Fluid Flow Dynamics in CO2 Sequestration in Deep Saline Aquifers

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Abstract

Problem set up:
The present study models fluid flow (CO2) in a closed system in context to CO2 sequestration in deep saline aquifers using the Sub surface flow module. A 2 dimensional heterogeneous porous reservoir (Fig. 1) 300 m x 910 m was fabricated using COMSOL Multiphysics® software, using Elder Darcy's Law. An impervious zone was placed at a depth of 710 m from top in order to replicate caprock.

Results and Discussions:
The spread of CO2 in different layers was studied. CO2 first migrated upwards by buoyancy and then spread at a slow rate laterally by means of advection. Within 750-900 years it had penetrated the second domain but could not make a way into the caprock due to its permeability. This spread is conspicuous in nature as there are segregated CO2-saturated brine strata which can be attributed to reservoir anisotropism.
Fig. 1 show the fluid flow for 2500 years in the formation. After 230 years, gas started migrating up to the second domain. By 550 years it reached the second domain and started to migrate further upwards reaching the third domain. CO2 was filled in domain 2 and 3 simultaneously owing to injection pressure and permeability effect.

Fig 1 shows the flow of CO2 after the plume reaches the maximum possible height.

Conclusion:

• On injection of CO2 the fluid starts to dissolve and migrate both laterally and vertically. The saturation of CO2 first increases and then decreases with time. The saturation is maximum in the peripheral injection zone.
• The extent of plume spread was found to be larger when a fixed plume height was considered. This is because higher the plume height higher the areal exposure of CO2.
• The vertical and lateral migration of CO2 in the reservoir took place simultaneously. It has been shown in many studies that initially, mass transport is diffusive and declines with time but the present study shows that diffusion is continuous the rates vary with time.

Figures used in the abstract

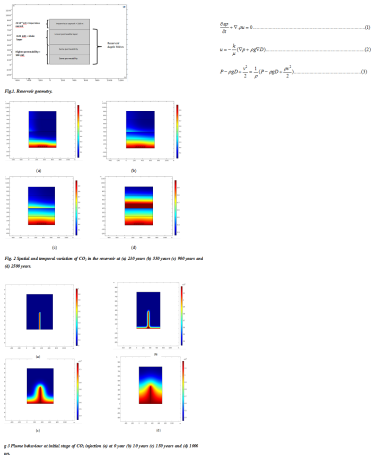

Figure 1: Figures representing fluid flow within a deep saline aquifer