Study on the blockage mechanism in low viscosity Boger-like fluid flows through unconsolidated beds

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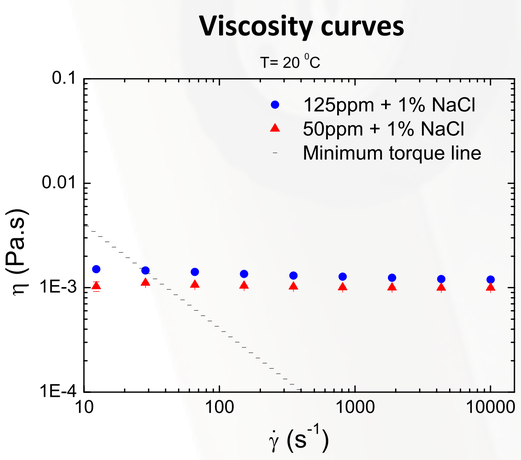
MOTIVATION

A gelation process was seen to occur when Boger-like fluids made from aqueous solutions of polyacrylamide (PAA) and NaCl flowed through porous media with certain characteristics. As these viscoelastic fluids flow through a porous medium, the pressure drop across the bed varies linearly with the flow rate, as also happens with Newtonian fluids. Above a critical flow rate, elastic effects set in and the pressure drop grows above the low-flow-rate linear regime. Increasing further the flow rate, a more dramatic increase in the slope of the pressure drop curve can be observed as a consequence of nanogel formation.

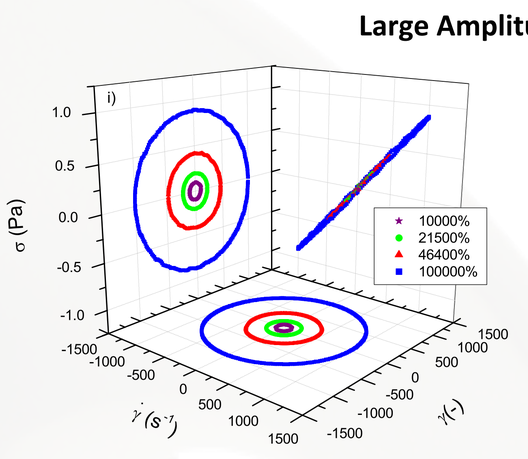
BOGER-LIKE FLUIDS

Viscosity curves

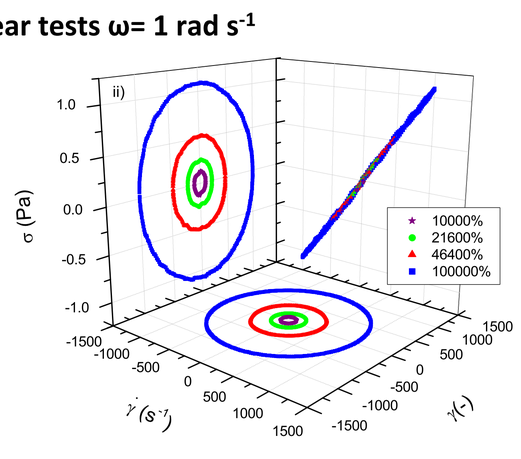


50 and 125 ppm of PAA with 1% of NaCl

Large Amplitude Oscillatory Shear tests ω= 1 rad s^{-1}

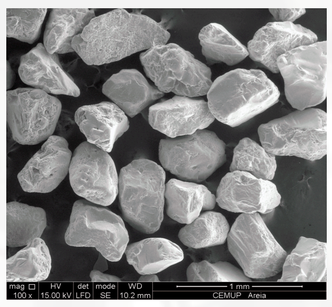


50 ppm of PAA with 1% of NaCl

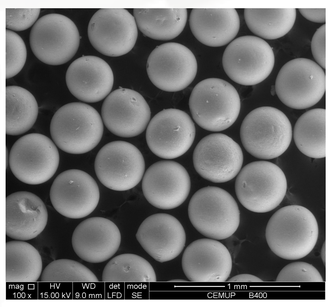


125 ppm of PAA with 1% of NaCl

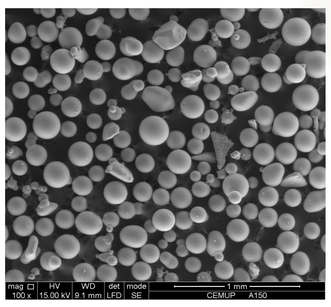
POROUS MEDIA



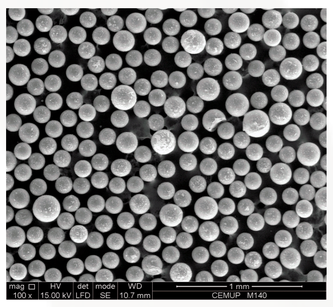
Sand x_{32}= 400 µm



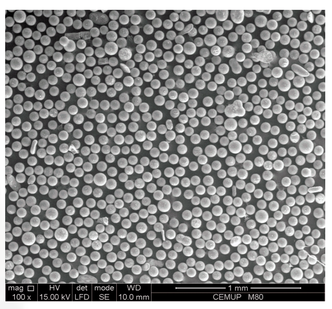
Ballotini x_{32}= 403 µm



Ballotini x_{32}= 150 µm

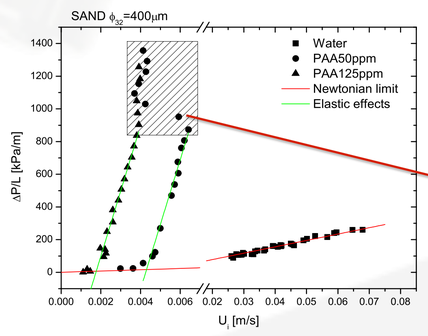


Plastic beads x_{32}= 142 µm



Plastic beads x_{32}=81 µm

Gelation



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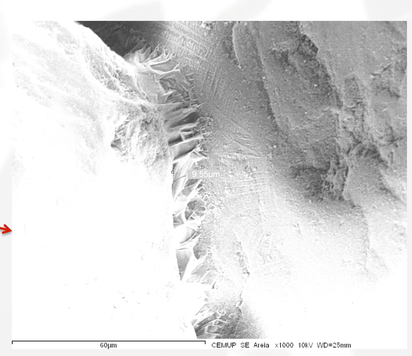
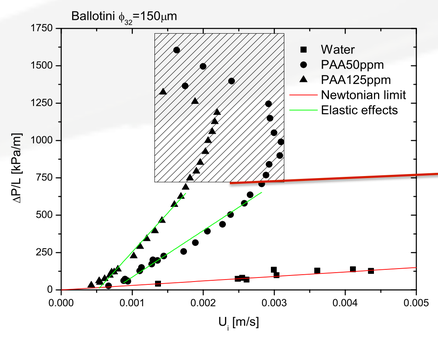
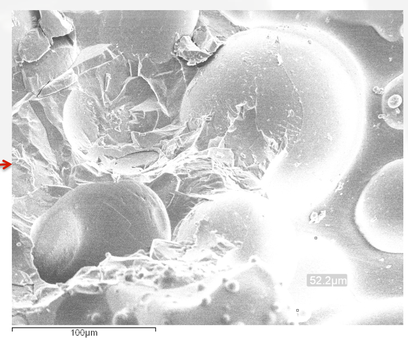
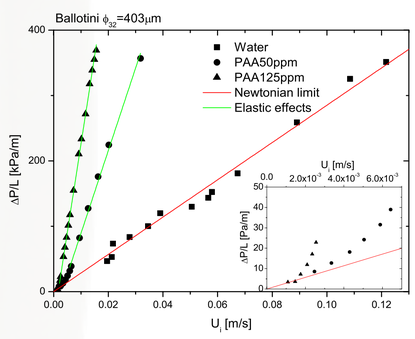




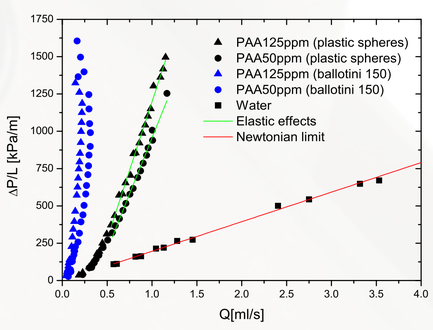
Ballotini x_{32}= 150 µm



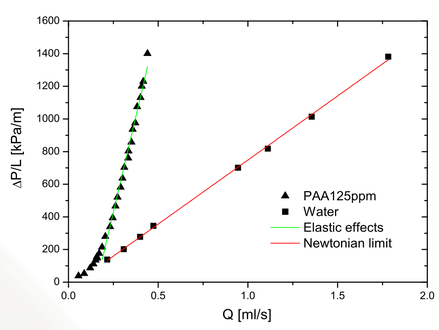
No Gelation



Ballotini x_{32}= 403 µm



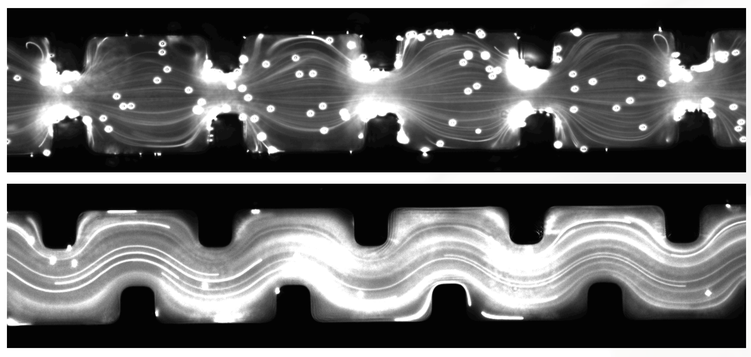
Plastic beads x_{32}= 142 µm



Plastic beads x_{32}=81 µm

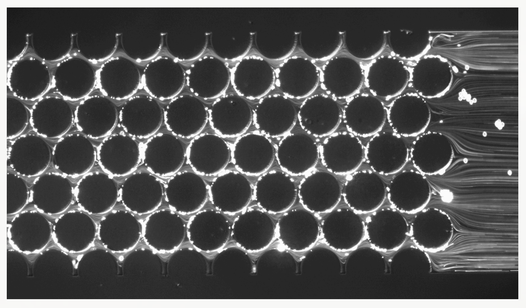
FLOW VISUALIZATIONS (PAA 50 ppm with 1%NaCl)

Contraction/expansion

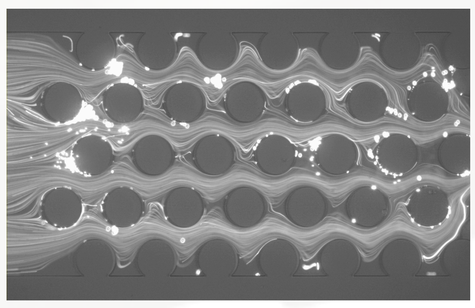


Symmetric, Q = 0.25 ml/hr (up) and asymmetric Q = 1.75 ml/hr (down)

Cylinders arrays



Interstitial spacing of 10 mm (Q =0.6 ml/hr)



Interstitial spacing 50 mm (Q = 0.2 ml/hr)

Conclusions

The results indicate that the nanogel inception occurs with the adsorption of PAA molecules on the surface of the porous media particles that contain silica on their surfaces. Subsequently, if the interparticle space is small enough a jamming process occurs leading to flow-induced gel formation.

References

Campo-Deaño, L., Galindo-Rosales, F. J., Pinho, F. T., Alves, M. A. and Oliveira, M. N. S. (2012) *Nanogel formation of polymer solutions flowing through porous media*. **Soft Matter**, 8, 6445-6453.

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