measured from core data and field simulation.

TERMINOLOGY AND BASIC THEORY

Residual oil saturation (Sor) is the fraction of oil that remains in the reservoir after primary and/or secondary recovery operations. The main factors controlling the value of Sor are pore geometry, rock wettability, and fluid properties specifically interfacial tension, viscosity, and density. In combination with the heterogeneity of the reservoir, these properties result in the overall recovery (ER) (Breit V.S., 1992).

According to Sareem (Sareem, A. M. S., 1992), the overall recovery (ER) is

$$E_R = E_D \times E_V \times E_P$$

with:

- ER = overall recovery (fraction of initial oil in place recovered)
- ED = displacement sweep efficiency or volume of oil displaced divided by total oil volume (fraction)
- EV = vertical or invasion efficiency (fraction of vertical reservoir section contacted by injection fluid)
- EP = pattern efficiency or pattern swept by total pattern area

The vertical sweep efficiency (EV) is a function of the vertical heterogeneity (layering) and the mobility (Cp/mD). The mobility ratio defined here is the ratio of the relative permeability of water (Kr) at residual