Development of Swelling-Rate-Controllable Particle Gels to Enhance CO_2 Flooding Sweep Efficiency and Storage Efficiency

Award Number: DE-FE0024558

Project Summary:

The overall objective of this project was to develop a novel particle-based gel technology that can be used to enhance carbon dioxide (CO_2) sweep efficiency and thus improve CO_2 storage in mature oilfields. Specifically, novel environment-friendly and temperature-responsive preformed particle gels with particle sizes ranging from nanometer level to a few millimeters were synthesized and evaluated relative to how they can enhance sweep efficiency. Criteria of reservoir selection as well as injection time were optimized for improving flooding efficiency and CO_2 storage.

Prime Performer:
University of Missouri

Principal Investigator:
Dr. Baojun Bai

Project Duration:
6/15/2015 – 3/31/2019

Performer Location:
Rolla, Missouri

Program:
Carbon Storage

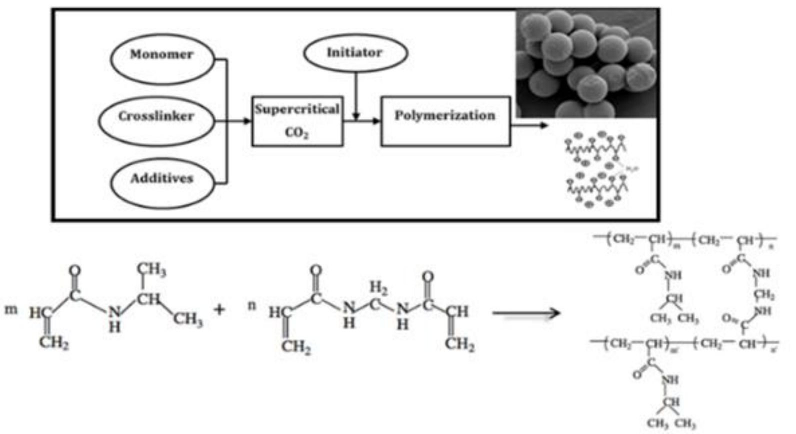

Figure 1. Schematic illustration of synthesis of nano-particle gels in supercritical CO_2.

Project Outcomes:

During this project, three types of novel preformed particle gels (PPGs) were successfully developed, including 2-acrylomido-2-methyl-propanesulfonic-acid sodium salt (AMPS) -based PPGs, CO_2 responsive PPGs (CR-PPG), and CO_2 resistance PPGs (CRG). The particles sizes were controlled and ranged from nanometer to millimeters, and the swelling time was controlled, ranging from a few hours to three months, depending on the type of conformance problems to be solved. The millimeter-sized PPGs (10 nanometers to a few millimeters) were obtained through bulk gel synthesis, cutting and drying, mechanically crushing and screening process, which were mainly used to solve the conduits, fractures, or fracture-like channels problems. The nano- and micro-sized PPGs were synthesized through either emulsion polymerization or dispersion polymerization process in supercritical CO_2, which were mainly designed to solve the matrix problem for far-wellbore conformance control (Figure 1). Overall, the project provided a series of reliable and cost-effective swelling-rate-controllable particle gel products that can be used to solve the different reservoir conformance problems for CO_2 flooding, which not only aids in improving oil recovery for CO_2 flooding projects but also helps to improve storage efficiency for CO_2 storage projects.