Enhanced Oil Recovery in Unconventional Reservoirs

Enhanced oil recovery in unconventional reservoirs has established a track record in the past few years. It is an important technology to investigate and implement to pursue longevity in the thousands of horizontal laterals that are reaching their terminal decline towards abandonment. These techniques have been proven to be technically feasible and to a certain degree, economically attractive. The techniques described in this paper are 1) gas injection in the huff n' puff mode 2) surfactant injection in the huff n' puff mode and 3) co-injection of both miscible gas and surfactant. The objectives of this presentation are to present laboratory evidence and field results for the three techniques described.

Laboratory justification behind each of the three methods is presented. Wettability alteration by surfactants as determined by contact angle measurements will be discussed. Results from core data are presented for each of the three methods that include gas penetration, imbibition, and the use of both mechanisms for co-injection of gas and surfactant. Experiments using time-lapse CT scanning demonstrate the saturation changes as oil is displaced when core samples are exposed to gas, surfactant, or a combination of both.

Miscible gas experiments conducted using time-lapse CT scanning indicate gas penetration induces saturation changes on reasonable time scales. Ample contact angle and imbibition data demonstrate that wettability alteration is the key to application of surfactants in unconventional reservoirs. Both techniques have been applied in successful field projects. Application of co-injection using both gas and surfactant capitalizing on the synergy between the mechanisms is especially intriguing, both from a laboratory and field perspective. Experiments are presented that show miscible gas displaces oil from larger pores and surfactant imbibition displaces oil from smaller pores during co-injection. Review of a co-injection project demonstrates key advantages over gas injection alone such as 1) prevention of rapid gas migration via fractures away from injection well 2) reduction of the necessity for high pressure compression to attain the MMP by utilizing co-injection of surfactant and gas and 3) a superior gas utilization factor as compared to gas-only projects showing the importance of surfactant during co-injection.

A novel co-injection method with both miscible gas and surfactant is described. The technique utilizes both the diffusion/swelling mechanism of miscible gas along with the ability of surfactant to alter wettability resulting in gas sweeping the larger pore spaces and aqueous phase surfactants to displace oil in smaller pores via capillary pressure. The net result in the field shows co-injection can achieve gas utilization factors in the range of 4-6 Mscf/barrel of EOR vs. typical gas utilization factors observed in gas only projects in the range of > 14 Mscf/barrel of EOR.

Bio

Dr. David Schechter has over 30 years of dedication to academic petroleum engineering and research in Enhanced Oil Recovery (EOR). He currently serves as Department Chair for the Craft & Hawkins Department of Petroleum Engineering at LSU. Dr. Schechter earned his BS in chemical engineering from The University of Texas at Austin and his PhD in physical chemistry from the University of Bristol, England. He began his career as a post-doctoral research associate, then Assistant Professor in the Department of Petroleum Engineering at Stanford University. He was then Senior Scientist at New Mexico Tech's Petroleum Recovery Research Center in Socorro, NM. At New Mexico Tech, he had a joint appointment as adjunct professor in the Department of Chemical Engineering. He also served as Interim Director of the Petroleum Recovery Research Center. At New Mexico Tech, he was author and PI of a 13-million-dollar Department of Energy project to test CO2 injection/sequestration in the Permian Basin. Dr. Schechter then served as Professor of Petroleum Engineering at Texas A&M University where he designed, constructed and managed the Chapparal-Fischer CO2 EOR laboratories. Dr. Schechter has mentored and graduated over 90 MSc and PhD students. More recently, Dr. Schechter worked as VP of reservoir engineering at EOR ETC and serves on their Board of Directors. EOR ETC applies cutting edge technology for co-injection of surfactant and gas for EOR. He also serves as Chief Technology Officer at Third Wave Production, a company devoted to the development and application of specific surfactant formulations for EOR in unconventional liquid reservoirs. Dr. Schechter has taught 90 reservoir and production engineering-related industry courses in 18 different countries. He has consulted extensively in Mexico and South America. Dr. Schechter holds one patent and has published over 170 journal articles and conference papers. He is a Distinguished Member of the Society of Petroleum Engineers, an honor bestowed to less than 1% of the worldwide membership.