



The Society of Rheology K12 Outreach Activities



Rod Climbing of “Anti-Gravity” Liquids

In this demo, we explore an intriguing behaviour of non-Newtonian liquids. The super slippery elastic liquid goo which is made up of long entangled polymer chains will be performing a feat that would be impossible to repeat using only water. In this experiment, a cylindrical rod will be immersed in the super slippery elastic liquid goo and will be rotated at a high speed using an electric motor. A good hint about what happens next is given away in the title of this demo!

What you will need to get started

- Gravi-Goo powder from Steve Spangler
- Water and a few drops of food coloring
- 0.5L or 1L bottle with screw top
- 15cm Metal rod machined to fit on motor
- Small motor and power supply
- Vertical stand holder
- Clear plastic 8oz cups
- Clean up- Paper towels and some water

Setting up the Experiment

1. Mix 5g of the Gravi-Goo powder with 150ml of water and let it stand for an hour.
2. Add some food coloring for fun.
3. The Goo can be stored in the bottles.
4. Assemble the vertical stand and fix the motor on it.
5. Push the supplied metal rod over the shaft of the motor and tighten the set screw to secure it in place. Finger tight is OK.
6. Pour some of the Goo into a cup and carefully immerse the rod one or two inches below the surface of the liquid. Leave some room in the cup to catch any spray. You don't want to make too big of a mess. Or do you?
7. Switch on the power supply.
8. The liquid will begin to climb up the rod as soon as it begins to rotate. Is it magic? Nope. It's science!





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Let's experiment!

1. Looking at the Goo in the cup. Does it look like it can defy gravity? Is it climbing the walls of the cup already?
2. Get a closer look by probing the Goo with sticks, spoons or your fingers if you want to get messy. If you pull your stick out of the Goo quickly what do you see? What if you let it drain from your stick. How is this different than water or honey?
3. Now to find out whether Goo can really defy gravity and climb the rod. Turn on the motor. What do you see? How high does it climb? Is it smooth or rough? What happens if you change motor speeds or rod size?
4. Can you think of ways to make it climb higher? As the rod spins, touch the Goo with your stick to help it go higher and higher. Does it stay high up the rod or fall down? How does it fall down?
5. What would happen if the rod was put into water instead? Try it. What do you see?
6. So, do you believe in magic now? Don't be fooled, read on to find out how this works. It's science not magic!





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**Science
is
FUN!**

How does it work?

Non-Newtonian liquids demonstrate many types of interesting behaviours which can be attributed to the heavily entangled network of polymer chains that are present in them. One such behaviour is the rod climbing effect. In this experiment, a rod is immersed in a solution of the Goo prepared in a previous demo. This rod is rotated at a high speed using an electric motor. As the rod rotates, the Goo doesn't move away from the rotating rod as water or oil would. Instead, it climbs up the rod and appears to defy gravity. This rod-climbing will continue as long as the rod continues to rotate. This phenomenon is a result of the viscoelastic nature of the Goo. The entangled polymer chains in the solution become stretched out as they flow around the submerged rotating rod. Because the polymer chains in solution are elastic, as they are stretched out, an elastic tension is produced in the solution in the direction of fluid motion that squeezes the liquid inward and drives it towards the rotating rod. When the liquid reaches the rotating rod, a large pressure is produced which drives the liquid up the rotating rod and perpendicular to the liquid interface. It might look like magic, but it's not. It's science.