Energy 223 – Winter 2018, Project Phase 1

Simulation of Single-phase Flow in a Two-Dimensional Homogeneous Reservoir

(due 1/29/2018, 5 pm)

Project Description

In Phase 1, you will write a simulator for single-phase oil flow in a horizontal homogeneous two-dimensional reservoir. In the base case, a single production well, which produces oil at a constant rate, is located in the center of the reservoir. The model parameters are listed below. You should use the discretization scheme described in class. Your solution should be implicit (i.e., you solve a matrix equation for $\mathbf{p}^{n+1}$), but you should evaluate the transmissibilities at the previous time (t_n). Note that you still need to update your transmissibilities after each time step using the newly obtained pressure field.

The Eclipse input files for the base case are provided. Your results should be close to the Eclipse results. An exact match may not be obtained because of slight differences in the implementation between your simulator and Eclipse. Once you have your simulator running and have achieved a reasonable match to the Eclipse results, use your code to investigate two additional scenarios. You can decide on which **two** additional cases to evaluate. Here are a few suggestions:

1. Include more than one producer and monitor p versus t at the center of the model (place the two wells away from the center of the model).
2. Perform a grid refinement study to assess convergence. How does the pressure response, or some particular quantity of interest, change with increasing refinement in x, y and t?
3. Run your model with an injector and a producer and monitor the approach to steady state. Can you predict the characteristic time to reach steady state?
4. Change the well constraint from a rate constraint to constant pressure in the well block (use a finer grid if you do this).

Report Guidelines

The report should be brief and should describe the governing equations, boundary conditions, unit consistency (conversion factors), numerical implementation, and results of all simulation runs. Simulation results should be displayed in graphical form to the extent possible (do not submit tables of numbers!). You should include:

1) Pressure profile evolution for the producer-well block with time. Compare your results with Eclipse.

2) Pressure map for the entire field at the end of the simulation run.

Briefly discus the results you obtained and differences with Eclipse. Be clear and concise. Include pertinent code in the Appendix. Excluding the code in the Appendix, the report (with title, text, figures and tables) should be *no more* than 8 pages (Times Roman font, 12 pt, 1.5 line spacing). Shorter reports are fine!

Grading (100 points)

- Description, formulation and basic results: 70 points
- Additional two cases and explanations: 30 points

Report Submission

Please place a hardcopy of your report in Amir Delgoshaie's mailbox (Rm 060 in GESB basement) or bring it to class. In addition, place a softcopy of your project (report and code) in the Assignment tab named "Project Phase 1" on Canvas and name it phase1_name.zip (by 1/29/2018 at 5 pm).

<u>Model Information</u>

Reservoir description

Reservoir dimensions: $L_x = L_y = 3500$ ft, $L_z = 100$ ft

Top depth: $D_{top} = 5000$ ft

Bottom depth: $D_{bot} = 5100$ ft

Permeability: $k_x = 200$, $k_y = 100$ md

Porosity (constant): $\phi = 0.25$

Rock compressibility: $c_R = 0$

Initial pressure of reservoir: $p_{init} = 6000$ psi

Fluid properties

Oil compressibility: $c_f = 1.2\times10^{-5}$ psi^{-1}

Oil density (at standard conditions): 49.1 lb$_m$/ft^3

Oil viscosity: $\mu_o = 2$ cp

Grid and simulation parameters

Number of grid blocks: NX = NY = 35, NZ = 1

Well location in base case: (18, 18) – center of the reservoir

Well rate (constant in time): 2000 STB/day

Run the simulator for 400 days