Video record of experiments on suction and injection of particles in 2% (weight) aqueous polyox (viscoelastic) and in a glycerin/water (Newtonian) mixture.

We used a piston pump to drive the fluid from a reservoir to another reservoir through a $0.185''$ tube. The particle diameter is $0.125''$. Fifteen different trials were recorded, indexed by RPM (Table **??**). The sequences one through four show sucking and injection of particles in a 2% aqueous polyox solution.

- There appears to be a critical velocity above which particles do not enter the tube. Even below this speed particles are difficult to suck into the tube.
- The fluid is sucked from long range from the bottom of the reservoir, like the reverse jet of a Newtonian fluid. It appears that only fluid in a long cylinder of small radius at the centerline gets sucked into the cylinder. The rejected fluid and particles return to the centerline in a big eddy which is the most verifiable result of the video record.

Similar conclusions can be drawn from sequences five to eight. Only particles at the center of the tube are sucked up. There appears to be no opening angle for the reverse jet into the pump. Particles can be pulled up from the body. In trials 7 and 8 we first did suction, then injection. They are very different. The fluid is injected as in a potential flow source, going out radially, but is sucked in a jet on the centerline.

Trial 11 shows how easy it is to suck particles into the tube when the fluid is Newtonian. This is altogether the opposite of what happens in a polyox solution.

Suction and injection of particles in the glycerin/water solution is much more symmetric than in polyox, but it is not symmetric (you can blow out a candle but can't suck it out).

The suction and injection of particles in the glycerin and water looks something like injection and suction in polyox, just the opposite. It is instructive to run the tape backward; then polyox backward looks like glycerin-water forward.

Trials 9 & 10, and 12 & 13 compare the performance of a crude pump in expelling particles when polyox and glycerine/water is used. Particles are always trapped by polyox; some particles are trapped in glycerin but in many cases all of the particles are expelled. This needs to be investigated

Trial	Fluid	Vcm/sec	Comments
1	P	11.5	Particles are sucked into the pipe at slow speeds, but not a high speeds
2	P	32.6	
3	P	60.1	
4	P	94.13	
5	P + dye	11.1	The die shows the streamlines
6	P + dye	32.6	
7	P + dye	60.1	Suction and injection are very different. Fluid is sucked in as a jet, extruded as a source
8	P	94.1	
9*	P	1.05	Particles are always trapped in the closing gap of the pump
10*	P	3.65	
11	10% G	40.7	The particles are easily sucked in the tube. Unlike Polyox
12*	10% G	1.05	It is much easier to pump out the particles in the Newtonian fluid
13*	10% G	1.05	
14	99% G + dye	30.8	The streamlines for suction & injection are nearly reversible for low speeds but for high-speed particles are sucked into a sink and extruded as a jet
15	99% G + dye	70.7	

Table 1: Description of experimental trials. The pipe diameter was $0.185''$, 1.48 times the particle diameter. Smaller particles ($D_t = 2.96D_p$) were used in trial 13. V in cm/sec is the superficial velocity in $0.185''$ pipe or it is the block speed in the pump used in trials *9,10,12,13. The letter P stands for 2% (weight) polyox in water, G stands for glycerin in water. The tables in Fluid Dynamics of Viscoelastic Liquids show that the wave speed in 2% polyox is about 35 cm/sec.

further as it appears to apply to trapped particles of sand found in the urethane seal are produced by such an action.