Boost Productivity from Mature Reservoirs
ELEVATE™ Miscible Gas Foam Flood Solutions
For more than half a century, oil and gas operators have used miscible gas floods of supercritical carbon dioxide (scCO₂), Nitrogen (N₂) and other hydrocarbon gases to extract additional oil from mature reservoirs after primary and secondary modes have been exhausted.

This effective enhanced oil recovery (EOR) technique is relatively simple: The gas is injected into a well, where it “mixes” directly with oil rather than physically forcing the oil up with pressure. This mixing reduces the oil’s viscosity and interfacial tension with the surrounding rock, making it easier to extract.

The popularity of the miscible gas foam flooding process across the industry is founded on its low risk and its low cost. Challenges – such as low sweep efficiencies due to reservoir heterogeneity and gas density – remain, keeping oil recovery efficiency lower than desired.

Dow offers unique field-proven solutions to meet those challenges. By combining the innovative chemistry of ELEVATE™ Foam Conformance Solution with Dow’s proven implementation expertise, producers can reach and recover more oil from existing wells, while simultaneously reducing operating expenditures.
Balancing Mobility and Conformance Issues

ELEVATE™ Foam Conformance Solution generates a “foam” of scCO₂ fluid and water in the formation to address the two key problems of conventional CO₂ flooding: mobility and conformance control. If there is not enough mobility of the CO₂, it cannot “sweep” the oil to the production well. However, if the CO₂ is not directed to where residual oil is, the various flow rates throughout the reservoir must conform with each other as closely as possible in order to sweep as much of the oil as possible.

ELEVATE Foam Conformance Solutions help producers strike the balance between efficiency and production. Unlike other foam systems, ELEVATE Foam Conformance Solution provides a high level of partitioning in the scCO₂ foam, allowing it to be carried to previously unreachable reservoir depths for better aerial and vertical sweep.

While CO₂ mobility is important to fluids production, inefficient use due to their natural heterogeneity or geological complexity can lead to high recycle rates and low Gas-to-Oil Ratios (GOR). The low relative viscosity of CO₂ can cause some CO₂ to “finger,” or diffuse, through areas of high oil saturation. In other cases, the low relative density of CO₂ can create gravity override, a condition where CO₂ tends to migrate toward the upper part of the oil producer, and miss a significant portion of recoverable oil.

ELEVATE Foam Conformance Solutions help generate just the right foam texture to overcome these conformance issues, resulting in increased oil recovery. At the same time, they minimize scCO₂ requirements, helping minimize costs of operation.
Our Proven Implementation Expertise Streamlines Your Operation

In an operation as complex as scCO₂ EOR, ELEVATE™ Foam Conformance Control Solution performance depends on many variables. With access to our team of experts who understand the mechanics of oil extraction, you can minimize the risks and maximize effectiveness.

Once a problematic field is pinpointed, our team will work closely with you to select a foam pilot area based on well injectivity, pattern size, current oil saturation, gas-to-oil ratio and gas utilization ratio.

Following an analysis of the geologic and reservoir simulation models, Dow will recommend a foaming solution. After laboratory testing of the foam design recommendation using reservoir rock and fluid samples, a foam model is built to incorporate into reservoir simulations. Dow experts can then provide a baseline extraction forecast to let you know how much additional oil is likely to be extractable.

A Collaborative Approach to EOR

<table>
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<th>Identify and Select&lt;br&gt;Field</th>
<th>Identify Foam&lt;br&gt;Flood Location</th>
<th>Chemistry&lt;br&gt;Development</th>
<th>Lab Evaluations</th>
<th>Reservoir Modeling</th>
<th>Field Implementation</th>
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<td>- Field geology&lt;br&gt;- Reservoir heterogeneity&lt;br&gt;- High GOR&lt;br&gt;- High GUR&lt;br&gt;- Good injectivity&lt;br&gt;- Good oil saturation&lt;br&gt;- Low CO₂ flood recovery</td>
<td>- Flood patterns&lt;br&gt;- Detailed analysis of geologic model&lt;br&gt;- Field operational constraints&lt;br&gt;- CO₂ supply constraints&lt;br&gt;- Success criteria</td>
<td>- Low adsorption&lt;br&gt;- Foam strength&lt;br&gt;- No emulsion tendency&lt;br&gt;- Surfactant CO₂ cloud point pressure&lt;br&gt;- Aqueous stability of surfactant in reservoir brine</td>
<td>- Surfactant phase behavior&lt;br&gt;- Adsorption&lt;br&gt;- Foam design experiments&lt;br&gt;- Surfactant partitioning in CO₂</td>
<td>- Field geology&lt;br&gt;- Reservoir conformance&lt;br&gt;- Oil characterization&lt;br&gt;- Available water, CO₂</td>
<td>- Injection skid design&lt;br&gt;- Field operations&lt;br&gt;- Final injection strategy&lt;br&gt;- Measure of success&lt;br&gt;- Injection profile&lt;br&gt;- Tracer test&lt;br&gt;- Well test</td>
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Testing Capabilities Minimize Risk, Maximize Yield

Dow has developed a state-of-the-art laboratory evaluation protocol including reservoir simulation capabilities to support field implementation.

Dow’s EOR lab features capabilities to test multiple core flood set-ups (formation response testers), pressure volume and temperature (PVT) cells, phase behavior equipment and interfacial tension measurement equipment. All of our testing is done under actual reservoir conditions to determine the best option for your operation and to allow fine-tuning to meet the precise downhole pressure, temperature and brine concentrations.
More EOR Solutions from Dow
Dow is developing a full suite of enhanced oil recovery techniques including improvements for thermal, miscible gas and improvements to water flooding (CEOR). Dow experts can customize solutions for each field and can help in formulation of complex EOR mixtures.

Dow’s Commitment to Sustainability
Dow’s commitment to sustainability is infused into the very DNA of our Company. In 2006, we launched our 2015 Sustainability Goals, which focused not only on the Company’s footprint in our own operations but also our handprint through the positive impact of Dow products and their role in global sustainable development. Now we have introduced our 2025 Sustainability Goals. With these Goals, Dow seeks to advance the wellbeing of humanity by helping lead the transition to a sustainable planet and society. The seven commitments that comprise the 2025 Sustainability Goals represent the next step in our long-term strategic journey. For more information on how sustainability is integrated into all aspects of our business and operations, please visit www.dow.com/sustainability.

Product Stewardship and Safety
Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products – from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including safety data sheets, should be consulted prior to use of Dow products. Current safety data sheets are available from Dow.
This guide is designed as a general product overview. Please contact your local Dow representative for up-to-date, detailed technical information, including registrations and use limitations, and to discuss individual applications or requirements.

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