SCHOOL OF
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Development and Application of Re-crosslinkable Preformed Particle Gels (RPPG) for Preferential Fluid Flow Control in Subsurface Reservoirs

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The existence of high conductivity features such as fractures, and void space conduits can severely restrict the sweep efficiency of water or chemical or gas floodings in subsurface formations, including oil and gas reservoirs, CO2 storage sites and geo-thermal reservoirs. Preformed particle gel (PPG), as a cost-effective technology, has been widely applied for more than 15,000 wells to control the preferential fluid flow problems in many oilfields. However, conventional PPGs have limited plugging efficiency in the reservoirs with large open fractures or void space conduits. After flooding fluids breakthrough, gel particles can easily be washed out from the fractures due to the lack of particle-particle association and particle-rock adhesion. We have developed a new type of preformed particle gels called recrosslinkable preformed particle gel (RPPG) that can be used to efficiently plug such high conductivity features. The products can re-crosslink to form a rubber-like bulk gel after being placed in a reservoir, coupling the advantages of the preformed particle gel and in-situ gel into one product. We have synthesized a series of such products with varied sizes from micrometers to millimeters and a wide range of temperature from 20 to 225 °C. One of such products has been successfully applied to solve the Wormhole/Void Space Conduit problem in West Sak field of Alaska. In this presentation, I will briefly introduce the advantages of PPG comparing traditional polymer gels, the properties and evaluation methods of newly developed RPPGs, their applied conditions, and their field application cases in fields. Finally, the future research directions in the area will be recommended.

Dr. Baojun Bai is a Curators' Distinguished Professor and the Lester R. Birbeck Endowed Chair in Petroleum Engineering at Missouri University of Science and Technology (S&T). He is also the head of Petroleum Engineering in the university and the director of Preformed Particle Gel Conformance Control Consortium.
He has had more than 30 years of experience in the research areas of conformance control, enhanced oil recovery, unconventional reservoir development, CO2 storage and geothermal. He has published more than 300 papers in peer-reviewed journal papers and over 160 papers in SPE conferences. Dr Bai is the recipient of the SPE Production and Operation International Award (2025), SPE IOR Pioneer Award (2024) and SPE Distinguished Achievements International Award for Petroleum Engineering Faculty in 2023. He became a Distinguished Member of SPE in 2019. Bai earned a Ph.D. in petroleum engineering from New Mexico Institute of Mining and Technology, a Ph.D. in petroleum geology from China University of Geosciences, a master's degree in petroleum engineering from the Graduate School of RIPED in PetroChina, and a bachelor's degree in reservoir engineering from Daqing Petroleum Institute, China. Dr. Bai was a post-Doctoral scholar at the California Institute of Technology in 2005 to 2006.