Classical pore network two-phase flow simulator – pnflow

*** This file is prepare by Ali Raeini, see Section 4 for Contact information.

Abstract

The pnextract code is very similar to the poreflow, developed by Valvatne and Blunt. The differences mostly are related to the structure of the code rather than the physical model. A brief summary of these changes are mentioned in the ChangeLog file in the pnflow codes. This file described the input file modifications compared to the poreflow code.

WARNING: This is an early draft, and needs further explanation

1 Input file

Syntax: The pnflow input file is contains a set of "keyword: data;". The data can span multiple lines. The colon after keyword can be replaced with # as in the original poreflow code. Anything following `%` are treated as comments.

Most of the keywords used in the original poreflow code are active here as well. This documentation primarily describes the new keywords or those that have been modified. see the file poreflow_ValvatneAndBlunt2004.pdf for the more detailed description of the input files.

```
% -*- LaTeX -*- % <- add this for syntax highlighting by geany text editor...

TITLE Berea ; % base name for the output files

NETWORK F  Berea ; % Base name of the network files, without _link1, _link2, node1.dat...
                   % F stands fr "not binary format"


SAT_CONTROL % this keyword replaces SAT_TARGET in poreflow code
% final     maxPc   deltaSw  DeltaPc   deltaPc  calc  calc  Inject from Escape to
%Saturation ----------------- min    Fraction  Kr    RI   Left Right  Left Right
    0.0     100000   0.05    10000.0    0.15    T      T     T    F      F   T
    1.00   -100000   0.05    10000.0    0.15    T      T     T    F      F   T
    0.00    100000   0.05    10000.0    0.15    T      T     T    F      F   T
;

CALC_BOX 0.15 1.0 ; % X bounds of the network used in rel-perms calculations

% Noet provide Morrows model number as well, similar to EQUIL_CON_ANG
INIT_CONT_ANG 1  0  0   0.2   3.0  rand   0.0 ;

EQUIL_CON_ANG 1  45 45 0.2   3.0  rand   0.0 ;

% Mixed wettability:
%FRAC_CON_ANG  0.7 T  120 150 0.2   3.0  corr 7 ;

RES_FORMAT  upscaling ; % excel, matlab or upscaling (text) output formats
```

Fig. 1: Sample input file for the pnflow two-phase flow simulations explaining the important keywords.

1.1 Other optional keywords

```
% Full 3D visualization,
%         file    radius   resolution -visualize: --------------------- all
%        prefix scale-factor  (6-18)  init  Drainage Imbibition corners steps
visualize  B       .1         8        T      F        F        F    F ;


%match-stick |  file   visualise   visualise visualise  visualise
%visualization| prefix  init       Drainage Imbibition all steps
visualizeLight  L       F           F         T          F ;


%         calc kr using  record press   num press
%          avg press       profiles     profiles
PRS_BDRS       F             F            20 ;

% PORE_FILL_ALG  blunt2 ;
```

```
% PORE_FILL_WGT   0.0  0.5  1.0  2.0  5.0  10.0  ;

% FLuid properties (viscosity, resistivity and interfacial tension ...):
%   interfacial Water Oil   Water    Oil     Water    Oil
%    tension    visc   visc resis.  resis.  density density
%     (mN/m)    (cp)   (cp)  (Ohm.m) (Ohm.m) (kg/m3) (kg/m3)
FLUID  30.0     1.0    1.0    1.2    1000.0  1000.0  1000.0 ;


REL_PERM_DEF  single F ;

%             min     Memory Scaling  Solver    Verbose Conductance
%          tolerance     Factor       output    Solver   cut-off
SOLVER_TUNE 1.0E-30       8             0        F        0.0 ;

SAT_COVERGENCE
%  minNumFillings  initStepSize  cutBack  maxIncr  stable disp
      10             0.1         0.8      2.0        F ;

DRAIN_SINGLETS   T ;  % T for yes, F for no

RAND_SEED      1002   ;


%  Network modification:

%clayFraction 0.2; % Adding clay, TODO: check
%or
%CLAY_EDIT 0.2 ; % note these can have different impact, test and see
%or
%AddClay  0.0 0.0 -0.2  -3.0   rand ; %For adding clay distribution, one can use:
```

where the arguments are the Weibull distribution parameters, similar to the EQUIL_CON_ANG keyword arguments 2 to 6. The first argument is the minimum clay fraction (in a throat), the second is the maximum clay fraction, the third and forth are the Weibull coefficients, and the fifth is the correlation with pore size.

2 Running the code

To run the pnflow executable, you should first generate the networks, see the documentation of pnextract executable. Then you can copy the sample input file from the src/doc folder and edit it by setting the NETWORK and other keywords, described below, and run the following command in terminal or in Microsoft Windows command-prompt (cmd).

```
pnflow input_pnflow.dat
```

The above command works if you put pnflow in system PATH. Otherwise, instead of pnflow, you should type the full path othe pnflow executable.

3 Compiling the code

Open a Linux terminal in the upper-most directory in the source code. and type ‘make‘. This should compile the Hypre linear equation solver as well as the pnflow code. The command ‘make mgw‘ cross-compiles the code into Windows executable.

For code developers:

A pnflow_tom.pro file is located in the src/pnflow directory, which can be imported to qtcreator IDE for project-based compilation of the code. Alternatively you can use geany IDE that can work with the provided make files directly.

We did not try to compile the code in Windows, although in theory this should be possible using a combination of cmake for compiling Hypre, and nmake or Microsoft Visual-Studio for compiling the pnflow codes.

4 Contacts

For any queries please email:

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Or visit: `http://www.imperial.ac.uk/earth-science/research/research-groups/perm/research/pore-scale-modelling`

References:

See `http://www.imperial.ac.uk/earth-science/research/research-groups/perm/research/pore-scale-modelling/publications/`