Gradient Barotropicity in Columns of Oil

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It has been widely remarked that one of today's most significant environmental problems deals with CO_2 emissions, as they are considered responsible for an increment in the global average temperatures of more than 1℃. Today's level of carbon-based primary energy demand makes a substantial reduction of CO_2 emission not realistic in the foreseeable future. Carbon Capture and Storage (CCS) has been, thereby, proposed as a good, sustainable option for our modern society. The most common CCS proposed techniques are the direct injection of CO_2 into the gas cap of a depleted oil reservoir or the use of CO_2 as a displacement fluid as part of an EOR approach.

However, the phase behaviour of CO_2 blended with diverse types of oils is extremely rich in its complexity. In some cases, coexisting phase inversion, i.e., barotropic phenomena, has been observed when mixing reservoir fluids with CO_2at high-pressure conditions. But phase barotropicity is not the only kind of barotropic behaviour that can develop. When CO_2 is gradually and horizontally injected close to the oil column base, a heavier non-equilibrium local mixture can result under full miscibility conditions. That is, an incipient non-equilibrium phase of higher density and lower viscosity can develop. This incipient fluid will move to lower levels of the oil column faster than the diffusion control chemical equilibrium can be reached, resulting in a gradient distribution of CO_2 with the highest concentration at the bottom of the column.

This behaviour is studied when CO_2 is combined with oils of different chemical structures, particularly addressing whether different chemical structures may show higher or lower CO_2 concentration gradient effects.