CO2BLOCK user guide

CO2BLOCK provides the automatic estimate of the CO_2 storage capacity of an aquifer. Please refer to De Simone and Krevor (2020) for details about the theoretical framework.

The tool is written in Matlab language and it is composed by six scripts. Users only need to open and modify the script "CO2BLOCK.m". There is no need to open or modify the other scripts, which is instead not recommended.

Input

It is necessary to provide an input file containing the aquifer parameters data, which must look as presented in the example file "example_data.xlsx" (do not change the column order). There is a set of strictly required parameters, whereas others are calculated by means of default values, when not provided (Table 1). Although default values provide reasonable estimation, we recommend the use of precise data which would allow for a more accurate prediction of the storage capacity.

In the "CO2BLOCK.m" script, users have to define directory and name of the input data file. Users also need to set some parameters. They are:

1. *correction*: set 'on' or 'off' to apply correction for superposition (off is the conservative option)
2. *dist_min*: minimum inter-well distance [km] (considering operational requirements).
3. *dist_max*: maximum inter-well distance [km]. If 'auto' is set, the tool automaticly calculate the maximum distance according to the reservoir area.
4. *nr_dist*: number of inter-well distances to explore (high numbers can cause slow calculation)
5. *nr_well_max*: maximum number of wells. If 'auto' is set, the tool automaticly calculate the maximum number of wells according to the reservoir area and the minimum inter-well distance.
6. *rw*: well radius [m]
7. *time_yr*: time of injection [years]

8. $maxQ$: maximum sustainable injection rate per well because of technological limitations [Mton/years]

The code work-flow is the following:

1. Acquisition of the parameters by reading the input data
2. Set some parameters with default values if they are not provided in the input data. Details are provided in Table 1.
3. Evaluation of the maximum sustainable pressure
4. Evaluation of the pressure build-up for a reference case
5. Estimate of the maximum sustainable injection rate
6. Inclusion of constraints and rescaling of the maximum injection rates if necessary
7. Evaluation of the plausible scenarios

Output

The tool calculates the storage capacity for each scenario of well number and distance. Output results are the maximum sustainable per-well injection rate and the maximum sustainable storage volume. They are provided both in graphical plots and in excel tables.

References

Altunin, V. and Sakhabetdinov, M. (1972). Viscosity of liquid and gaseous carbon dioxide at temperatures 220-1300 k and pressure up to 1200 bar. *Teploenergetika*, 8:85–89.

Batzle, M. and Wang, Z. (1992). Seismic properties of pore fluids. *Geophysics*, 57(11):1396–1408.

De Simone, S. and Krevor, S. (2020). A tool for rapid first order estimates of dynamic storage resource capacity in saline aquifers. *submitted*.

Redlich, O. and Kwong, J. N. (1949). On the thermodynamics of solutions. v. an equation of state. fugacities of gaseous solutions. *Chemical reviews*, 44(1):233–244.

Spycher, N., Pruess, K., and Ennis-King, J. (2003). Co2-h2o mixtures in the geological sequestration of co2. i. assessment and calculation of mutual solubilities from 12 to 100 c and up to 600 bar. *Geochimica et cosmochimica acta*, 67(16):3015–3031.

Table 1: Required and default parameters assumed when not provided.

Required parameters	**Default parameters**	**Default values**
Domain BC (open/closed)	Rock compressibility, c_r	5×10^{-4} MPa^{-1}
Shallowest depth, ζ	Brine compressibility, c_w	3×10^{-4} MPa^{-1}
Mean depth, ζ_m	Brine salinity, χ	180000 ppm
Thickness, H	Shallowest pressure, p_0	10 MPa/km $\times\zeta$
Surface, A_{res}	Mean pressure, $\overline{p_0}$	10 MPa/km $\times\zeta_m$
Permeability, κ	Mean Temperature, $\overline{T_0}$	$33°$/km $\times\zeta_m + 15°$
Porosity, ϕ	CO_2 density, ρ_c	calculated with respect to $\overline{p_0}$ and $\overline{T_0}$, according to Redlich and Kwong (1949) (with the parameters proposed by Spycher et al. (2003))
	CO_2viscosity, μ_c	calculated with respect to $\overline{p_0}$ and $\overline{T_0}$, according to Altunin and Sakhabetdinov (1972)
	Brine viscosity, μ_w	calculated with respect to $\overline{T_0}$ and χ, according to Batzle and Wang (1992)
	Vertical stress, σ_v	23 MPa/km $\times\zeta_m$
	Stress ratio, k_0	0.7
	Friction coefficient, φ	$30°$
	Cohesion, C	0 MPa
	Tensile strength, S_0	0 MPa