# Numerical Simulations of Vertical Water Redistribution in Sand using COMSOL and HYDRUS Software

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Moisture redistribution process in porous media has a wide range of practical applications in petroleum industry, agriculture engineering, hydrology and carbon/$CO_2$ sequestration. Recently, a vertical water redistribution experiment was designed. A thin column with dimensions of 50 (height) by 1.2 cm (inner diameter) was employed. Five water tensiometers were mounted along the column at a distance of 1, 13, 25, 37 and 49 cm from the top. Two air tensiometers were mounted at 15 and 35 cm from the top to measure air pressure. Initially, the column was packed with saturated medium sand. The bottom of the column was open to the air to drain the sand gradually under gravity. Once the equilibrium had reached, the column was reversed to let moisture in the sand redistribute. During free drainage and redistribution processes, saturation was measured by gamma transmission method, and water and air pressure were measured by tensiometers. Numerical simulations were used to estimate saturation distribution over the whole column and the duration of experiments.
In this work, we used both 1D and 2D models using Richards equation to simulate this vertical redistribution process. Both COMSOL and HYDRUS-1D were used to solve 1D model, while COMSOL was employed to solve 2D model. In 1D simulations, equilibrium time is found to increase linearly during free drainage process, as the length of the column increases. It is 1.4 d for the length of 50 cm, which is employed in experiments. In 2D simulations, water saturation profiles are non-uniform along the width of the domain at earlier time steps, while become almost uniform when it reaches equilibrium. By comparison, the average saturation distribution along the column in 2D simulations considering different values of width is exactly the same as the one in 1D simulations. The simulated results are to be compared with experimental results.

Keywords: Water redistribution, Richards' equation, Tensiometers, Numerical Simulation

 