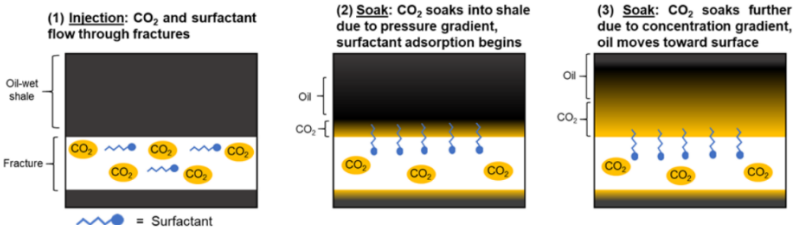
TECHBRIEF

NETL Ref. No: 19N-02



CO_2-Soluble Additives for Wettability Modification in Oil Recovery

Opportunity

Enhancing hydrocarbon production from low-permeability and unconventional formations often requires modifying how reservoir surfaces interact with injected fluids. Researchers at the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and the University of Pittsburgh (Pitt.) established a method that uses carbon dioxide (CO_2) as a carrier fluid for specialized CO_2-soluble compounds that diffuse into and adsorb onto mineral surfaces. These additives include surfactants, amphiphilic polymers, and low-molecular-weight ketones that remain soluble under injection pressures near their cloud points. Once adsorbed, the compounds decrease oil-wettability or increase water wettability or CO_2-philicity, shifting the interfacial balance that controls fluid displacement. Because the additives are delivered in CO_2 rather than water, they penetrate tight formations more effectively and avoid the viscosity and mass-transfer limitations associated with aqueous surfactant treatments. The method can also incorporate controlled soak periods to maximize diffusion and adsorption before production resumes, supporting improved recovery in formations where conventional foams and water-based enhanced oil recovery (EOR) agents underperform. This technology is available for licensing and/or further collaborative research from NETL in collaboration with Pitt.

Problems Addressed

- Recovering oil from unconventional shale formations presents a significant challenge due to the complex nature of these reservoirs.
- While CO_2-soluble surfactants have been investigated, their primary application has been in generating foams within conventional formations to improve CO_2 mobility, rather than directly addressing wettability alteration in unconventional shale.

Potential Commercial Applications

- EOR Services for Unconventional Shale: novel process for oilfield service companies and operators to increase oil recovery from shale formations.
- Manufacturing and Supply of CO_2-Soluble Surfactants: chemical manufacturers can develop, produce, and supply the specialized CO_2-soluble surfactants required for this EOR.

Competitive Advantages

- Enhanced Wettability Alteration: CO_2-surfactant solution directly alters wettability, improving oil displacement efficiency.
- Improved Oil Recovery Efficiency: combined solvent and surfactant action enhances oil recovery by simultaneously reducing viscosity and modifying wettability.

Publications

R. Enick, et al. Method of oil recovery using compositions of carbon dioxide and compounds to increase carbon dioxide wettability of formations. (2025). United States Patent and Trademark Office. U.S. Patent No.: 12,286,589.

Intellectual Property Status

A U.S. patent (U.S. 12,286,589) was issued on April 29, 2025, and expires on September 6, 2041.

Licensing / Collaboration

Partnerships@netl.doe.gov

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