

Introduction to Enhanced Oil Recovery

Introduction to Enhanced Oil Recovery (EOR)

Graduate-level overview – concise, organized, and ready for study.

1. Why EOR Is Needed

Aspect	Conventional Production	Limitation
Primary recovery	Natural reservoir pressure drives oil to the wellbore.	Typically recovers 5–15% of original oil in place (OOIP).
Secondary recovery	Water or gas injection maintains pressure.	Boosts recovery to 30–40% of OOIP.
Enhanced Oil Recovery (EOR)	Any technique that alters fluid/rock properties to mobilize additional oil after primary & secondary stages.	Targets the remaining 60–70% of OOIP that is trapped by capillary forces, viscosity, or heterogeneity.

2. Fundamental Mechanisms of EOR

- Mobility Control** – Reduce the mobility ratio (water/oil or gas/oil) to improve sweep efficiency.
- Interfacial Tension (IFT) Reduction** – Lower capillary forces that trap oil in pore throats.
- Wettability Alteration** – Change rock surface from oil-wet to water-wet (or vice-versa) to improve displacement.
- Reservoir Conditioning** – Raise temperature or modify rock/fluid chemistry to enhance flow.

3. Main EOR Methods

Method	Primary Physical Principle	Typical Reservoir Conditions	Key Advantages	Typical Limitations
--------	----------------------------	------------------------------	----------------	---------------------

Introduction to Enhanced Oil Recovery

Thermal (Steam) EOR	Viscosity reduction by heating heavy oil; steam expands and pushes oil.	Heavy, high? viscosity oil (API?<?20), shallow to moderate depth.	Large incremental recovery (10?30? % of OOIP); well? established.	High energy cost; water?resource intensive; not suitable for light oil.
Gas?Based EOR	1) Gas injection – miscibility reduces IFT; 2) CO? flooding – miscible or immiscible displacement.	Light to medium oil; moderate to high reservoir pressure; good permeability.	Can achieve high recovery (up to 50? % OOIP); CO? provides sequestration benefit.	Requires large gas volumes; miscibility pressure may be high; CO? handling and corrosion issues.
Chemical EOR	1) Polymer flooding – increase water viscosity ? mobility control. 2) Surfactant flooding – lower IFT. 3) Alkali?surfactant ?polymer (ASP) – combined effects.	Light to medium oil; moderate temperature (<? 100?°C); adequate permeability (>?10 ?mD).	Flexible formulation; can be tailored to specific rock/fluid properties.	High chemical cost; adsorption loss; potential formation damage; requires careful design.
Micro? /Nanofluid EOR	Nanoparticles modify wettability, reduce IFT, and improve conformance.	Emerging; applicable to a range of oil types.	Small volumes, high surface activity; can be combined with other EOR.	Limited field data; cost of nanomaterials; stability concerns.
Hybrid / Sequential Methods	Combination of two or more techniques (e.g., thermal?+? chemical).	Tailored to complex reservoirs.	Synergistic effects; can overcome individual method limits.	Higher operational complexity; integrated design needed.

4. Screening and Feasibility Assessment

1. Reservoir Characterization