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Determination of polymer retention rate at pore size in porous media

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Polymer flooding plays a key role in enhancing oil recovery process around worldwide oil fields. Viscoelastic polymer added into water can improve sweep efficiency either by reducing mobility ratio or by lowering the degree of heterogeneity of layers [1]. It may result from factors such as the decreasing size or clogging of pore throat due to polymer retention within the reservoir rock, the elevated shear viscosity and tensile viscosity when injected fluids flows through porous media. Field calculations indicate polymer retention ranges from approximately 50 to 250μg/g in some reservoir [2]. Excessive polymer retention can make injection difficulty, the concentration loss deeper in reservoir, and poor oil recovery rate [3]. It is necessary to determine if polymer molecule filtrate or trap at some pore size. The objective of this work is to quantify polymer retention rate at pore size, calculate comprehensive retention rate of polymer in the core and analyze the factors on retention rate at pore size and in the core. Polymer solution filtration experiments were carried using a special uniform pore size of porous media ——polycarbonate filter membrane, with pore size 0.01μm-5.00μm, diameter 47-48mm and thickness 9-10μm. Partially hydrolyzed polyacrylamide (HPAM) were used as polymers with molecular weight of 14 million g/mol at 1000mg/L and 27 million g/mol at 500mg/L-1200mg/L. The polymer retention rate at pore size (Prp, %) was the percentage of polymer concentration after filtration through uniform pore size of porous media and before filtration, and polymer concentration was measured through a range of uniform porous media by starch-cadmium iodide method. The comprehensive retention rate of polymer in the core (Prc, %) was calculated by combining the pore size distribution with polymer retention rate varying from pore size. The results show that there is obvious correlation between retention rate of HPAM at pore size and Rtp, which is the ratio of pore throat radius (Rt) to polymer hydrodynamic radius (Rp) and is used to characterize the relative size of polymer molecule and pore throat (Fig1.). It is found that when Rtp≤0.5, retention rate can reach about 80%; When 0.5< Rtp ≤1.2, 20%-80% of the retention occurs, and retention rate is less than 20% when Rtp>1.2. The comprehensive retention rate increases significantly with the decrease of permeability. When the permeability decreases from 1000mD to 50mD, Prc increases from 30% to 60% (Fig2.). The higher the molecular weight, the larger the concentration and the higher the retention rate. The comprehensive retention rate of polymer in the core can predict the clogging degree of polymer and the retention rate at pore size can be further used to determine the distribution of polymer trapped in reservoir.

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