Rheology Results for Sludge & Polymer

Brought to you by
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Introduction

- King Country Waste Water South Treatment Plant is using more polymer than they want to and still not getting the separation efficiency desired.
- It has been speculated that given the high viscosity of the fluids, significant mixing is required to cause proper flocculation
- Maxing out on the presently installed Sharpe Mixer is still not producing the desired mixing results.
- Understanding flow and mixing properties of these unusual low index fluids will help solve the problem

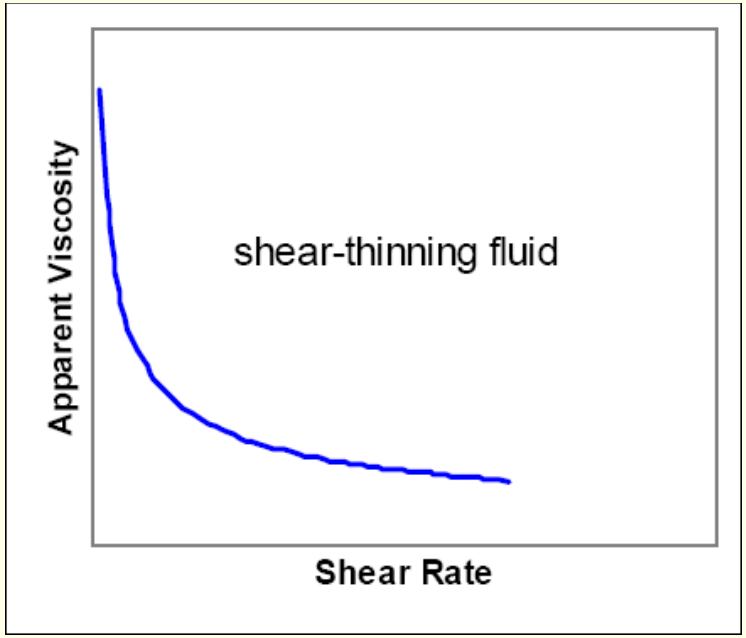
Objectives

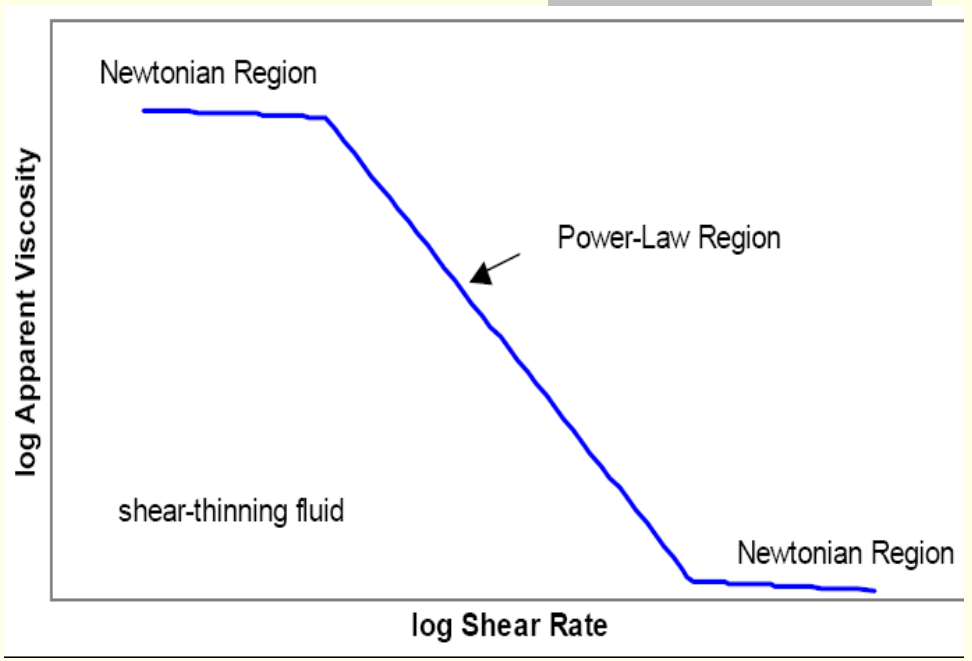
- The overall class objective is to model the flow and mixing of the polymer and sludge under various situations
- Experimentally determine fluid behavior of the two fluids and various mixtures thereof

Experimental Set Up

- Two cups of digested sludge and polymer (Ciba Zetag 8819) samples were obtained on site
- Transported to Sharpe Mixer Labs for Viscosity testing with a Brookfield DVII+ viscometer
- Different spindles were used for various viscosity ranges

Expectations and Analysis

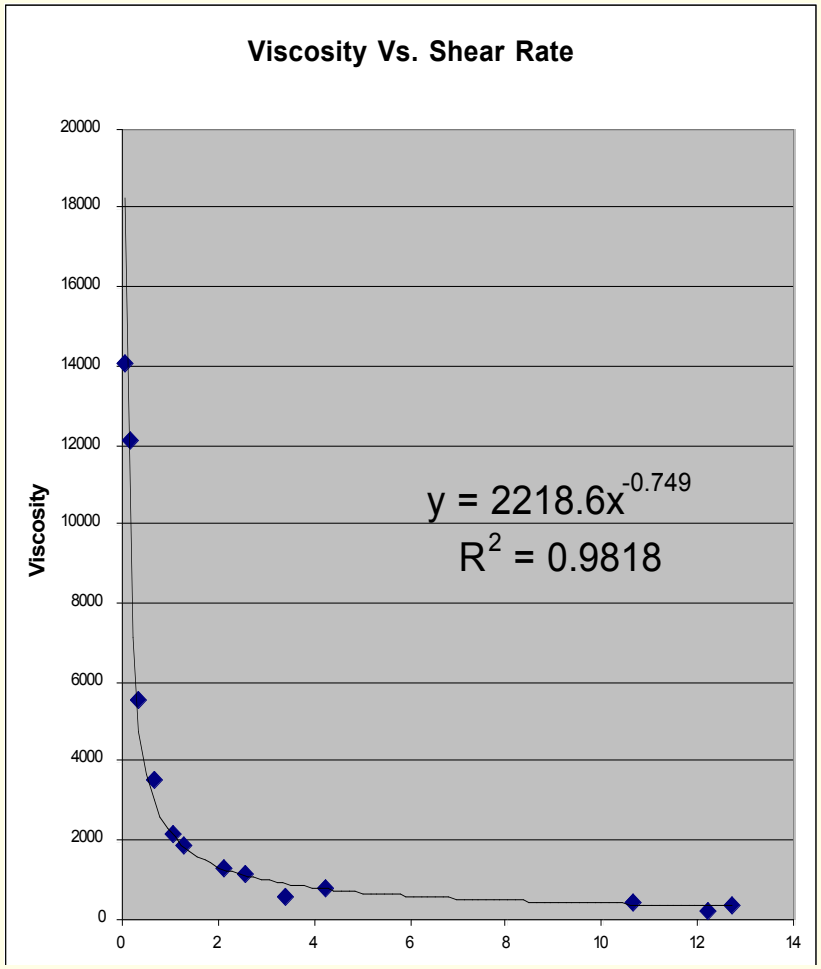


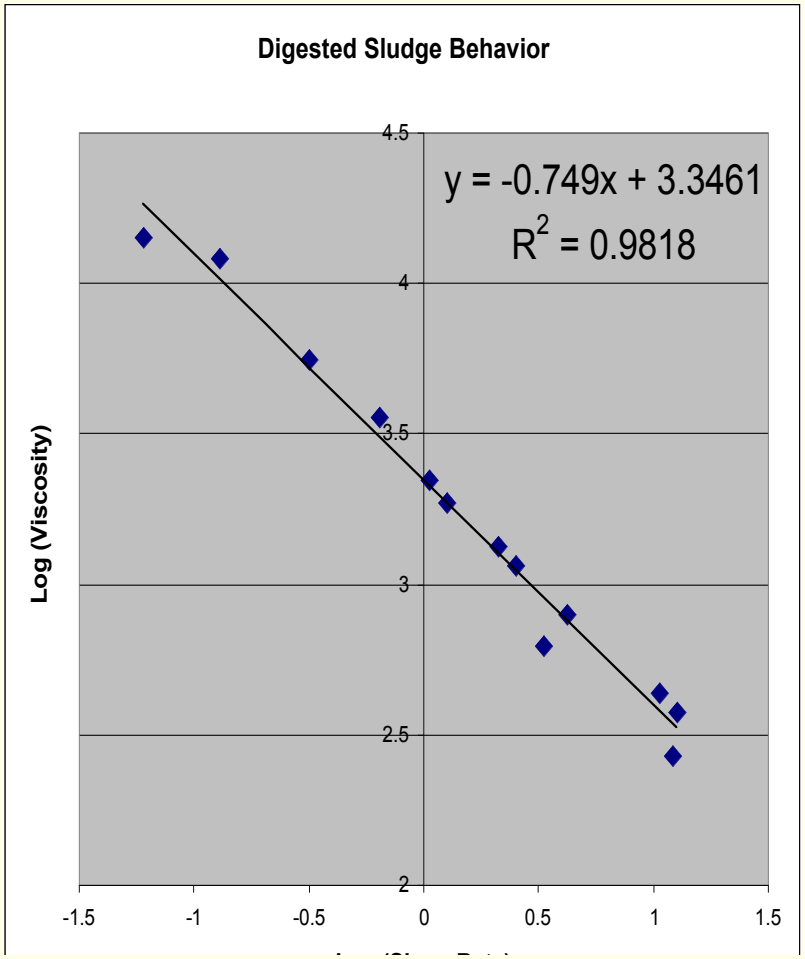


Curve fits can quantify the behavior of this fluid which is known to have power law properties. Power law fluids are governed by the following equations:

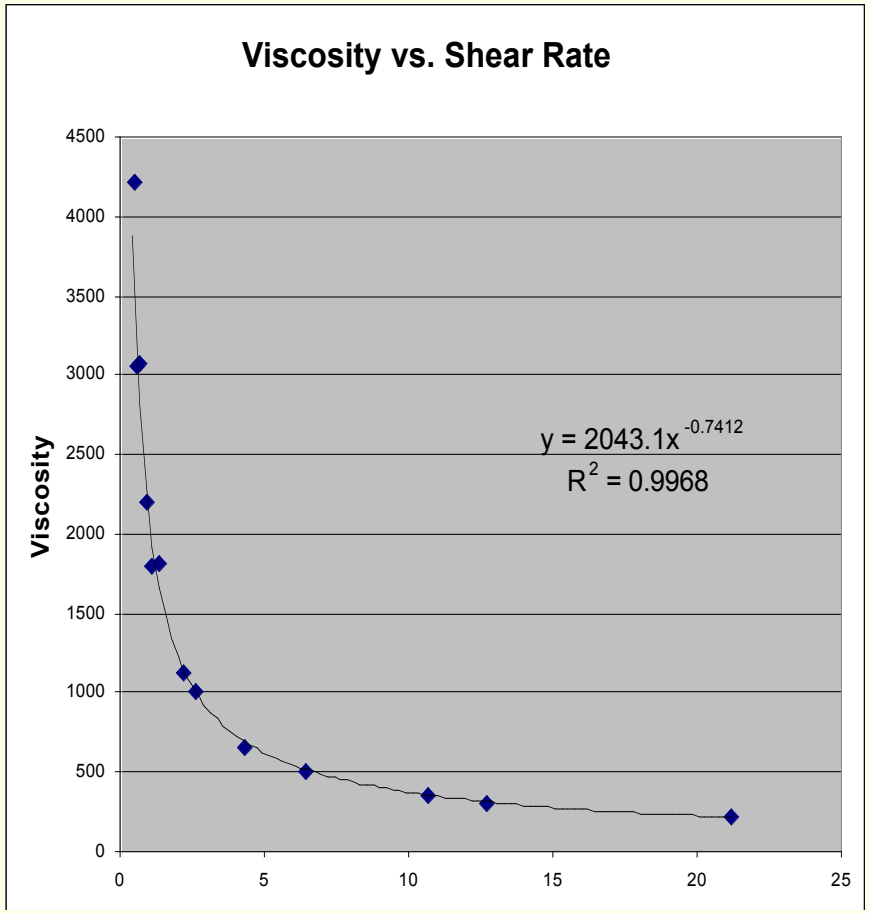
$$\eta = \kappa \dot{\theta}^{b} \qquad \& \qquad \log\eta = a + b\log\dot{\theta}$$

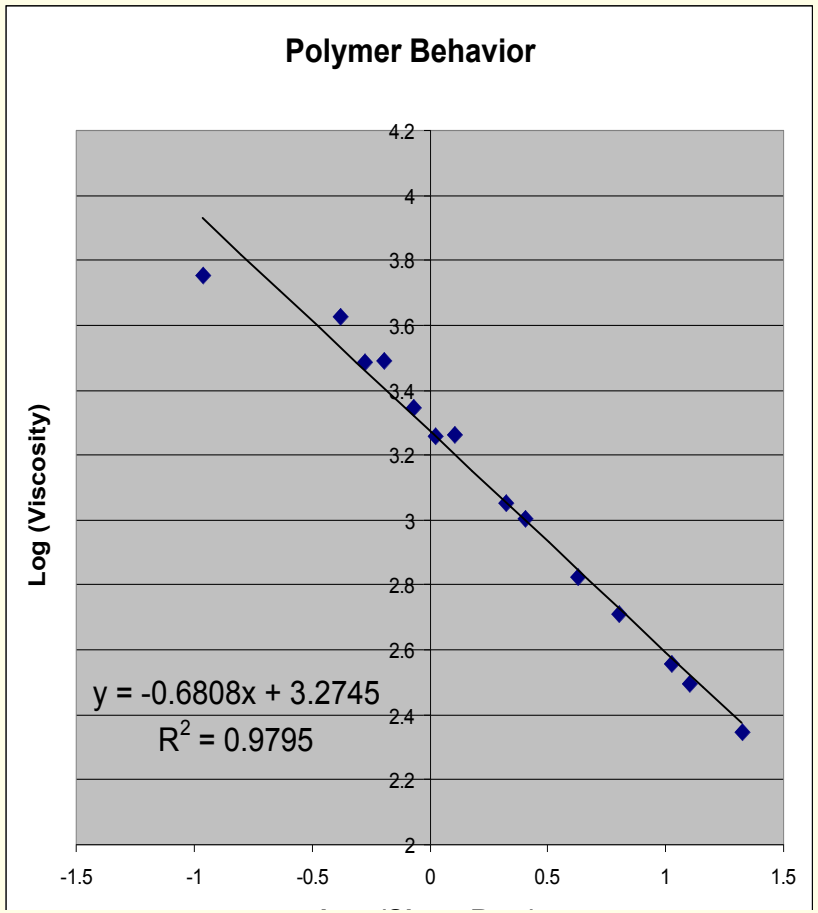
Viscosity of Digested Sludge





Viscosity of Polymer





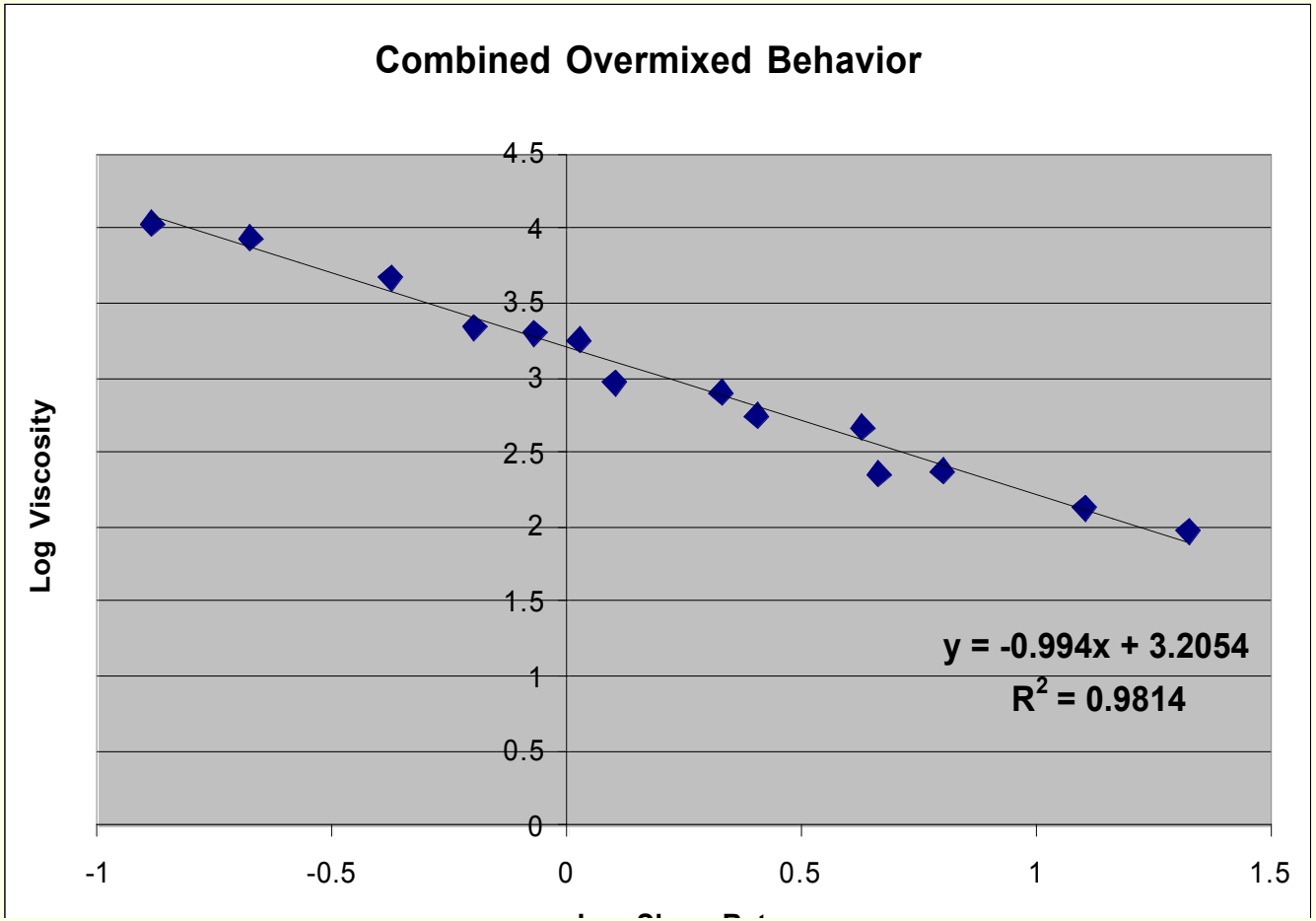
Mixture of Sludge and Polymer

- Recipe: 46 ml of polymer per 235 ml sludge
- Vigorous mixing produces flocculation and coagulation
- Unable to measure viscosity of anything that's not continuous because water forms a liquid bearing around coagulated solids

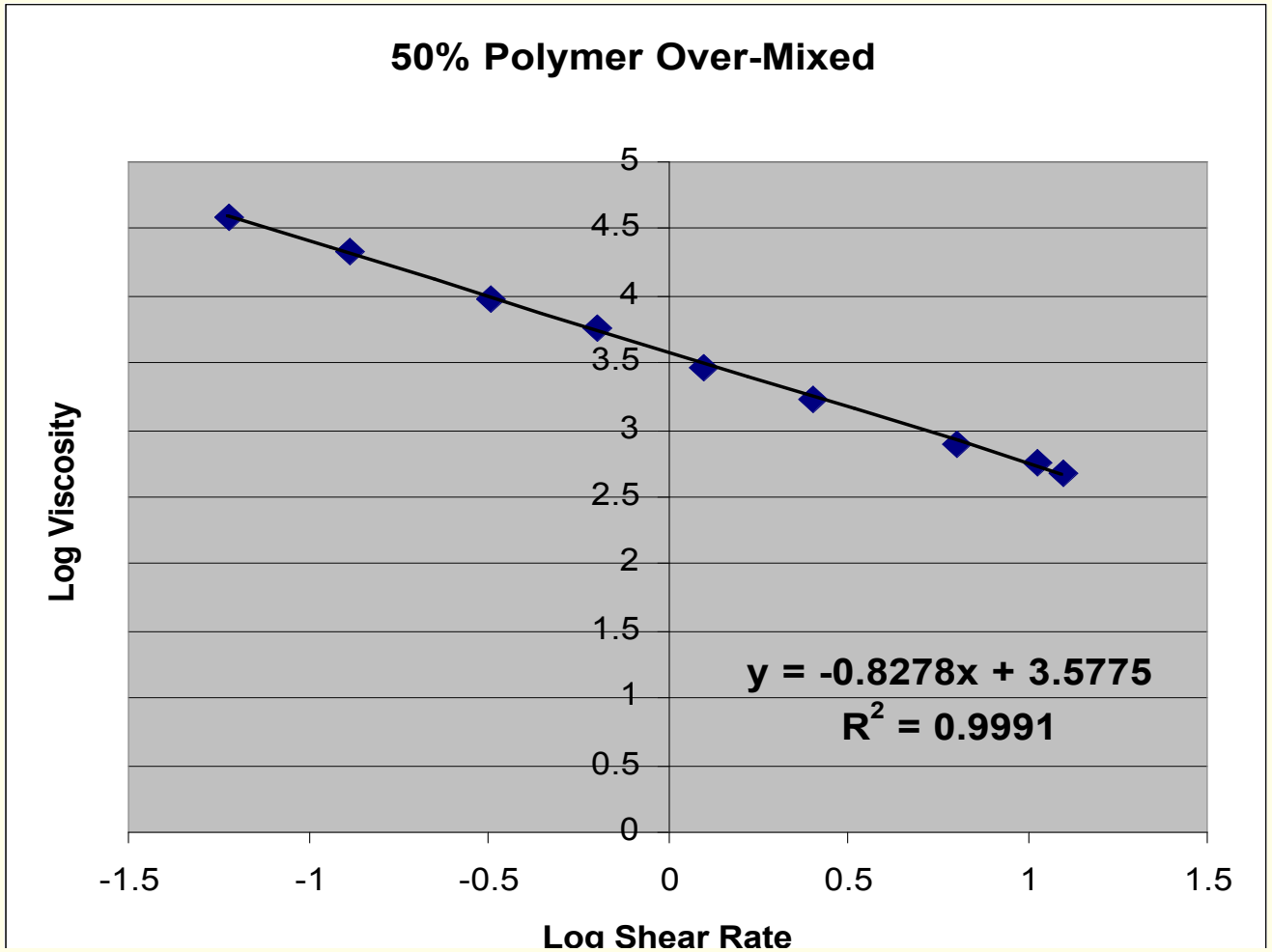
Observations

- Produced jello-like chunks in relatively clear liquid water
- Prolonged mixing produces chunks of smaller sizes and ultimately over-mixing reduces mixture back into a continuous fluid

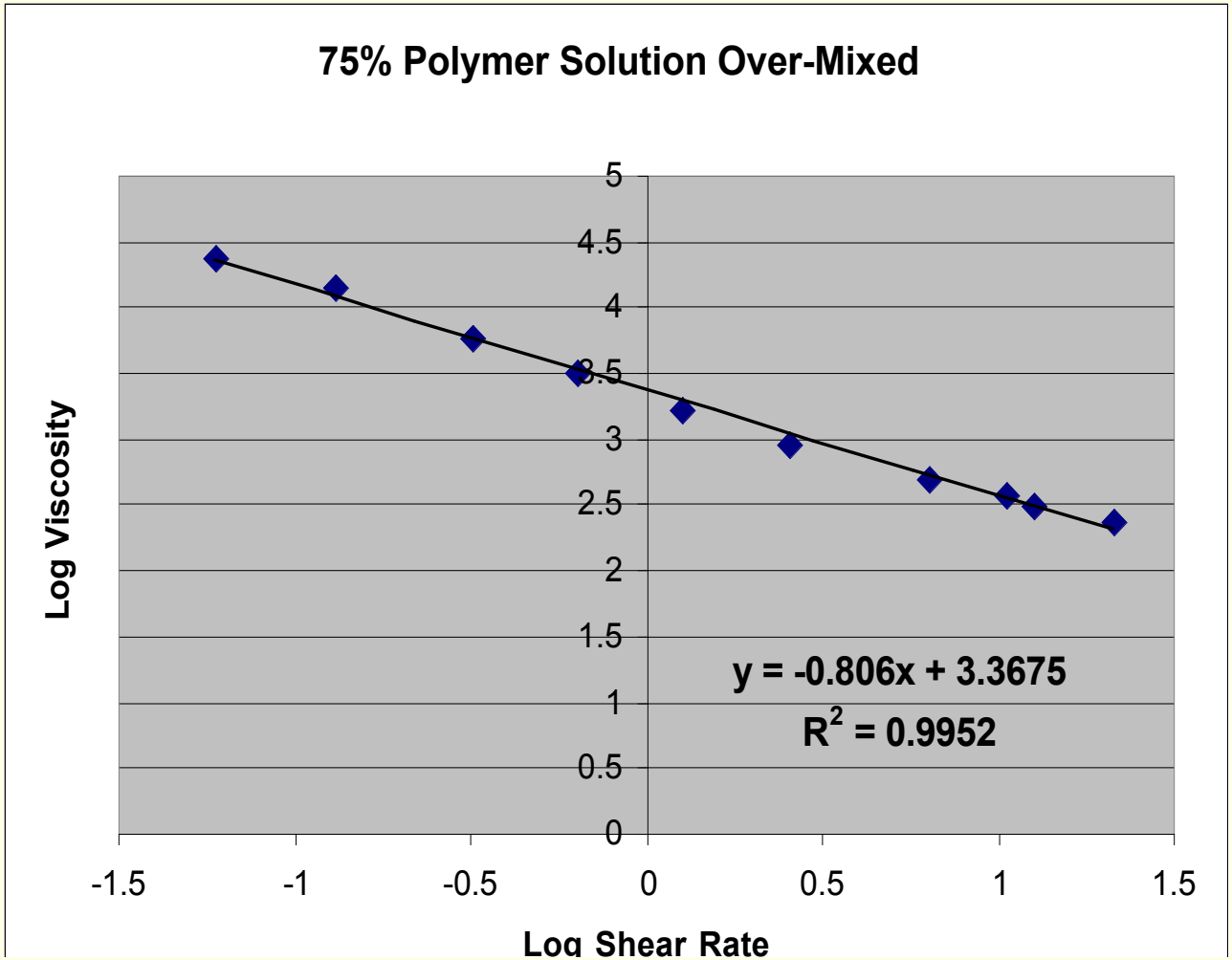
Viscosity of Over-mixed Sludge



50% polymer strength



75% polymer strength



Conclusions

Solution	Power law index
Polymer	0.319
Sludge	0.251
Over-Mixed	0.055

- All solutions are strongly non-Newtonian, shear thinning, power law fluids
- Both the polymer and the sludge have very low power indexes (table)
- Viscosity data is crucial to FEMLAB modeling of flow and mixing situations