**Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021**
**CSME Congress 2021**
**June 27-30, 2021, Charlottetown, PE, Canada**

# Mechanics of bubbles in a yield stress fluid

Masoud Daneshi[1*], Miguel Eagleton[1], Marjan Zare[2], Ian Frigaard[1,2]
[1] Department of Mechanical Engineering, University of British Columbia, Vancouver, Canada
[2] Department of Mathematics, University of British Columbia, Vancouver, Canada
*masoud.daneshi@ubc.ca

ABSTRACT

In this paper, we study mechanics of bubbles in a yield stress fluid. This scenario can be found in a wide range of industrial and natural settings including natural and man-made ponds, oil well drilling and well-control applications, and nuclear waste storage. The original motivation of the study stems from relevant observations in oil sands tailings ponds. Recent studies indicate that anaerobic microorganisms contribute to the degradation of naphtha hydrocarbons and naphthenic acids in the FFT/MFT layers of oil sands tailings ponds, which leads to methane emissions from the ponds. The FFT and MFT layers are colloidal suspensions, which behave like viscoplastic fluids with time-dependent rheology: changing both with age and depth in the pond. The key feature of a viscoplastic fluid is its yield stress: the material flows only if the imposed stress exceeds the yield stress. This raises questions regarding the stability of bubbles that are trapped in a yield stress fluid, that we try to answer in this research through a series of targeted experiments. A vacuum chamber system was used to control the concentration and size of bubbles trapped in the fluid. A series of experiments have been performed to investigate the stability of both bubble clouds, and a single bubble. Our results show that the rheology of the material as well as interaction between bubbles affect the onset of motion significantly. According to our findings, a single bubble starts to rise in a solution with higher polymer concentration, i.e. higher yield stress and elastic modulus, at a larger size and with a larger aspect ratio. Furthermore, our results confirm that bubble clouds become unstable at a smaller bubble size in comparison with that of a single bubble. We believe this is related to the interaction of stress fields around the bubbles. To further clarify this point, we extend our study by looking at more fundamental scenarios, i.e. two or three bubbles at different orientations and separation distances. We examine this problem using both an experimental and a numerical approach to demonstrate how the stress fields around neighbouring bubbles interfere with each other and how this affects their onset of motion in a yield stress fluid.

**Acknowledgement** This research was made possible by funding from NSERC and COSIA/IOSI (project numbers CRDPJ 537806-18 and IOSI Project #2018-10).