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Role of pore structure and moisture content on gas diffusion in porous media

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Diffusion in porous materials of hazardous gases such as ^{222}Rn, CO_2, CO, NH_3 and VOCs has become a concern for public health and security. Radon gas, for example, is a natural radioactive gas present in some soils and able to penetrate buildings through the building envelope in contact with the soil. ^{222}Rn can accumulate within buildings and consequently be inhaled by their occupants. Gas diffusion in a porous material depends on its pore structure and decreases with moisture content, although its quantity and rate of reduction is not well established.

In this research, we used a wide range of sedimentary porous rocks with different petrographic and petrophysical characteristics. Pore structure was described in terms of porosity, pore size distribution and specific surface area, using mercury intrusion porosimetry, the nitrogen and water adsorption techniques, and the helium pycnometer. CO_2 gas diffusion coefficient was measured with a laboratory device that works under different hygrometric conditions.

Results conclude water pore condensation reduces both connected porosity and pore size and as a consequence the CO_2 diffusion coefficient. This variation is especially important in rocks with small pores, although it occurs in all the studied porous materials. Thus, when relative humidity varies from 20 to 90%, the reduction of CO_2 diffusion coefficient for the rock with thinnest pores is by 50%. Porous rocks with larger pores and higher porosity values present the highest CO_2 diffusion, although pore size is the most significant parameter within the transport coefficients. It greatly affects both the tortuosity factor of the CO_2 gaseous diffusion. Diffusion coefficient of CO_2 measurements in partial saturated porous media can be used to characterised the gas diffusion of other hazardous gases such as ^{222}Rn and CO.