Analytical, explicit and implicit solution of the one-dimensional diffusivity equation

a) Review the derivations in Lecture note 1 under Solution of the difference equations (pages 5-8).

b) Download ex1.f from Blackboard or the external home page and placed in a new folder on your user on the server computer pet.geo.ntnu.no. Start the terminal window (Xwin32 on Windows or Xquartz on Mac). In the terminal window go to the new folder and compile & link the program using the command:

f95 –o exercise1 ex1.f

The executable module exercise1 is then generated in your folder.

c) Type exercise1 to run the program and an initial list of properties will be typed on your screen and you are asked to make any changes in the properties. Make any changes you would like. Next you will be asked on the screen to select analytical solution (A), explicit solution (E), or implicit solution (I). Finally, you are asked to specify a name for the output file (select a logical name for each case below).

Test data

Test the program using the following basic data (these are defaults in the code):

$\phi=0.2$
$k=1.0\ D$
$N=10$
$T_{max}=0.2\ sec$
$\Delta T=0.2\ sec$
$\mu=1.0\ cp$
$c=10^{-4}\ atm^{-1}$
$L=100\ cm$
$P_0=1\ atm$
$P_L=2\ atm$
$P_R=1\ atm$

Please change the input data and run the following cases:

1) Generate analytical solutions for all grid blocks at time intervals of 0.00025 s.

2) Run the explicit formulation using increasing time step sizes of Δt=0.00025, 0.0005, 0.00075, 0.00125... until the solution becomes unstable

3) Compare the stability of the explicit runs with the theoretical stability criterion ($\Delta t \le 0.5\Delta x^2 \frac{\phi\mu c}{k}$).

4) Run the implicit formulation using time steps of Δt=0.0005, 0.005 and 0.05.

5) Make plots of pressures vs. time in block no. 5 for explicit (Δt=0.0005), implicit (Δt=0.005) and analytical solutions (export output files and plot in excel).

6) Make plots of pressures vs. x for explicit (Δt=0.0005), implicit (Δt=0.005) and analytical solutions (export output files and plot in excel).

Hand in the plots with brief comments by email to Eirik (eirikkal@stud.ntnu.no). Please include one figure for each case (1-6).

Deadline: To be announced