CHAPTER I
INTRODUCTION

Nowadays energy from petroleum still plays the most significant role in industries and communities all around the world. A statistical review of world energy indicated that the global oil consumption had grown 0.7% to reach 88 million barrels per day from the previous year, while the oil production has been increased by 1.1 million barrels per day, or 1.3%. Thus, the global supply of oil production is less than the global oil demand. Figure 1.1 shows the total word oil production and consumption in 2011 were 83.57 and 88.03 million barrels daily, respectively.

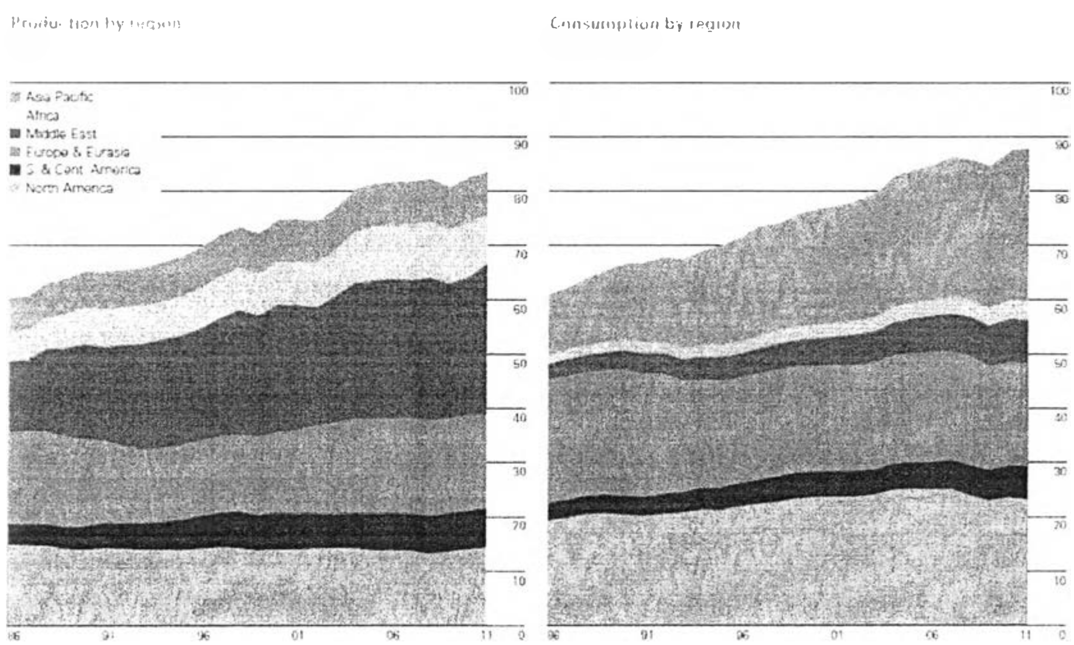

Figure 1.1 Comparison of world oil production (left) and world oil consumption (right) (BP Statistic Review of World Energy June 2011).

The conventional light oil is always the first choice, if possible, due to low production cost. However, new supply from exploitation of unconventional resources is necessary. The unconventional resources including oil sands, extra-heavy oil, biofuel, coal-to-liquid, gas-to-liquid, and shale oil grow on an average of 4.6% per year(Rajnauth, 2012).In this study heavy oil is considered because of increasing important supplying energy in Canada. Heavy oil property includes viscosity ranging from 1,000 to 10,000 cp, low API gravity, high carbon residues, low hydrocarbon to carbon ratio and high content of asphaltene, nitrogen, heavy metals and sulphur. Typically, formation of heavy oil occurrences are around 30% porosity, high permeability, shallow depth less than 1,000 m, unconsolidated sand deposit, thickness ranging from 15 m to 300 m(Ali *et al.*, 1976; Brook *et al.*, 1998; Mai *et al.*, 2010; Selby *et al.*, 1989).

Traditionally, production of oil reservoir considers in three stages, which are primary, secondary and tertiary. Primary recovery is a production of oil from the reservoir under natural force, gains approximately 5 - 20% of original oil in place (OOIP). Secondary recovery, which refers to production of oil through utilization of immiscible gas, water, and combination of both as injection fluid to raise or maintain the reservoir, could be increased up to 30 – 40% of OOIP(Hadia *et al.*, 2011; Harrasi *et al.*, 2012; Winoto *et al.*, 2012).Enhanced or tertiary recovery refers to the additional techniques other than primary and recovery stage. This stage could be increased up to 50% of OOIP. In this study, the secondary recovery of waterflooding, carbon dioxide flooding, and water-alternating-gas (WAG) were considered in order to improve the original oil in place.

Waterflooding is the most common method used to enhance oil recovery because this method is considered as the safest, easiest and cheapest method(Aktas *et al.*, 2008). The efficiency of waterflooding project depends on various factors and unfavourable condition could lead to very poor efficiency. The main problem of poor sweep efficiency is due to low viscosity of water and its high mobility ratio with the oil(Wassmuth *et al.*, 2007).

Immiscible carbon dioxide flooding becomes interesting and promising techniques for heavy oil because it can solve the problem of high mobility between CO2 and heavy. This problem will create the channelling and fingering in the heavy oil reservoir. CO2 displacement process increases oil recovery by reduction of oil viscosity, swelling of oil, vaporization of oil, miscibility effects, reduction of interfacial tension, solution gas drive during blow-down , and increase in injectivity(Jha, 1985; Jha, 1986; Khatib *et al.*, 1981; Mungan, 1991).

Water-Alternating-Gas(WAG) is normally used for controlling gas mobility. The technique of WAG is a combination of two oil recovery methods which are waterflooding and gas injection. In general, gas does not penetrate into whole region and tend to pass through high permeability zones. Consequently, water entry pressure into porous media is increased and continuously injected water is passed to the lower permeability regions. As result, injected water displaces the residual oil and also forced the injected gas inside the pores(Derakhshanfar *et al.*, 2012; Khatib *et al.*, 1981).

Reservoir simulation had been developed into the flexible and widely tools in reservoir engineering. The reservoir simulation program is used to predict the future performance of oil and gas reservoirs over wide range of operating condition. Thus, simulation is usually applied for all reservoir types and all reservoir performance studies. As an asset building and maintaining, an oil fields are normally time consuming and expensive. Hence, reservoir models are typically builded for identifying the number of wells required, reduction of reservoir pressure predicting and the expected production of oil, gas and water. Simulation is faster, cheaper and more reliable than other methods for prediction the performance.

A reservoir model was divided into a number of grid blocks. Each block was related to a designated location in the reservoir condition which included porosity, permeability, relative permeability, etc. IMEX module of CMG reservoir simulator was used for simulation this study. The objective of this study was comparative the error between experimental result and simulation results.