Full Steam Ahead for Greater Production
High-Temperature Additives for Improving Thermal Enhanced Oil Recovery
Heavy oil and bitumen are the most abundant, but most difficult-to-recover hydrocarbon sources. With heavy oil viscosities in the thousands of centipoises and bitumen viscosities over 1 million, these oils need to be heated to be produced.

Thermal systems, including hot water and steam, have been used for many years to lower the viscosity of these oils so that they can flow to producing wells. Steam floods and steam-assisted gravity drainage (SAGD) processes continue to be implemented in many parts of the world. While they are considered very effective ways of recovering heavy oil, they are still not efficient – with steam-to-oil ratios in some SAGD operations well above four.

Thermal enhanced oil recovery (EOR), particularly steam processes, suffer from similar issues to other displacement processes – conformance and mobility control. In addition, the condensed water is not a good solvent for oil and therefore does fully recover the oil trapped in tighter and smaller pores.

Dow is developing solutions to combat both problems – ELEVATE™ Steam Foam Additives to control conformance issues in steam floods and hot spots in SAGD, as well as ELEVATE SAGD SOR Improvement Additives to improve the efficiency of SAGD operations. These additives help increase oil production rate, increase total oil recovery over time and decrease steam-to-oil ratios. Combined with Dow’s implementation expertise, backed by decades of experience in additives for use in oil production, these products will help recover more oil while significantly reducing water and energy use.

Proven Productivity Improvement
ELEVATE™ Steam Foam Additives have been specifically designed for high temperatures, such as those found in reservoirs being produced with steam. These additives have been tested and show no adverse effects on the formation or any downhole or topside equipment, with minimal effect on separation, water treatment or water recycling operations. In some cases, products have been tested at boiler tube conditions to simulate steam plant recycling processes.

ELEVATE Steam Foam Additives have been extensively tested in the lab and in the field and show increased recovery rates. The products, co-injected as liquids into the steam line, quickly vaporize and travel to the steam chamber edge to loosen bitumen and increase recovery rates. Dow experts are able to detect returns of our product in the produced emulsion to track performance.

The dense foams created by injection of Dow steam foam additives overcome steam conformance issues by blocking high-permeable zones, forcing the steam into the oil-rich areas not yet reached (Figure 1.) They also minimize the effects of “hot spots” in SAGD processes by dispersing steam throughout the well more uniformly, preventing the steam from channeling, allowing more consistent steam chamber growth.

Advantages of ELEVATE™ Additives for Steam Foam EOR
- Resist degradation at high temperature
- Minimum absorption of surfactant in the reservoir formation
- Ability to foam at high temperatures and pressures
- Can be winterized for use in temperatures as low as -40 °C

Figure 1. Steam foams generated with ELEVATE™ Surfactants can reach oil bypassed by initial methods.
Steam Foam Additives for Enhanced Oil Recovery

Testing Capabilities Minimize Your Risk, Maximize Your Yield
From initial research through lab evaluation, modeling and field trials through full-scale implementation, Dow is at your side to develop a solution that maximizes oil recovery rates in your thermal EOR operation.

Dow has developed laboratory evaluation and reservoir simulation capabilities to support field implementation and help customers get more out of previously difficult-to-produce reserves.

Dow’s EOR lab features extensive capabilities to test multiple core flood set-ups (including various steam configurations) using 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 pressure, temperature and brine concentrations.

Support from Lab to Field
Dow has an established process to support development of customer-tailored solutions from initial laboratory testing all the way through final field implementation.

It begins with rigorous in-house experimental capabilities to test additive performance, de-risk field implementation and meet customer-specific requirements.

We work with customers to review or develop new chemistries and perform lab evaluations. Using the customers’ conditions and understanding of the process, reservoir modeling is completed. A field trial is then run to make sure the additives perform to desired goals and, once successful, on to full-scale implementation.

More EOR Solutions from Dow
Dow has additional EOR solutions that can be customized for each field and can help in formulation of complex surfactant/co-surfactant/co-solvent mixtures. EOR techniques often lead to water treatment issues including mineral scaling, unresolved emulsions and water cleanup. Dow can work with you to find the optimal solution to water treatment needs for EOR.

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 dow.com/sustainability.

Figure 2: Dow supports development of effective solutions from initial analysis through final field implementation.
**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.

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### The Dow Chemical Company

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