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**NSERC USRA Report**  
**Gas Migration in Viscoplastic Fluids**  
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After drilling oil and gas wells, there is an annulus between the production casing and rock formation that is filled with cement slurry and left to set and solidify. Before the cement slurry solidifies, gas may enter the cemented annulus and create channels that allow for undesirable flow paths for reservoir fluids including hydrocarbons. This can lead to a decrease in well productivity and environmental impacts.

Our goal is to study the invasion process, using a model of a column of carbopol solution and injecting water at the bottom of the column. The water is contained in a box attached to the column by a length of tubing; the box can be raised with a jack to increase the pressure difference between the water and carbopol until invasion occurs, with pressure obeying the equation:

$$P = \rho g \Delta h$$

where  $P$  is pressure,  $\rho$  is the density of the water,  $g$  is the gravitational field strength, and  $\Delta h$  is the change in height of the water. To better visualize the invasion process, we added a fluorescent compound to the water and used a laser to make the fluorescent particles glow. We ran experiments over a range of yield stress values of carbopol and different carbopol column heights.

For an experiment, first a small bubble of water is allowed to form at the base of the acrylic box that will contain the carbopol column. We then fill the box with carbopol to the desired height, either 5, 12.5, or 24 inches. We level the surface of the carbopol column and ensure that it is at the same height as the water in the other box by adding or removing water. We then open the valve that allows water to flow from its box to the carbopol box and begin recording, using a motorized jack to lift the water box until the pressure difference causes an invasion to occur. Invasions typically begin as a dome of water, but with additional pressure an interface grows within the carbopol, expanding upwards and creating a feathered shape.

As my work term ended before data analysis began, I cannot say for certain what the relationship between the invasion pressure and yield stress of the carbopol is, though it seems to be linear. The invasion pressure also increases with higher height/diameter ratios for the carbopol column.