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Complex Fluid Invasion
Experimentation and Apparatus Design

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INTRODUCTION

This document is a brief report of the research undertaken in the Complex Fluids Lab (Rusty Hut 123) for the Fluids Invasion Experiment supervised by PhD student Marjan Zare between May and September 2014. Over the four months the research has included:

I) Designing and optimizing the experimental apparatus.

II) Preparing various concentrations of carbopol and running rheological tests on said carbopol.

III) Refining the experimental procedure and running experiments to obtain repeatable data data.

All of the work that has been completed has been with the help of many people, including but not limited to Marjan Zare, Ian Frigaard, Kamran Alba, Ali Etrati, Shamsuddin Rahmani, and Markus Fengler.

I – DESIGN AND OPTIMISATION OF EXERIMENTAL APPARATUS

In May, a large part of the experimental apparatus had already been built by Shamsuddin Rahmani. This included the aluminum framework for a large part of the set-up and the clear acrylic boxes that were to contain the carbopol and fluid injection point. With the help of Markus Fengler, I added to the experimental set up, buy building a drying and storage rack for the boxes, adding a sliding platform for the bucket (that is used to dispense carbopol into the boxes), redesigning and machining the carbopol dispensing mechanism, and finding and installing the most suitable valve to be implemented in the apparatus. Once the apparatus appeared to be completely ready, test experiments were run in order to see what needed further refinement. These

refinements were largely adjustments to the procedure and will be outlined in part III.

II – PREPARING CARBOPOL AND RUNNING RHEOLOGY TESTS

A large part of the fluid invasion experiment is the preparation and study of the fluid in question that is carbopol. As per the instruction of Marjan Zare, I experimented with different methods of carbopol preparation. This included preparing different quantities with various methods of preparation and various mixers. From there we would evaluate the effect of the specific method on the carbopol, by running the experiments and evaluating results as well as running rheological tests on the carbopol. We have now settled on a method that yields homogenous and consistent rheology of carbopol that accommodates for good repeatable data in the experiments.

III – REFINING THE PROCEDURE AND RUNNING THE EXPERIMENTS

When we started running the experiments there were a number of issues that were solved through various methods. One issue was that the carbopol would block the injection nozzle. This meant that excessive pressure was needed in order for the fluid to invade into the carbopol, destroying the value of the data obtained. This problem was solved by reducing the length of the pipe between the box and the valve that contains the fluid of injection, further decreasing the compressibility of that fluid. Another problem that arose was that of bubbles being trapped in the interface between the two fluids. This problem was solved by adjusting the procedure, so that the ink fills the nozzle and the

carbopol is poured on to a completely flat surface so that no air may be trapped.

CONCLUSION

It has been a very interesting and important learning process to go through the design and execution phase of experimental research. The opportunity to troubleshoot problems that have arisen with the apparatus and procedure has been highly valuable. Additionally it has been fulfilling to broaden my knowledge experimental procedures, and non-Newtonian fluids.