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EFFICIENCY OF MICROPORE SWEEP DURING VISCOELASTIC POLYMER FLOODING FOR ENHANCED OIL RECOVERY

Abstract

Polymer flooding is widely implemented as a mobility-control method for enhanced oil recovery (EOR); however, incremental recovery beyond mobility improvement is frequently reported and remains incompletely explained. This review examines the role of viscoelasticity in improving micropore sweep efficiency during polymer flooding. A clear distinction is made between micropore access (flow penetration into low-connectivity microdomains) and micropore mobilization (release of trapped oil in dead-end pores and corners). The analysis synthesizes experimental observations, pore-scale simulations, and rheological considerations to evaluate whether elastic stresses contribute to additional oil displacement mechanisms beyond shear viscosity effects. Particular attention is given to extensional flow behavior in converging–diverging pore geometries, the influence of crude oil viscosity, and the role of salinity, temperature, and mechanical degradation in suppressing viscoelastic responses. The review demonstrates that viscoelastic contributions to oil recovery are condition-dependent and most pronounced within specific viscosity and operational windows. Variability in reported results is largely attributed to inconsistent rheological characterization and insufficient consideration of degradation effects. Standardized brine-conditioned rheological protocols, including extensional metrics where feasible, are recommended to improve reproducibility and predictive capability. The findings highlight the need for multi-scale validation linking pore-scale mechanisms to core-scale displacement and field performance.

Keywords: Viscoelastic polymer flooding; micropore sweep efficiency; enhanced oil recovery; pore-scale mechanisms; residual oil mobilization

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Introduction

Polymer flooding is among the most established chemical EOR methods, commonly justified through mobility control: increasing aqueous-phase viscosity reduces the mobility ratio, stabilizes displacement fronts, and improves macroscopic sweep in heterogeneous reservoirs. Yet, many polymer-flood case studies and laboratory reports document incremental oil recovery that cannot be fully explained by viscosity enhancement alone, particularly when changes in microscopic displacement efficiency or residual oil saturation are observed. This disconnect has motivated renewed interest in polymer viscoelasticity and how elastic stresses interact with pore geometry, interfacial phenomena, and trapping mechanisms at the microscale.

A central theme emerging from the literature is that viscoelastic polymer solutions can introduce additional forces beyond those captured by Newtonian viscosity. Comprehensive reviews highlight multiple candidate mechanisms, including elastic instabilities in constrictions, normal-stress-driven effects, and enhanced displacement in dead-end or corner regions where oil is commonly trapped [1, 2]. At pore scale, simulations and experiments increasingly suggest that local stress build-up near contact regions can deform and mobilize trapped oil ganglia through breakup pathways such as pinch-off, providing a plausible route for microscopic improvement at moderate capillary numbers [3]. Connecting these mechanistic insights to field-relevant screening criteria remains challenging due to inconsistent reporting of rheology, ambiguity in selecting appropriate Deborah numbers for porous media, and limited use of extensional metrics despite their relevance to converging–diverging flow [1, 4].

Heavy oil reservoirs are a particularly important context for this discussion. In such systems, mobility control alone may be insufficient if oil viscosity is very high, and the feasibility of polymer flooding depends on both injectivity and the ability of polymer elasticity to contribute to oil mobilization. Recent experimental work has emphasized a practical "viscosity limit" for effective elastic displacement, indicating that polymer viscoelasticity delivers measurable incremental recovery only within certain crude-viscosity and operational conditions [5]. Microscopic experiments in heterogeneous heavy oil settings also show that sweep and displacement efficiencies are strongly coupled, and that micro-displacement in less-accessible regions can govern incremental recovery [6]. Salinity and temperature can degrade polymer elasticity, altering flow fields and reducing the pore-scale benefits observed under benign laboratory brines [7, 8]. Mechanical degradation during injection through shear and high pressure gradients further complicates interpretation of "elastic effects," since molecular weight loss and chain scission directly reduce viscoelastic response [9]. This focused review synthesizes peer-reviewed studies spanning pore-scale mechanisms, heavy oil experiments, harsh-condition performance, degradation, and numerical modeling. The objective is to provide a mechanism-based framework for micropore sweep improvement in viscoelastic polymer flooding, emphasize rheological descriptors and translate literature insights into practical screening and reporting guidance.

Materials and methods

This work is a focused narrative review that synthesizes peer-reviewed literature on micropore-scale displacement during viscoelastic polymer flooding. A structured search was performed in Google Scholar and ScienceDirect using combinations of keywords including viscoelastic polymer flooding, pore-scale, dead-end pores, corner residual oil, extensional viscosity, heavy oil, high salinity, polymer degradation, and numerical modeling. Only studies relevant to (i) pore-scale mobilization mechanisms, (ii) rheological characterization linked to porous-media response, (iii) performance under harsh reservoir conditions (high salinity/temperature), (iv) polymer mechanical degradation, or (v) pore-/core-scale numerical modeling were retained.

Results and discussion

Rheology and descriptors relevant to micropore sweep

Shear viscosity remains essential to polymer flooding because it controls mobility ratio and stabilizes displacement fronts; however, micropore sweep efficiency often depends on mechanisms not captured by viscosity alone. Reviews based on extensive laboratory datasets emphasize that polymer performance may include an "elastic contribution," particularly in geometries characterized by repeated contraction–expansion, streamline curvature, and interfacial deformation [1, 2]. This distinction is critical in micropores and dead-ends, where local velocities are low and capillary trapping dominates. Under such conditions, incremental mobilization is expected only if the displacing phase develops additional stresses that can perturb the local force balance near interfaces and in pore throats.

A major unresolved issue is the selection of rheological metrics that meaningfully correlate with porous-media response. Small-amplitude oscillatory tests (G'/G'') and relaxation times are widely reported, yet petroleum engineering literature notes that Deborah numbers derived from oscillatory shear may not reflect the deformation history experienced in pore networks, where extensional kinematics are prevalent [4]. Extensional rheology is therefore increasingly highlighted as a more physically relevant descriptor for converging–diverging flows, since pore throats behave as repeated extensional elements. Experimental comparisons of fluids with similar shear viscosity but different elastic response further support the view that elasticity-related descriptors can correlate with incremental recovery beyond purely viscous mobility control [10]. For review consistency and reproducibility, studies should report at minimum a full viscosity curve versus shear rate and at least one elasticity-related metric together with brine composition and temperature, since salinity and harsh conditions can suppress elasticity and alter microflow structure [7, 8].

Pore-scale mechanisms

Micropore sweep is strongly governed by pore–throat architecture and connectivity, which differ systematically across permeability classes. Remaining oil after flooding frequently concentrates in poorly connected microdomains, pore corners, and dead-end features because local pressure gradients and velocities are insufficient to overcome capillary confinement. A pore-network representation across permeability levels provides an effective visual explanation of why low-permeability domains are prone to bypassing and persistent trapping. Remaining-oil characterization studies further show that the occurrence and morphology of residual oil depend on permeability-related pore structure, reinforcing the need to interpret polymer flooding outcomes through pore-network connectivity rather than bulk permeability alone [11]. This structural argument establishes the "access problem": improving macroscopic sweep does not automatically guarantee invasion into microporous regions.

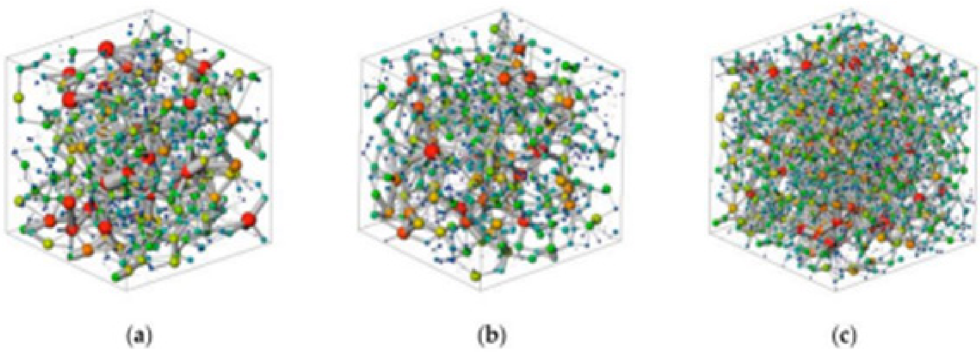

Figure 1 – Pore network model of reservoirs with different permeability:
(a) high, (b) medium, (c) low. Reproduced from [11]

Beyond access, micropore sweep requires mobilization from geometries where oil remains protected, notably corners and dead-end pores. Conceptually, viscoelastic polymer solutions can generate additional elastic stresses during deformation in converging–diverging microgeometries, potentially altering the local force balance near the oil–water interface and facilitating detachment, deformation, or transport of trapped oil. Mechanistic discussions in the review literature describe elasticity-enabled mobilization in dead-ends and corner regions, while also emphasizing that the effect is conditional on flow regime, wettability, and preservation of viscoelasticity in brine [1, 2]. Numerical setups designed around dead-end capillary geometries provide a controlled platform to study these effects, since they isolate the geometry-driven deformation field that is difficult to separate in heterogeneous cores.

Figure 2 is positioned here because it establishes the canonical dead-end geometry and the computational representation used to evaluate viscoelastic behavior in confined pore elements [12].

Pore-scale simulations provide an interpretable route to connect viscoelastic constitutive behavior to displacement outcomes in simplified microgeometries. In fractional-order viscoelastic formulations, the order parameter can be interpreted as controlling the strength of "memory" in stress response, which in turn modifies the stress distribution and flow field within dead-end geometries.

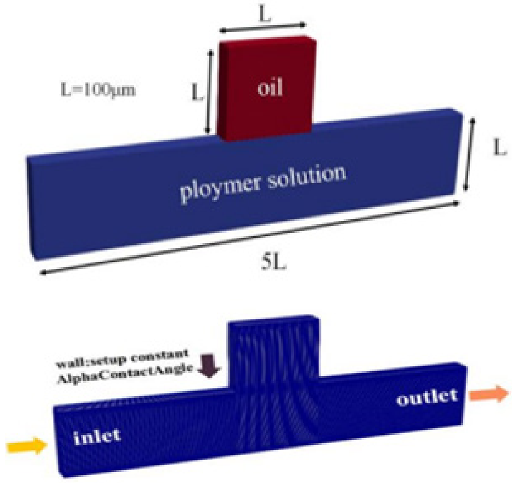

Figure 2 – Physical and Numerical model
of the dead-end capillary [12]

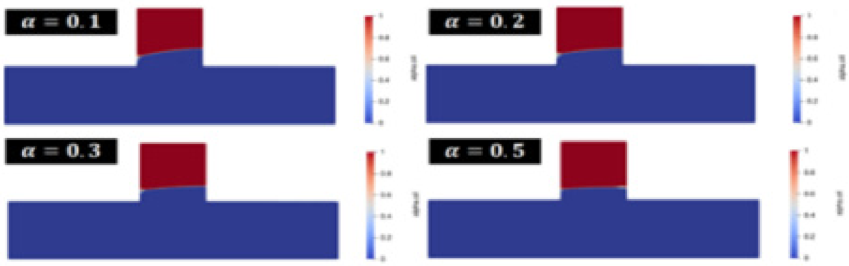

Figure 3 – Simulation results of viscoelastic displacement in a dead-end geometry
for different fractional derivative orders (α). [12]

Simulation results reported for different fractional orders show distinct displacement patterns and support the mechanistic hypothesis that enhanced elastic response can promote more effective displacement in confined regions, consistent with the broader idea that elasticity becomes most relevant in strongly deformational pore elements [12]. In a review context, these results should be framed as mechanistic support rather than universal prediction: they highlight sensitivity to constitutive assumptions and boundary conditions, and they underscore why consistent rheological reporting is necessary to interpret cross-study differences.

Heavy oil displacement and the "viscosity window" for elastic contribution

Heavy oil systems provide a stringent test for polymer flooding because viscous forces, injectivity constraints, and capillary trapping interact more strongly than in light-oil settings. While mobility control remains a primary driver for polymer flooding, multiple studies argue that viscoelasticity can contribute additional microscopic displacement only within a practical range of oil viscosities and operating conditions. Authors present a controlled experimental program explicitly designed to investigate a "viscosity limit" for elastic contribution during polymer flooding of heavy oils [5]. Their experimental workflow (Figure 4) provides a transparent basis for evaluating displacement behavior under consistent coreflood conditions, enabling mechanistic interpretation rather than anecdotal comparison.

A key point for micropore sweep is that elasticity-driven mobilization does not increase indefinitely with oil viscosity. At high viscosities, displacement becomes dominated by severe mobility contrast, and the displacing phase can no longer generate sufficient deformation to activate elastic stresses in trapped-oil geometries. Thus, an operational "window" exists where polymer viscoelasticity and pore-scale deformation rates are adequate to enhance mobilization. Microscopic studies in heterogeneous heavy-oil systems confirm that sweep and displacement efficiencies are limited by both heterogeneity and viscosity; improvements occur mainly when the displacing phase can access and perturb low-connectivity microdomains rather than simply stabilize dominant flow channels. [6].

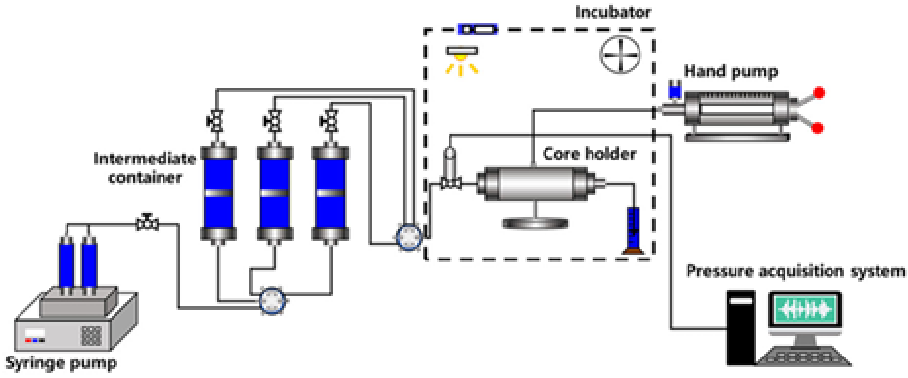

Figure 4 – Schematic diagram of the core displacement experiment process.
Reproduced from [5]

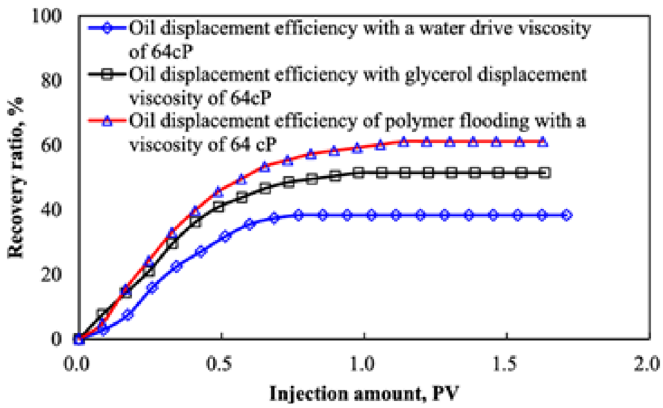

Figure 5 – Displacement results [5]

Figure 5 compares displacement performance under the conditions reported, indicating that incremental benefits depend on crude viscosity and operating conditions [5]

Even when polymer flooding is conceptually attractive for heavy oil, harsh reservoir conditions can suppress the very viscoelastic features that motivate micropore-scale improvement. High salinity, especially with divalent ions, screens electrostatic repulsion along polymer chains and promotes coil contraction, reducing hydrodynamic volume and weakening elastic response. Pore-scale experimental evidence demonstrates that salinity-driven loss of viscoelasticity leads to measurable changes in microflow structures, supporting the broader interpretation that micropore mobilization benefits are conditional on preserving polymer elastic behavior in the injected brine [13]. From a review standpoint, this is a crucial "why results vary" point: two studies can report similar apparent viscosities at a given shear rate, yet exhibit different micropore-scale outcomes if one polymer loses elasticity under brine conditions.

Temperature adds another constraint, particularly for heavy-oil reservoirs where elevated temperature may exist naturally or be introduced by operations. Under high-temperature/high-salinity (HTHS) conditions, polymer selection becomes a design problem: either employ polymers with improved thermal and salt tolerance or accept that elasticity-driven mechanisms will be attenuated and the flood will behave predominantly as a mobility-control process. Laboratory studies targeting HTHS heavy oil settings report that appropriate polymer formulations can still deliver meaningful incremental recovery, but they also reinforce that brine chemistry and temperature must be treated as first-order variables rather than secondary details [8].

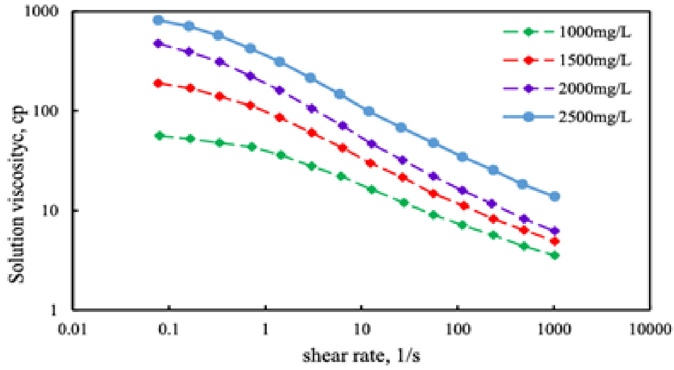

Figure 6 – Rheology of polymer solution at different locations from the bottom of the well (reported by the source study) [5]

Figure 6 is placed here because rheological response "at different locations" illustrates the practical reality that polymer rheology is not uniform across the system. In review language, it supports the statement that in-situ effective rheology evolves with position and deformation history, and therefore "elastic contribution" must be discussed as a function of operational context rather than as a fixed property of the polymer [4, 5].

A practical limitation that often receives insufficient attention in mechanism-focused discussions is polymer integrity. Viscoelastic mobilization relies on maintaining chain length and microstructural response; mechanical degradation reduces molecular weight and can weaken or eliminate the elastic component even if the solution retains some shear-thinning behaviour. Experimental evaluation of HPAM mechanical degradation under conditions relevant to injection operations shows that factors such as pressure drop, flow through constrictions, and handling processes can significantly affect polymer properties [9]. For a review, the implication is direct: claims of "elastic contribution" must be interpreted in the context of polymer degradation history. Two floods using nominally the same polymer grade and concentration can yield different micropore-scale outcomes if one experiences stronger mechanical scission prior to entering the formation.

This integrity argument also feeds back into the heavy-oil "window" concept. If polymer elasticity is reduced by salinity/temperature and further weakened by degradation, then even reservoirs that appear "screened" for polymer flooding based on viscosity ratio may not realize micropore-scale benefits.

Modeling across scales

Modeling plays a central role in viscoelastic polymer flooding research because many of the proposed "micropore sweep" mechanisms are inherently local: they are activated in pore throats, corners, and dead-end geometries where deformation history, interfacial curvature, and contact-line dynamics govern whether trapped oil remains immobile or becomes mobilized. At the pore scale, one major contribution of modern multiphase viscoelastic simulations is to make the stress pathways visible and testable. For example, Lattice-Boltzmann-based multiphase modeling has been used to show how viscoelastic stresses can localize near contact regions and influence droplet deformation and mobilization routes such as pinch-off-type breakup in confined geometries, providing a physically interpretable explanation for microscopic mobilization beyond Newtonian capillary-number arguments [3]. In parallel, simplified "canonical" pore elements such as dead-end capillaries remain useful because they isolate trapping geometry and allow systematic sensitivity studies to the constitutive description. Fractional-order Maxwell formulations, for instance, provide a parameterized way to represent stress memory and relaxation behavior and have been applied to predict how changes in viscoelastic response can alter displacement patterns and residual trapping in dead-end configurations. [12].

A frequent critique of pore-scale modeling is that idealized geometries may not represent real rock topology. This is why microflow simulations on reconstructed pore structures have become increasingly influential. CT-informed workflows that generate realistic pore geometries and solve non-Newtonian/viscoelastic multiphase flow in computational frameworks (e.g., OpenFOAM-based approaches) provide an intermediate modeling layer between idealized pore elements and core/field-scale behavior [14]. Microflow modeling is explicitly used to investigate viscoelastic polymer flooding in heterogeneous reservoir contexts, enabling the evaluation of how heterogeneity, connectivity, and local deformation fields influence displacement patterns and flow diversion at pore scale. This matters for “micropore sweep efficiency” because access to micropores is often controlled by connectivity and preferential flow paths, while mobilization depends on whether local deformation rates and stress development are sufficient to perturb capillary trapping [11]. Microflow models therefore help reconcile why laboratory studies may disagree: two polymer solutions with similar apparent shear viscosity can produce different microdisplacement outcomes if one preserves elastic response under the specific brine and deformation conditions encountered in the pore network, an issue also emphasized by discussions on extensional relevance and unresolved characterization challenges [1].

At Darcy (reservoir) scale, the practical challenge is different: field decisions require models that are computationally tractable and parameterizable from available data, even though true pore-scale stress localization cannot be resolved directly. Many field-relevant simulations focus on incorporating the dominant non-Newtonian features most commonly shear-thinning—through effective viscosity or dynamic viscosity formulations, with the aim of improving predictions of injectivity, mobility control, and sweep under realistic operational constraints. Study of authors provides a Darcy-scale polymer flooding framework that uses a dynamic viscosity model to represent shear-thinning behavior in a way compatible with continuum-scale simulation needs [15]

Field-scale modeling is also widely used to test hybrid chemical systems where viscoelasticity and interfacial chemistry are coupled, especially in complex reservoir architectures such as naturally fractured systems. A field-scale simulation study of viscoelastic surfactant (VES) flooding in naturally fractured reservoirs illustrates how viscoelastic chemical systems can be evaluated against waterflooding and conventional chemical flooding strategies in terms of recovery and water-cut trends under fracture–matrix transfer conditions. In a polymer-focused micropore sweep review, the point of including such work is not to claim direct equivalence between VES and polymer viscoelasticity, but to show that (i) viscoelastic properties are being treated as design variables at scale, and (ii) multi-physics coupling is a realistic pathway when polymer elasticity alone is insufficient for access and mobilization across heterogeneous domains [16].

Any model-based interpretation must remain consistent with polymer integrity and the possibility that viscoelastic response degrades before the fluid even reaches the targeted pore regions. Mechanical degradation of HPAM solutions during preparation and flow through restrictions is experimentally documented and provides a clear caution: if chain scission reduces molecular weight and elasticity, then the pore-scale mechanisms predicted by viscoelastic constitutive models may not be realized in practice unless degradation is minimized or explicitly accounted for. Similarly, pore-scale experiments show that high salinity can suppress viscoelasticity and alter microflow fields, which should be reflected either through brine-conditioned rheology inputs or through conservative interpretation of “elastic contribution” in models [13]. The most defensible modeling hierarchy for journal-quality review synthesis is: (1) pore-scale models to establish plausible mobilization pathways and identify the controlling stress/geometry conditions ; (2) geometry-resolved microflow simulations to test those pathways under realistic pore connectivity and heterogeneity ; and (3) Darcy/field-scale models to translate non-Newtonian transport behavior and operational constraints into sweep-level predictions while acknowledging that explicit micropore mobilization must be supported by compatible rheology and integrity evidence[12, 13 ,15].

Limitations and research gaps

Even though the literature increasingly supports the plausibility of elasticity-assisted microscopic displacement, several limitations constrain how confidently viscoelastic polymer flooding can be generalized as a micropore sweep solution. First, a major limitation is the non-standardized characterization of “viscoelasticity”. Many studies still rely on shear viscosity or oscillatory rheology alone, yet porous-media flow is dominated by converging–diverging kinematics and interfacial deformation. As emphasized in petroleum engineering discussions, Deborah numbers derived from small-amplitude oscillatory tests may not map cleanly to pore-network deformation histories, which complicates cross-study comparison and contributes to apparently contradictory conclusions regarding residual oil reduction and “elastic contribution” [1, 4]. Without consistent reporting of relaxation behavior and, where possible, extensional response, it remains difficult to identify transferable thresholds for when micropore-scale benefits should be expected.

Second, pore-scale mechanisms are highly conditional on brine chemistry and reservoir harshness. Salinity can suppress polymer elasticity and alter microflow fields, meaning that the same polymer system may behave fundamentally differently across reservoirs or even within a single field if injected water composition varies [13]. Temperature further accelerates chemical and mechanical processes that degrade polymer performance, and heavy-oil reservoirs represent a stringent regime where even if macroscopic mobility control is improved, elastic contributions may operate only within a limited crude-viscosity window [5, 8].

Third, polymer integrity and mechanical degradation remain under-accounted in both experiments and models. Chain scission during preparation, pumping, and flow through restrictions can reduce molecular weight and weaken elastic response, potentially collapsing the displacement behavior toward a predominantly shear-thinning viscous regime even when the injected formulation was designed to be viscoelastic [9]. This limitation affects the interpretation of both laboratory studies and modeling efforts: pore-scale models that assume intact polymer viscoelasticity may overestimate elastic stress development if degradation is significant in practice, while Darcy-scale models that represent polymers only through effective viscosity cannot directly capture elastic stress localization mechanisms.

The literature supports viscoelasticity as a potentially important lever for micropore mobilization, but it also highlights the need for standardized rheological reporting, brine-conditioned characterization, degradation-aware interpretation, and multi-scale validation.

Conclusion

1. Polymer flooding performance cannot be fully interpreted through shear viscosity and mobility ratio alone. Under appropriate conditions, viscoelastic stresses may contribute to additional microscopic displacement mechanisms.
2. Micropore sweep improvement involves two distinct processes: (i) access to low-connectivity microdomains and (ii) mobilization of oil trapped in dead-end pores and corners. These processes should not be conflated.
3. Elastic contributions are strongly dependent on crude oil viscosity, salinity, temperature, and operational conditions. A practical viscosity window appears to exist beyond which elastic benefits diminish.
4. Extensional flow behavior in converging–diverging pore geometries is likely more relevant than oscillatory shear descriptors alone. Standard rheological reporting should therefore extend beyond zero-shear viscosity.
5. Mechanical degradation significantly reduces polymer elasticity and may explain inconsistencies across published studies. Degradation-aware experimental protocols are essential for reliable interpretation.

6. Future progress requires a multi-scale framework integrating pore-scale imaging, microfluidic validation, core flooding experiments, and reservoir-scale modeling.

Overall, viscoelastic polymer flooding represents a condition-dependent enhancement mechanism that must be rigorously characterized to ensure reproducibility and field applicability.

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ҚАБАТТАРДЫҢ МҰНАЙБЕРГІШТІГІН АРТТЫРУ ҮШІН ТҰТҚЫР СЕРПІМДІ ПОЛИМЕРЛЕРМЕН СУ АЙДАУ КЕЗІНДЕ МИКРОКЕУЕКТЕРДІ ТАЗАРТУ ТИІМДІЛІГІ

Андатпа

Полимерлі су айдау қабаттардың мұнай өндірісін (ҚМБА) арттыру үшін ұтқырлықты бақылау әдісі ретінде кеңінен қолданылады, дегенмен ұтқырлықты арттырғаннан кейін оның біртіндеп қалпына келуі туралы жиі хабарланады, бұл толық түсіндірілмеген құбылыс. Бұл шолу полимерлерді суды айдау кезінде микрокеуектерді тазарту тиімділігін арттырудағы тұтқыр серпімділіктің рөлін қарастырады. Микро-кеуектерге қол жеткізу (төмен байланысқан микродомендерге ағынның енуі) мен микрокеуектердің жылжуы (тұйық тесіктер мен бұрыштардан мұнайды босату) арасында нақты айырмашылық бар. Талдау серпімді кернеулердің ығысу тұтқырлығы әсерінен бөлек мұнайды ығыстырудың қосымша механизмдеріне ықпалын бағалау үшін эксперименттік бақылауларды, кеуек масштабы бойынша модельдеуді және реологиялық пайымдарды қорытындылайды. Кеуектердің қосылу және ажырау геометриясы жағдайында созылу кезіндегі ағын режиміне, шикі мұнай тұтқырлығының әсеріне және тұтқыр серпімді реакцияларды әлсіретудегі тұздылықтың, температураның және механикалық бұзылудың рөліне ерекше назар аударылады. Бұл шолу тұтқырлықтың мұнай өндіруге әсері пайдалану жағдайларына тәуелді екенін және белгілі бір тұтқырлық мәндері мен пайдалану кезеңдерінде айқын көрінетінін көрсетеді. Ұсынылған нәтижелердегі айырмашылықтар көбіне реологиялық сипаттамалардың сәйкес келмеуімен және деградация салдарының жеткіліксіз ескерілуімен түсіндіріледі. Қайталанымдылық пен болжамдылықты жақсарту үшін тұзды ерітіндіні кондиционерлеуге негізделген стандартталған реологиялық хаттамаларды, мүмкіндігінше сандық көрсеткіштермен бірге пайдалану ұсынылады. Нәтижелер кеуек масштабының өзгеру механизмдерін өзек масштабы бойынша ығыстырумен және кен орнын пайдалану сипаттамаларымен байланыстыратын көп масштабты тексерудің қажеттілігін көрсетеді.

Тірек сөздер: тұтқыр-серпімді полимерлі су айдау, микрокеуектерді қамту тиімділігі, мұнай бергіштігін арттыру, кеуек масштабы механизмдері, қалдық мұнайды мобилизациялау.

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ЭФФЕКТИВНОСТЬ ОЧИСТКИ МИКРОПОР ПРИ ЗАВОДНЕНИИ ВЯЗКОУПРУГИМИ ПОЛИМЕРАМИ ДЛЯ ПОВЫШЕНИЯ НЕФТЕОТДАЧИ ПЛАСТОВ

Аннотация

Полимерное заводнение широко применяется в качестве метода контроля подвижности для повышения нефтеотдачи пластов (EOR), однако часто сообщается о постепенном восстановлении после повышения подвижности, что остается неполным объяснением. В этом обзоре рассматривается роль вязкоупругости в повышении эффективности очистки микропор при заводнении полимеров. Проводится четкое различие между доступом к микропорам (проникновение потока в микродомены с низкой связностью) и мобилизацией микропор (высвобождение захваченного масла из тупиковых пор и углов). Анализ обобщает экспериментальные наблюдения, моделирование масштаба пор и реологические соображения, чтобы оценить, влияют ли упругие напряжения на дополнительные механизмы вытеснения нефти, помимо влияния сдвиговой вязкости. Особое внимание уделяется режиму течения при растяжении в условиях сходящейся и расходящейся геометрии пор, влиянию вязкости сырой нефти и роли солености, температуры и механического разрушения в подавлении вязкоупругих реакций. Обзор показывает, что влияние вязкоупругости на нефтеотдачу зависит от условий эксплуатации и наиболее выражено в пределах определенной вязкости и эксплуатационных периодов. Различия в представленных результатах в значительной степени объясняются несогласованностью реологических характеристик и недостаточным учетом последствий деградации. Для улучшения воспроизводимости и прогнозирования рекомендуется использовать стандартизированные реологические протоколы, основанные на кондиционировании рассола, включая, где это возможно, количественные показатели. Полученные результаты подчеркивают необходимость многомасштабной проверки, связывающей механизмы изменения масштаба пор со смещением керна и эксплуатационными характеристиками месторождения.

Ключевые слова: вязкоупругое полимерное заводнение, эффективность охвата микропор, повышение нефтеотдачи, поромасштабные механизмы, мобилизация остаточной нефти.