Permedia Mixing Validation Study 1

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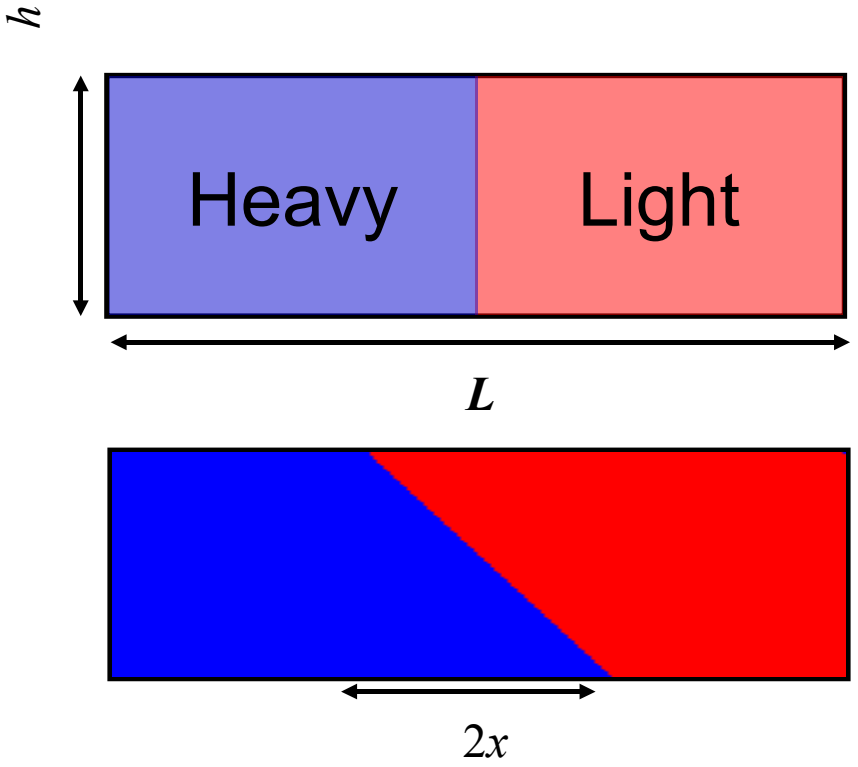
Free Convection after England et al., 1995

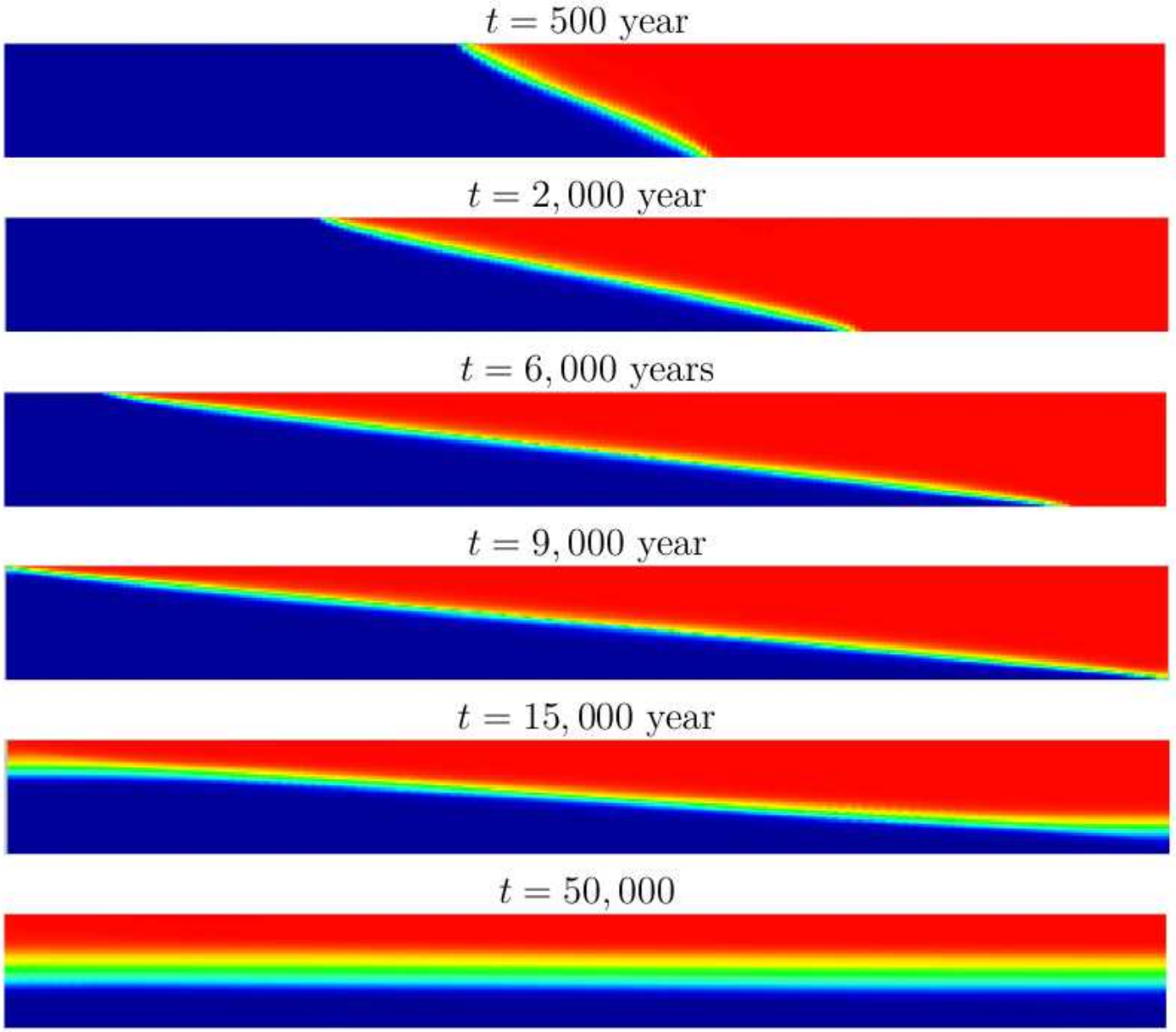
- A simple rectangular mesh was created with uniform porosity and permeability to test the MPath model calculations



Reservoir width: 1000 m
Reservoir height: 100 m
Fluid Viscosity: 1cp
Density difference: 10 kg/m3
Horizontal permeability: 100 md
Vertical permeability: 0.01 to 100 md
Rock porosity: 0.2

England, W.A., Muggeridge, A.H., Clifford, P.J., and Tang, Z. (1995) Modelling density-driven mixing rates in petroleum reservoirs on geological time-scales, with application to the detection of barriers in the Forties Field (UKCS). From Cubitt, J.M. and England, W.A. (eds), The Geochemistry of Reservoirs, Geological Society Special Publication No. 86, pp. 185-201.

Results


$t = 500$ year
$t = 2,000$ year
$t = 6,000$ years
$t = 9,000$ year
$t = 15,000$ year
$t = 50,000$

Comparison with analytical solution

- Good match with analytical solution:

$$\left(\frac{2x}{h}\right)^2 = \frac{16}{3}F^2\frac{K_h}{K_v}\frac{(t/t_0)^2}{1+t/t_0)}, \quad t_0 = \frac{4}{3}\frac{\phi h\mu F}{K_v g\Delta\rho},$$

where

$K_h = 100md$	:	the horizontal permeability;
$K_v = 100md$	:	the vertical permeability
$h = 100m$	:	the height;
$\mu = 1cp$	:	the viscosity
$F = 1$	:	a function of the viscosities
$\Delta\rho = 10kg/m^3$	:	the density difference
$2x$	:	the width of the interface .

The table below contains the computed and analytic values for $\frac{2x}{h}$:

time[years]	numerical	analytic
500	4.400	5.097
1,000	6.560	7.492
2,000	9.50	10.815
3,000	11.70	13.34
5,000	15.30	17.32
7,000	18.25	20.54

Mass balance error

- The mass of the heavier component increases only 0.0024% after 50,000 years