CHAPTER I
INTRODUCTION

Crude oil, natural gas, and water are the most concern to petroleum engineers. Although they sometimes occur as solid or semisolid, usually at lower temperature and pressure, as paraffin, gas-hydrate, ice, or high pour-point crude in the ground and in the wells, they occur mainly as fluids, either in the vapor (gaseous) or in the liquid phase or in common. Even solid materials are used, such as in drilling, cementing, and fracturing, they are handled as fluid of slurry. The division of the well and reservoir fluids between the liquid and vapor phases depends mainly on the temperature and pressure. The state or phase of a fluid in the reservoir usually changes with pressure and the temperature remains substantially constant. In many cases, the state of phase in the reservoir is quite unrelated to the state of the fluid when it is produced at the surface. The precise knowledge of the behavior of single fluid of crude oil, natural gas, and water, or in combination under static conditions or in motion of the reservoir rock and in pipes and under changing temperature and pressure is a main concern of petroleum engineers.

During the 1960s, the terms reservoir simulation and reservoir mathematical modeling became popular. These terms are synonymous and refer to the ability to use mathematical formulas to predict the performance of an oil or gas reservoir. Reservoir simulation was aided by the development of large-scale and high-speed digital computers. Sophisticated numerical methods were also developed to allow the solution of a large number of equations by finite-difference or finite-element techniques (Craft, Hawkins, and Terry, 1991).

The procedure consists of selecting a division point or node in the well and dividing the system at this point. The locations of the most commonly used nodes are shown in Figure 1.1.

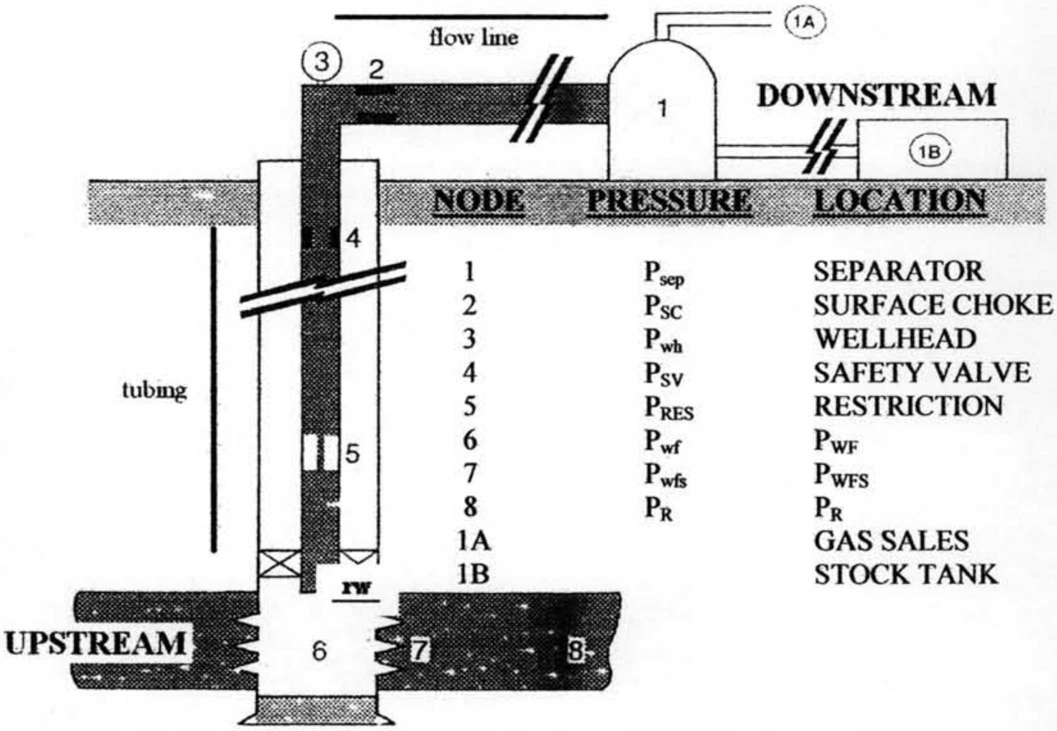

Figure 1.1 Location of various nodes (Begges, 2004).

All upstream components of the node comprise the inflow section, while all the downstream components of the node consist of the outflow section. A relationship between flow rate and pressure drop must be available for each component in the system. The flow rate through the system can be determined once the following requirements are satisfied:

1. Flow into the node equals flow out of the node.
2. Only one pressure can exist at a node.

The reservoir simulation model is the computer program which is one of important and rapid changing tools of petroleum engineering research. It is used for the evaluation of remaining oil and recovery factors under different modes of operations (such as water injection, gas injection, water and gas injection, natural depletion, and production rate), evaluating effects of sensitivity of an aquifer (size, geometry, continuity, and strength) on natural waterdrive, comparison of development schemes for required offtake, pressure maintenance and so on, the effects of uncertainties in reservoir description in complex reservoir on development planning, the effects of continuity of pore space and fluids, particularly with horizontal well placements, and the effects of the location of platforms and the spacing of the wells, and sensitivity tests for small-and large-scale heterogeneities.

A good reservoir simulation model required good geological input, accurate reservoir geometry with porosity trends, permeability trends, layer and shale distributions and so on. The material balance, porous media flow equations and capillary pressure can be formulated into mathematical non-linear, partial differential equations, which can be solved by a computer.

The reservoir simulation is therefore valuable because the analytical solutions exist only for simple examples, and computer simulation has now become so sophisticated that it can give realistic analysis and reservoirs can be produced only once, but the simulator can be run many times to compare depletion strategies.

This thesis work will focus on development of the validated reservoir simulation model for natural gas. The governing equations in this model formulation are transient mass balance and Darcy's law. The main purpose in this thesis work is to apply a finite difference method (FDM), which uses alternating-direction implicit (ADI) method for solving the governing equations. ADI method is solved by coding into FORTRAN program.