CHAPTER I

INTRODUCTION

Several reservoirs that have been waterflooded still have potential for recovering additional volumes of oil. Water alternating gas (WAG) injection is one of enhanced oil recovery methods that can be used to recover additional oil. WAG is a process that combines effects from two traditional methods water and gas flooding. Theoretically, gas injection itself helps reduce residual oil saturation but can cause viscous fingering due to high mobility of gas when compared to oil. Whereas in water injection, water has decent mobility but water injection leaves more residual oil than gas injection. WAG process can reduce the impact of viscous fingering by decreasing gas mobility using water and at the same time, it can reduce residual oil saturation.

The optimum WAG injection can be justified from ultimate oil recovery which depends on many parameters. Reservoir properties such as horizontal permeability and vertical to horizontal permeability ratio are known to be the significant parameters that affect the recovery factor. Therefore in this work, we optimize the WAG process for different value of horizontal permeability, vertical to horizontal permeability ratio and positions of production and injection wells.

In order tc maximize the ultimate recovery factor, two control parameters, water-gas ratio and slug size will be optimized. Many studies have shown that improvement of sweep efficiency of WAG injection can be achieved by supplying gas to the gas/water front at a rate corresponding to the volume of gas trapped by the advancing water. Gas bank ahead of the front enables another gas bank to reduce residual oil. Therefore, optimization of water gas ratio will directly enhance the WAG injection scheme. The second parameter is slug size which is the time period to complete a full cycle of alteration. It is a period of gas followed by a period of water injection. Segregated flow which decreases the injection efficiency can occur if gas is injected in high volume. This can lead to gas overriding and early breakthrough. On the other hand, water can underride gas leading to water underridement. Thus, the suitable slug size will help achieve the optimal recovery.

In general, a WAG process contains changes in displacement mechanism between drainage (gas injection) and imbibition (water injection). Hence, simulating the WAG injection should consider the effects from relative permeability hysteresis. Hysteresis in non-wetting phase is more pronounce than in wetting phase because the difference in relative permeability between drainage and imbibition process is larger than the difference in wetting phase case. Several authors had constructed the relative permeability hysteresis model used in reservoir simulation. In this study, two relative permeability hysteresis model are used. The first model is Killough model. The other one is Larsen and Skauge model.

Due to the fact that Larsen and Skauge hysteresis model is available in black oil reservoir simulation only, the optimization of WAG process conducted on both black oil and compositional reservoir model will use Killough relative permeability hysteresis model. The effect of Larsen and Skauge model is investigated separately.

The main objective of this study is to provide a guideline to create an injection strategy of WAG process for various reservoir properties in order to achieve the ultimate oil recovery within a curtain period. Importantly, the effect of each parameter will be thoroughly investigated during the study.