CHE636A Simulation Project

Date Due: April 22nd, 2022

Problem Statement: Oil recovery from an oil reservoir can be broadly divided into three categories: primary recovery, secondary recovery and tertiary recovery. Primary recovery is due to depressurization of an oil reservoir and is a relatively simple process. In this process, wells are drilled at various locations in an oil field and fluids are allowed to flow. When doing this, the reservoir pressure is decreased as fluids continue to flow until the pressure is low enough to bring fluids from the subsurface to the surface on its own. At this stage, no more or very little fluid is produced and other techniques such as secondary and tertiary recovery are required. In this simulation, we will develop a program to simulate primary recovery. We will treat primary recovery as a single-phase flow where only oil is mobile; water is often present in the reservoir but does not flow due to its low saturation. Further, we will limit ourself to one-dimension and ignore gravity effects.

To simulation primary recovery, develop a one-dimensional code for single phase flow through porous media using implicit finite difference. The code should include at least two wells at both the ends of the reservoir (that is, at gridblocks 1 & Nx). The user should have the option to use these wells for production at constant flow or constant pressure conditions (and switch between the two as desired).

(a) Use the following reservoir & fluid properties to run the simulation.

Permeability: 9.6×10^{-14} m^2	Initial pressure: 13×10^6 MPa
Porosity: 0.1	viscosity of oil: 0.001 Pa.s
Length: 1000 m	Productivity index: 1.3×10^{-10} $m^3/s/Pa$
Width: 100 m	Total compressibility: 2×10^{-9} Pa^{-1}
Thickness: 10 m	P_{BHP}: 0.1 x 10^6 MPa

Assume that only one well, at the last gridblock, is active (other is shut off) and is producing at constant pressure. Take Nx=100, Ny=1 and dt = 50 seconds (dx=L/Nx), run the simulations for 300,000 seconds: (a) obtain the pressure profile of this gridblock (that is, the last gridblock which has the well) as a function of time (b) at the end of 300,000 seconds, obtain the pressure profile of the reservoir (c) plot the pressure profiles (part a & b) when the viscosity is increased by 10 times and compare your result with part (a) & (b)

(b) Solve part (a) assuming that the permeability of gridblocks varies according to the following:

$$k_{new} = k\left(1 - 0.9 * \frac{n_x}{N_x}\right)$$

Where k_{new} is the new permeability of a gridblock, k is the original permeability, and n_x is the gridblock number (take Nx=100).

(c) Solve part (b) for tmax=100,000 seconds assuming that both the wells (at nx=1 and nx=100) are producing at constant pressure (P_{BHB} and J same as given in the table above).

(d) Assuming that only one well, at the last gridblock, is producing at a constant flow of Q=5 m^3/s for tmax = 60,000 seconds. Plot the pressure of the gridblock as a function of time.