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A Review on Polymer Adsorption in Carbonate and Sandstone Reservoirs

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Of the innumerable EOR techniques, Polymer flooding is one of the most effective methods which aids oil recovery (Khalilinezhad et al., 2019; Lamas et al., 2021) by increasing the viscosity of water (Chang, 1978; Saboorian-Jooybari et al., 2016; Panthi et al., 2016b; Mohsenatabar Firozjaii and Saghafi, 2020; Lu et al., 2021) hence lowering the water-oil mobility ratio (Jennings RR et al., 1971; Dano et al., 2019), thus improving the volumetric sweep efficiency (Sandiford, 1964; Rashidi et al., 2009; Han et al., 2014; Yoo et al., 2020; Lamas et al., 2021). Polymer flooding has been widely used over the years in the case of sandstone reservoirs with lower temperatures, low salinity, and high permeabilities (Zhang and Seright, 2014; Panthi et al., 2016a; Oluwaseun Taiwo et al., 2019; Yoo et al., 2020; Bera et al., 2020; Zhu et al., 2020). However, its application is limited in the case of carbonates reservoirs due to complex heterogeneity, low permeability values less than 100mD (Saberhosseini et al., 2019; Khalilinezhad et al., 2021; Mahmoodpour et al., 2021), higher reservoir temperature, i.e., above 850C, high salinity above 100,000ppm (Lu et al., 2014; Das et al., 2020) and hardness over 1,000ppm (Diab and Al-Shalabi, 2019; Abalkhail et al., 2020; Mogensen and Masalmeh, 2020).
The success of a polymer flooding project depends on the efficient transport and propagation of polymer slug through the reservoir. As polymer solution flow through the porous media, interactions happen between the rock surface and the polymer molecules, which causes these polymer molecules to be retained on to the rock surface (Huh et al., 1990; Rashidi et al., 2009; Gaillard et al., 2014; Alfazazi et al., 2020), thus resulting the injected fluid to be deprived of polymer molecules and causing the reduction in viscosity (Zamani et al., 2017; Skauge et al., 2018; Zhang et al., 2021) and further reducing the efficiency of the polymer flooding (Riahinezhad et al., 2017; Al-Hajri et al., 2018; Liang et al., 2019). Polymer retention can be caused due to polymer adsorption onto the rock surface, mechanical entrapment of polymer molecules in the tiny pores of the porous media, and hydrodynamic retention due to varying flow rates (Sorbie, 1991; Al-Hajri et al., 2018; Sugar et al., 2020). A higher amount of polymer adsorption can cause a delayed polymer propagation resulting delay in the oil displacement. The significant economic impact due to the delayed polymer prorogation caused by the polymers being permanently lost to the porous rock resulted in increased consumption of chemicals and increased injection period. Some pores of reservoir rocks are relatively small, which restricts the entry of large size polymer molecules. The bulk of these pores through which polymers cannot penetrate is known as inaccessible pore volume. Further, due to this inaccessible pore volume, a polymer solution will sweep through less pore volume in a porous medium; thus, there will be an early breakthrough of polymer solution. There are many factors affecting polymer adsorption including polymer type, polymer concentration, salinity, presence of oil and type of rock surface.

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