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Selecting Injected Viscosity In Polymer Flood Projects: Still A Controversial Question

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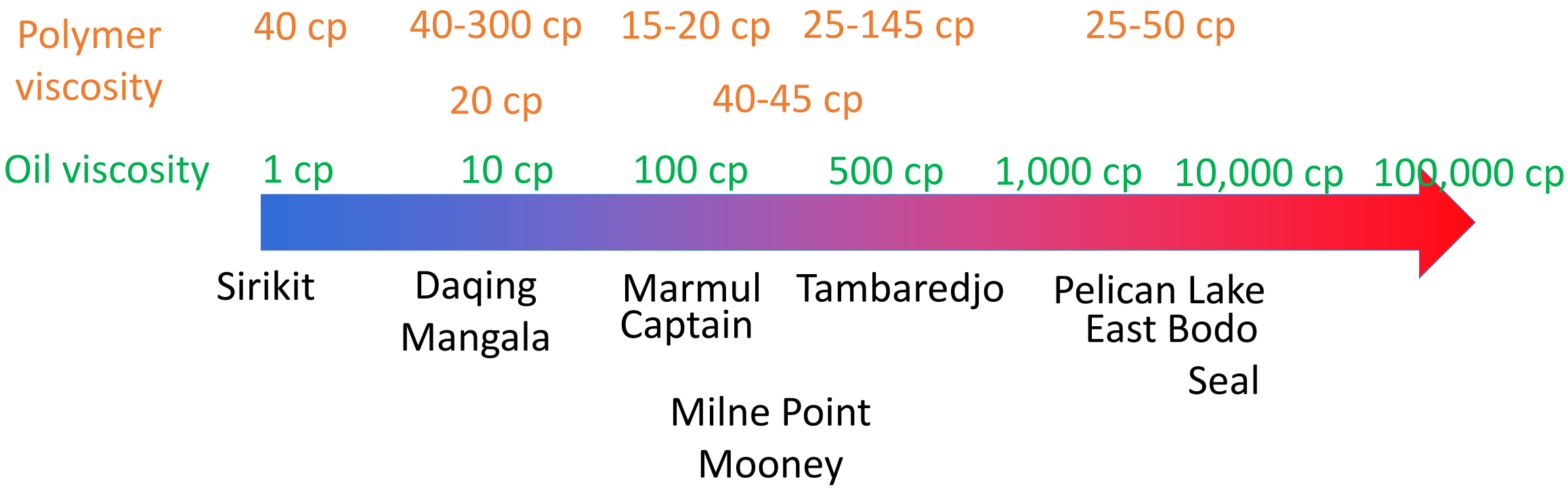
Polymer flood field experience



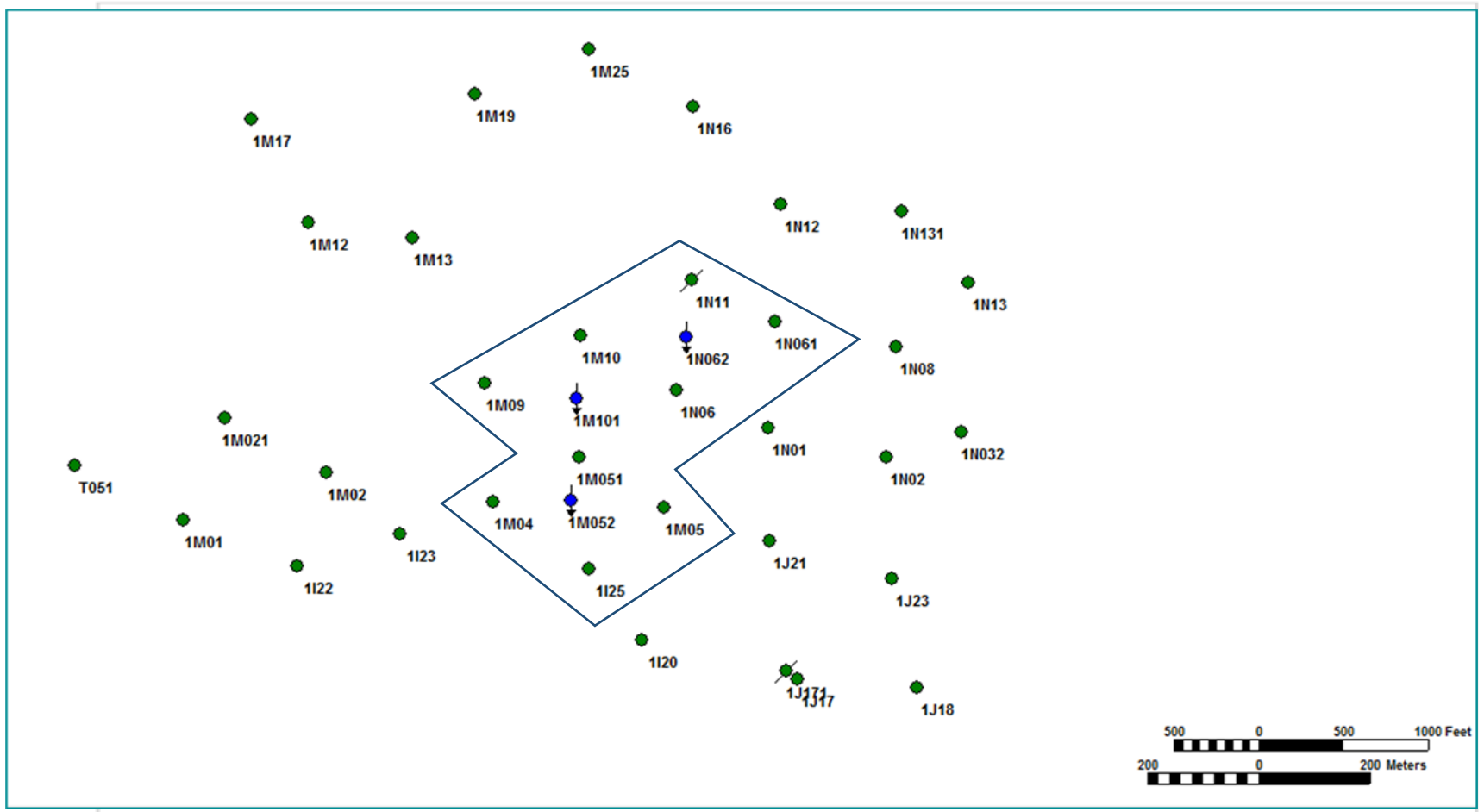
Mobility ratio M

Mobility of displacing fluid/Mobility of displaced fluid

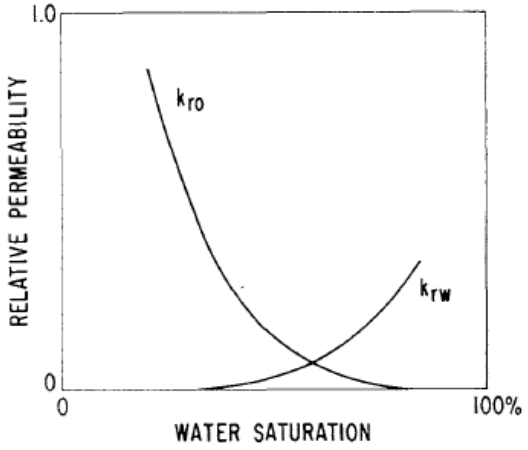
$$(kr_{wm}/\mu_p) / (kr_{om}/ \mu_o) = (kr_{wm}/kr_{om}) \times (\mu_o / \mu_p)$$

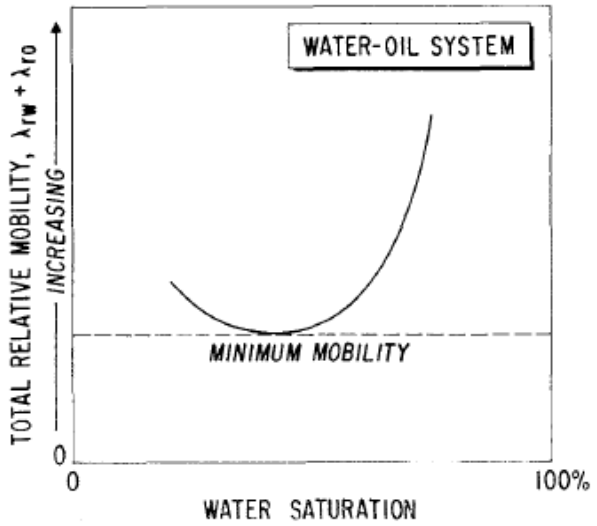
Could contribute but not the answer

Tambaredjo (SPE-181499)



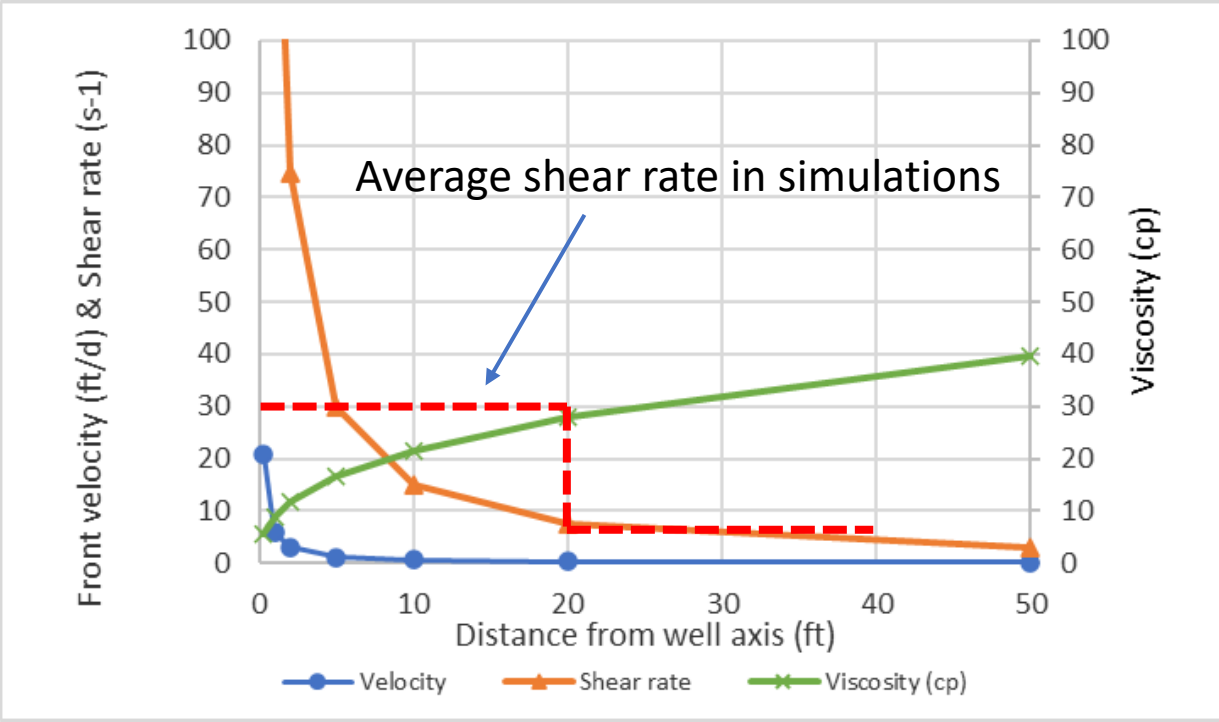
Selecting polymer viscosity – theory



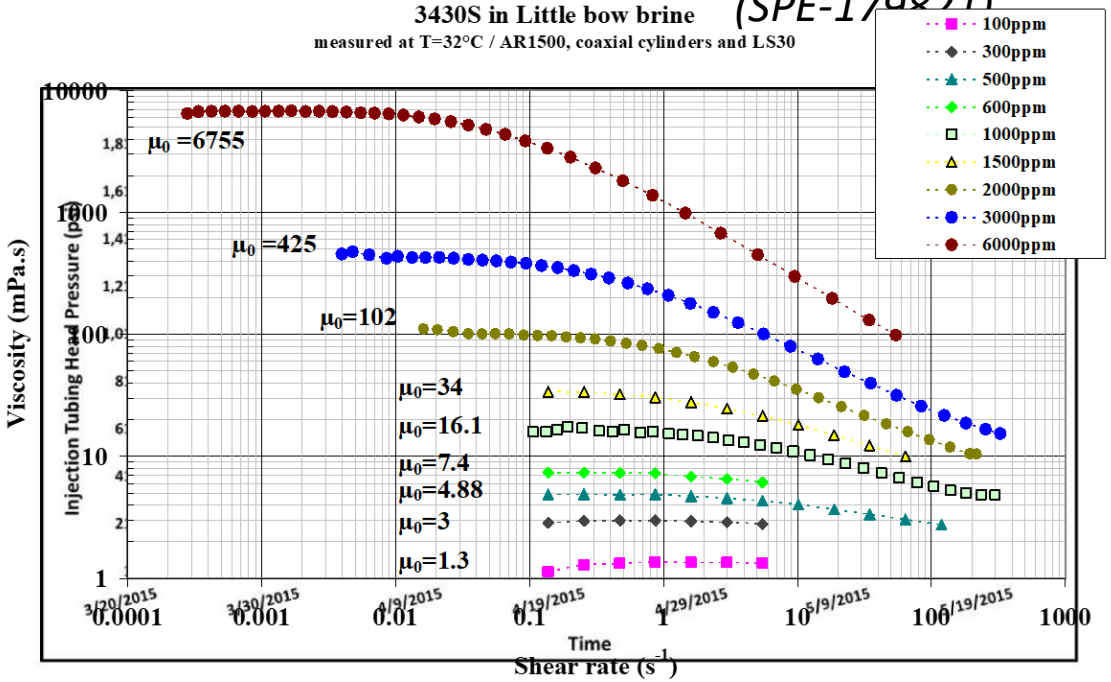


- Gogarty (SPE-1847-E-PA)
- Mobility is sum of oil + water mobility
- Design (target) mobility for mobility control is minimum fluid mobility
- Extremely conservative

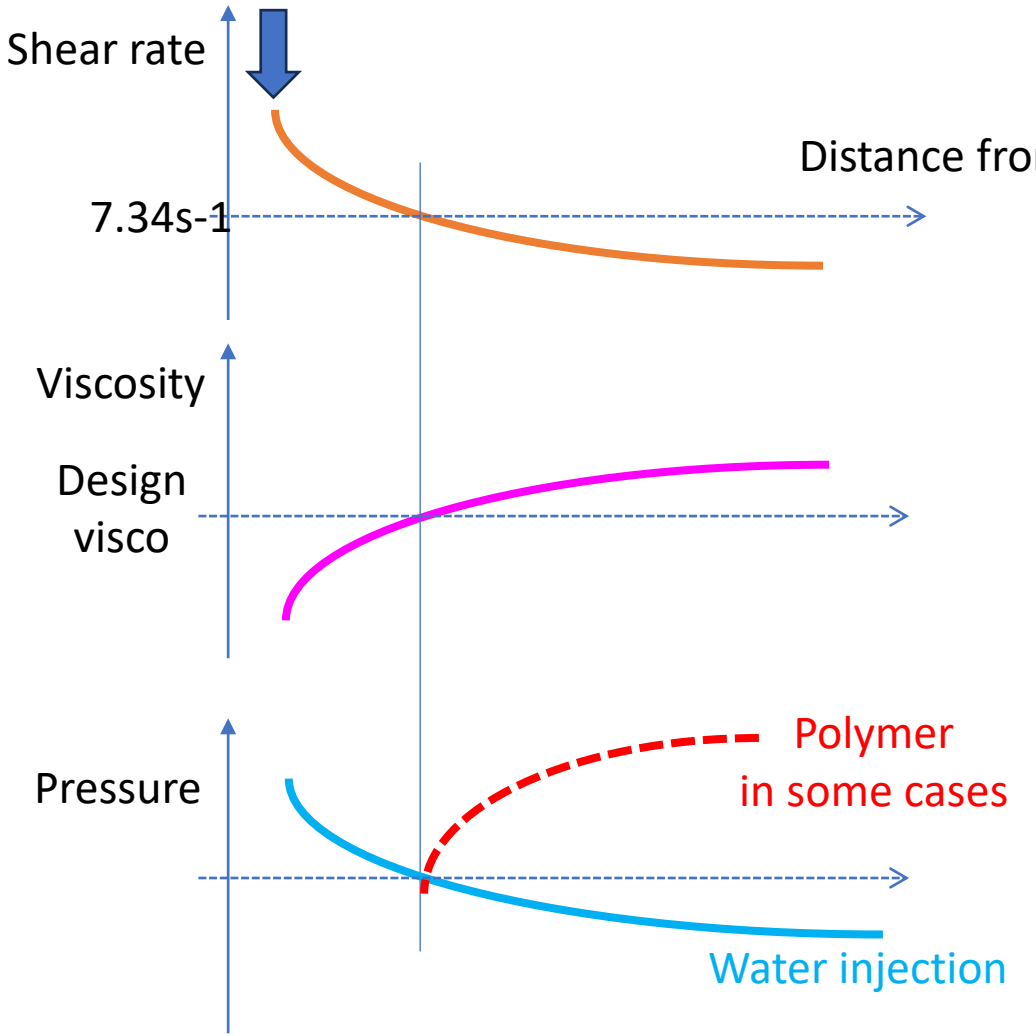
Injectivity in simulations

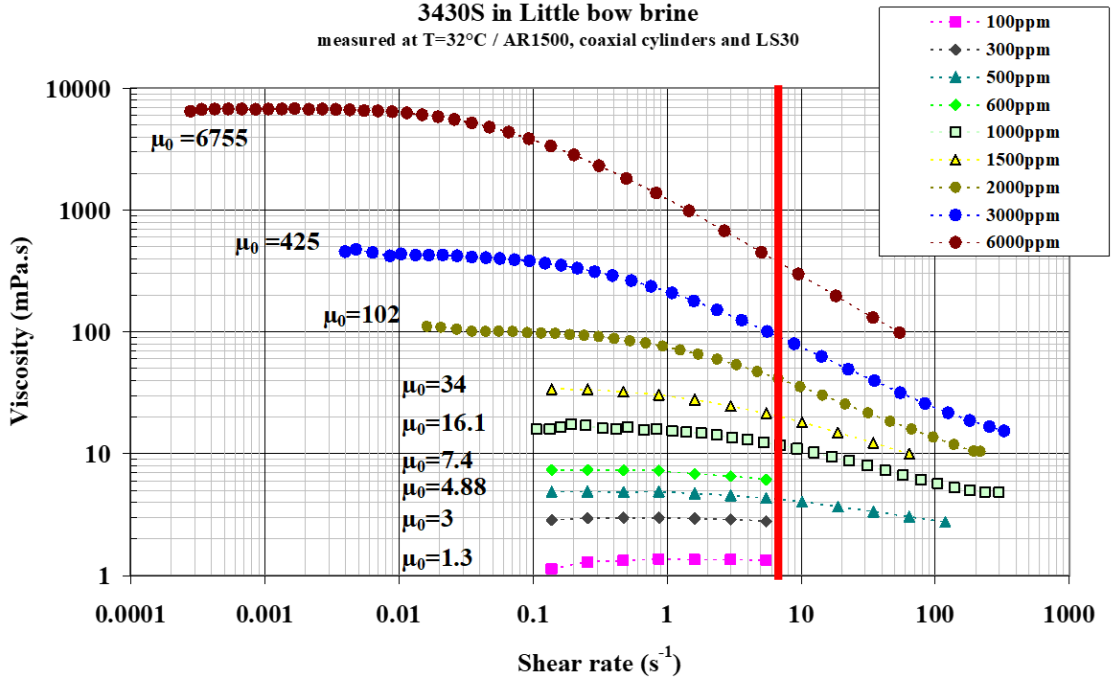


(SPE-179821)



Pressure barrier (SPE-209462)



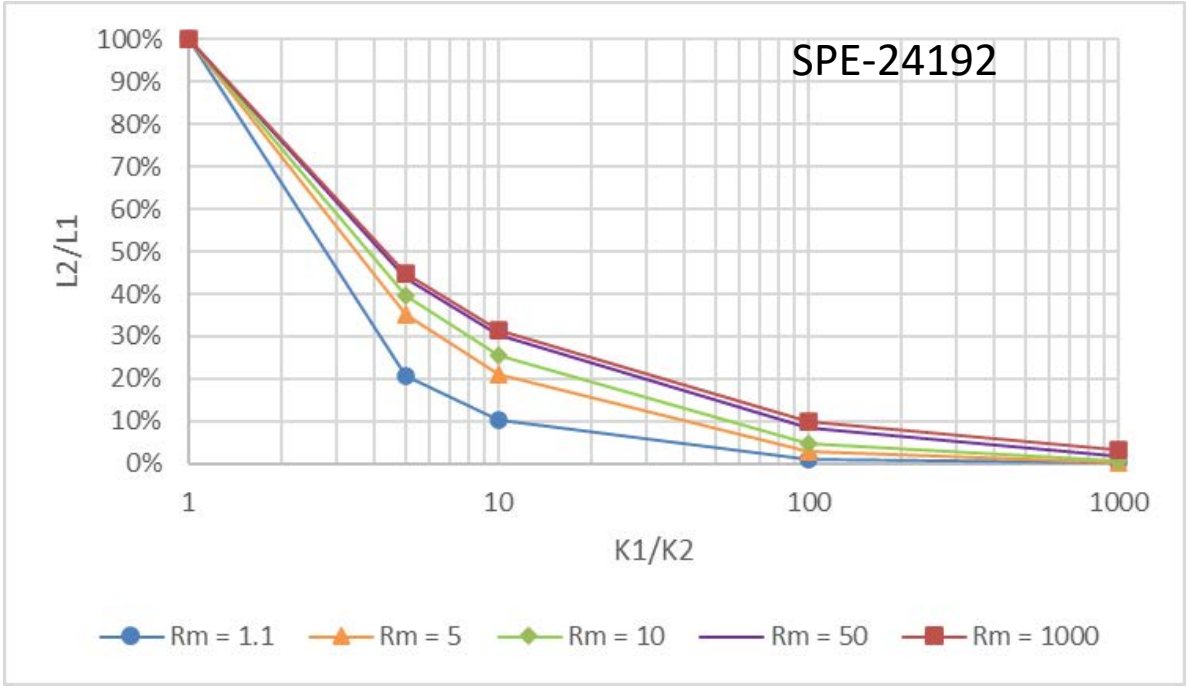


What happens in case of no-crossflow

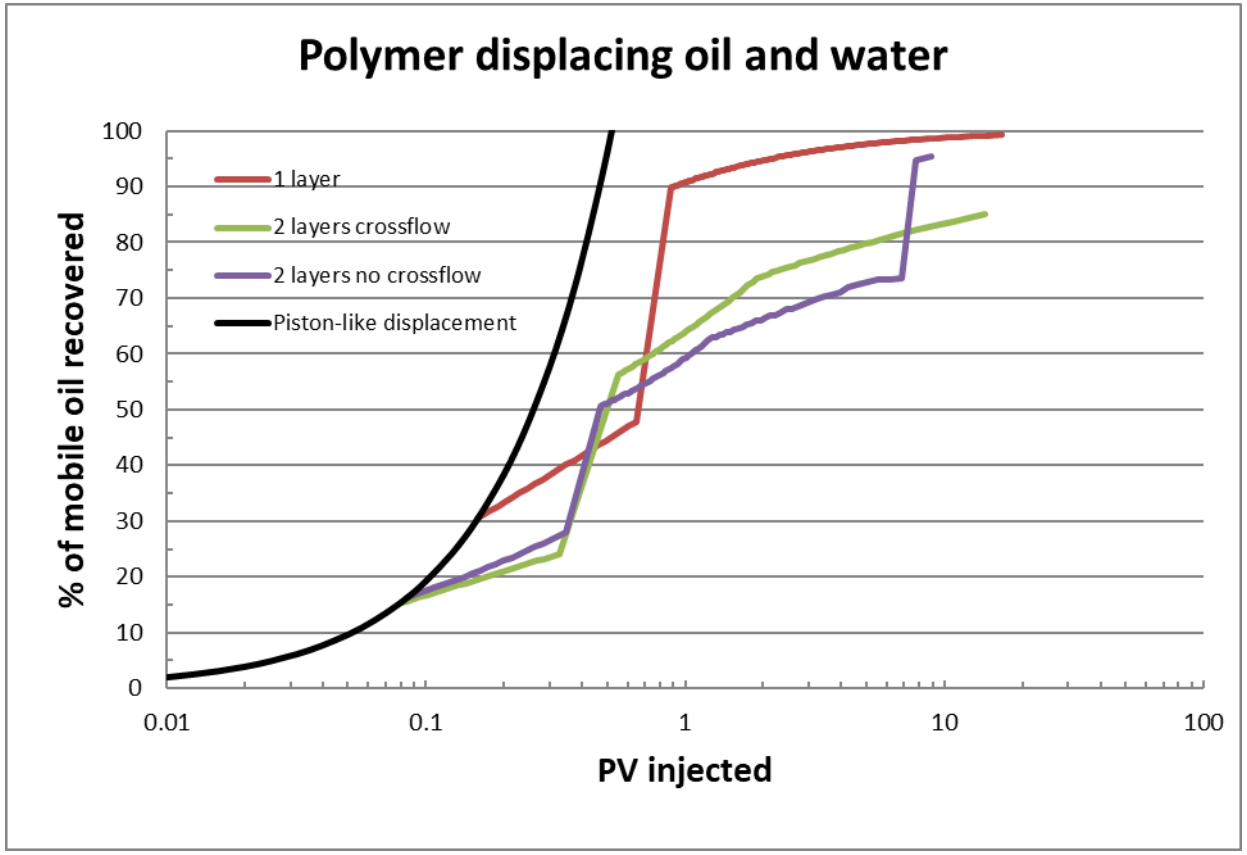
L1 = Layer 1

L2 = Layer 2

Progress of polymer in lower perm layer is limited



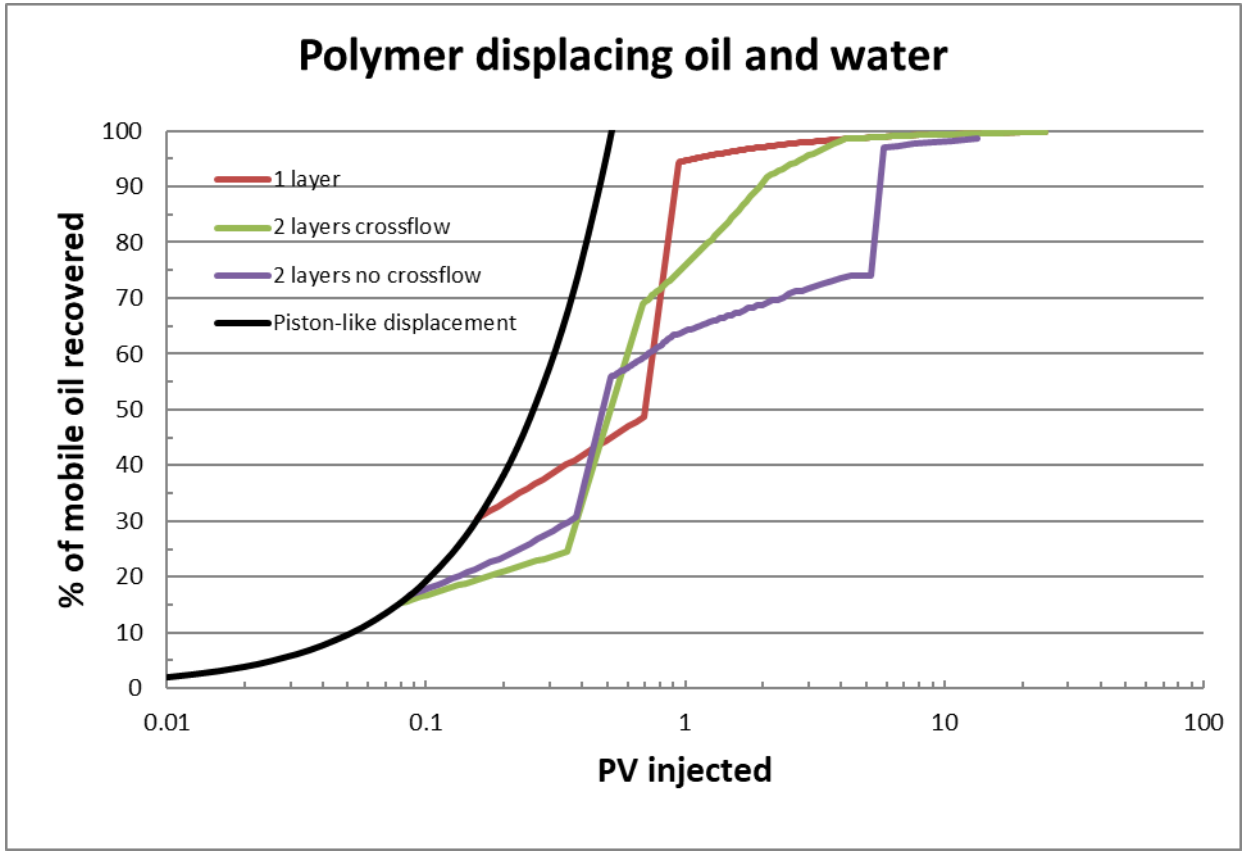
Recovery factor in 2-layers (2,000 md/200 md)



M = 1

Oil viscosity = 50 cp / Polymer viscosity 15 cp / M = 1

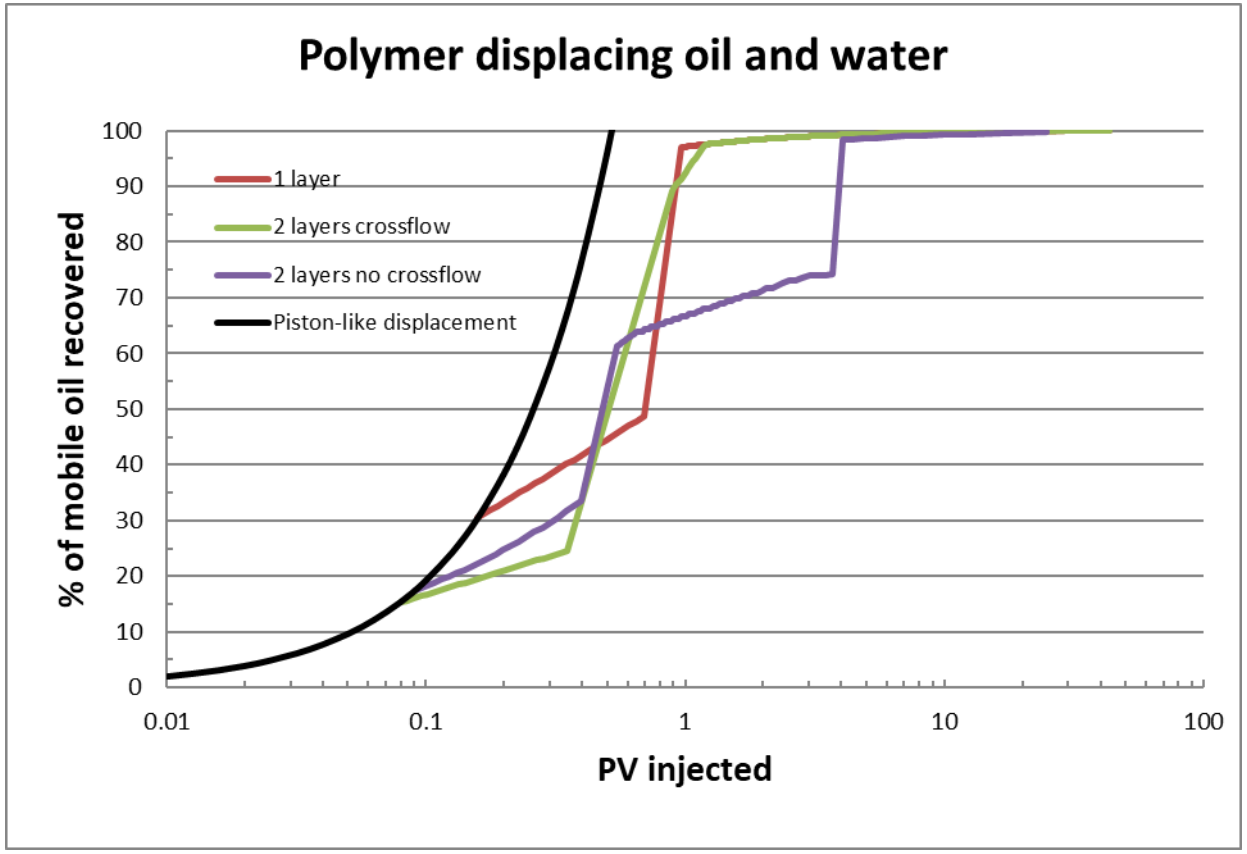
Recovery factor in 2-layers (2,000 md/200 md)



M = 0.50

Oil viscosity = 50 cp / Polymer viscosity 30 cp / M = 0.50

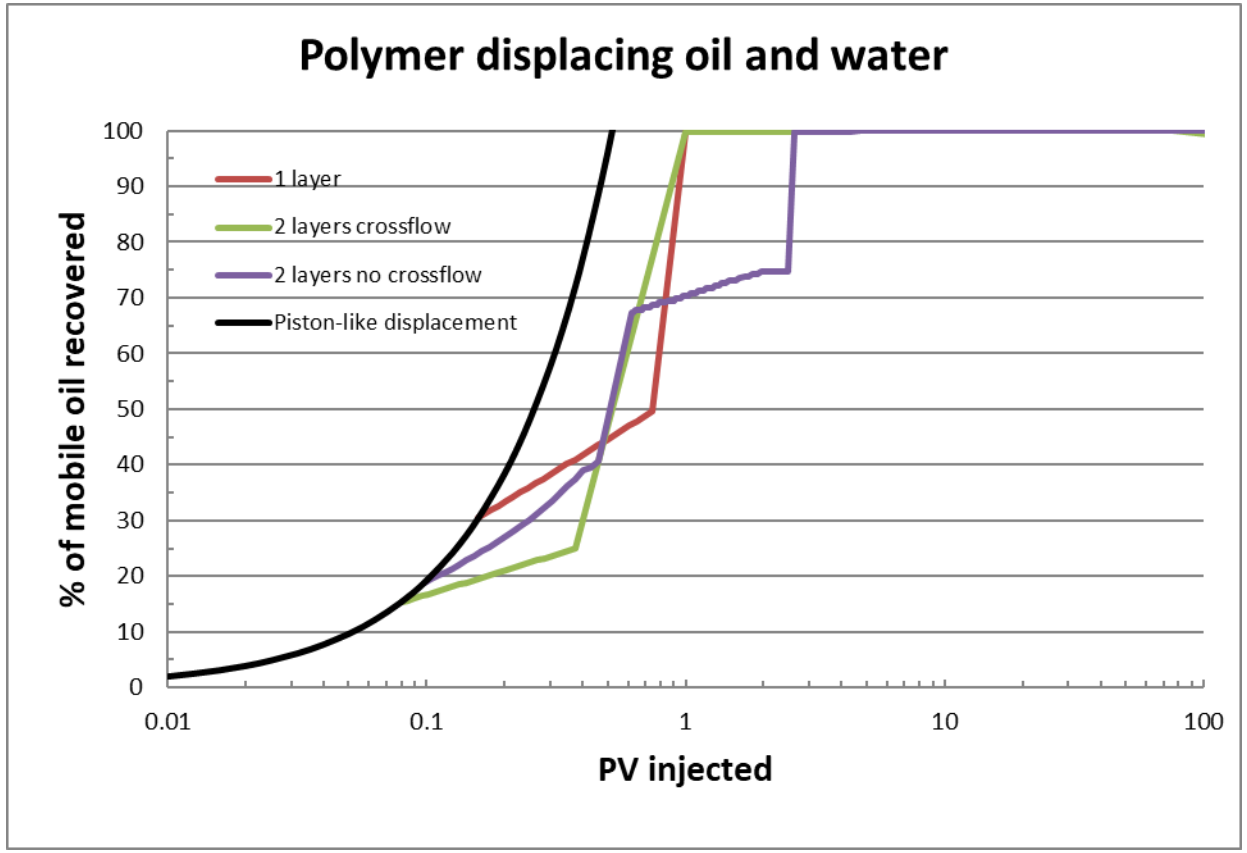
Recovery factor in 2-layers (2,000 md/200 md)



M = 0.25

Oil viscosity = 50 cp / Polymer viscosity 60 cp / M = 0.25

Recovery factor in 2-layers (2,000 md/200 md)



M = 0.025

Oil viscosity = 50 cp / Polymer viscosity 600 cp / M = 0.025

Oil/water separation issues with polymer

Polymer slows down process (viscosity)

- Makes separation more difficult through formation of emulsions
- Use of chemicals to ease separation needs to be carefully considered especially if water is reused for polymer make-up
- Chemicals alone do not appear to be sufficient

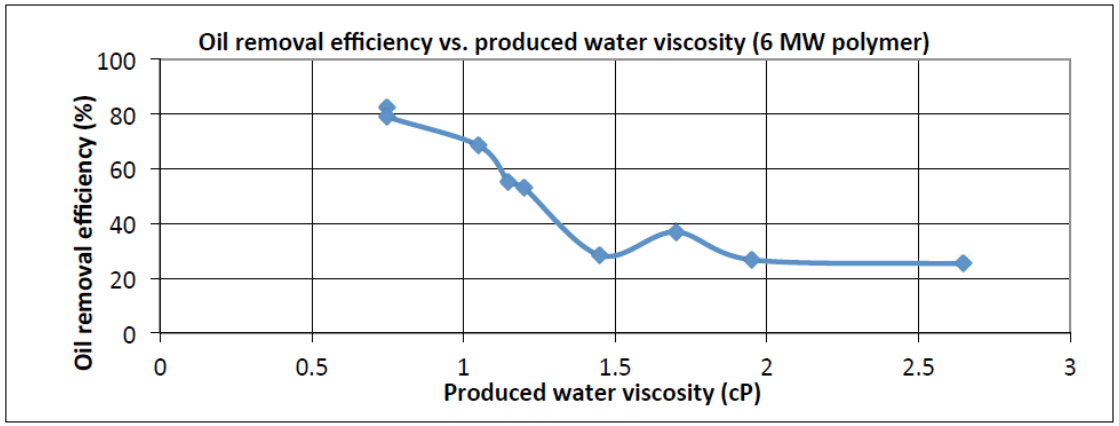


Figure 1 Oil Removal efficiency vs. Produced water viscosity relationship

Settling velocity

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

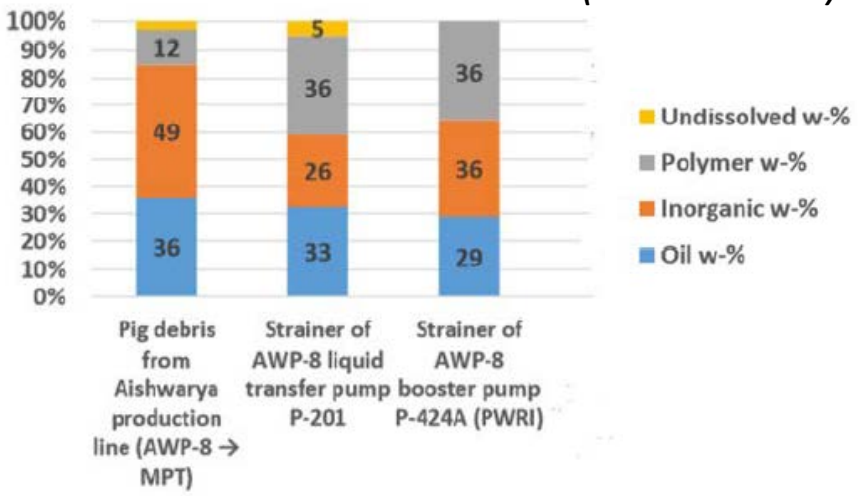
Fluid viscosity

(Stokes law)

Equipment fouling

(SPE-203446)

(Aishwariya - SPE-203446)



Factors to consider

- Cost
- Incremental recovery
- Heterogeneity/Layering
- Injectivity
- Pressure barrier
- Separation issues
- Vibration, casing issues (SPE-200084)

Conclusions

- Polymer viscosity selection is not straightforward
- Many factors need to be considered
- Beware simulations
- Lower viscosity often preferred