Floating and Melting of Ice in Oil

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Abstract. The workshop investigates position and orientation of ice during melting in two immiscible fluids, the water, and the oil. The theoretical calculation of position of ice using Archimedes law cannot account for orientation of the ice cube. In addition, observations are not consistent with calculated predictions, and this experimental workshop will allow to find the reasons for this inconsistency.

Introduction

The MUSE workshop in Jyväskylä several years ago discussed a standard Introductory physics exercise of ice in two immiscible fluids with different densities, one higher than ice (water for example) and one lower than ice (oil for example). The problem was turned around and led to a thought-provoking discussion: Does ice move up to the fluid with lower density, down or stays in the same position, if one pours a thick layer of fluid with density lower than ice to the glass with water and ice. Although the calculation of position of ice-cube was discussed and calculated to subtle details, the experiment was not performed. The problem was considered theoretically only, although in [1] experiment is mentioned, which one of us do not recall.

This workshop will approach to the same problem experimentally. Experimental results are not consistent with predictions discussed at MUSE workshop. For understanding of observed phenomena during melting of ice in two immiscible fluids system one has to consider much more than Archimedes law.

The framework

It is well known that experiments provide experience on which students can easier construct the new knowledge. If students are encouraged to form inquiry questions, design experiments, and draw conclusions based on experimental results, they become responsible for their own learning and usually they better comprehend the content [2].

This activity focuses on a very simple experiment using hands-on means, which could be accompanied by a simple exercise based on Archimedes law. Surprisingly, theoretical consideration and experimental results are not consistent. Therefore, the activity also demonstrates circumstances often met in research, when theoretical ideas are tested. Extremely rare are occasions where already the first experiment is consistent with predictions of the model. Usually research, when results are obtained, starts.

The content of the workshop

Recently we remembered the activity [1] and have decided to try to reproduce the setting in a real experiment. We used ice from the tap water, tap water and sunflower oil. Surprise, surprise, outcomes were very far from the ones predicted theoretically. Position of ice cube was different from expected, ice cube has two (meta)stable positions, at the surface of oil, and at the interface between water and oil, we even observed the heat engine, where an ice cube was an essential part. We tried to figure out reasons for differences between theoretical predictions and

experimental results, and as a test of our understanding, we were able to reproduce the theoretical prediction, but it was not straightforward.

Conclusions

In this workshop, we will compare the theory and experiment, and investigate reasons, why they are not consistent. We will also establish conditions, when the experimental results are consistent with theoretical predictions from the example discussed in [1].

References

[1] S. Faletič, M. Gojkošek, and K. Jeličić, MUSE workshop: reflections and feedback. In: Lindell, A. (Ed.), Kahkonen, A.-L. (Ed.), Viiri, J. (Ed.). *Physics alive: proceedings*. Jyväskylä University, (2012) 191-196.

[2] D. Sokolowska, *Volume 1: Inquiry Based Learning to Enhance Teaching*, 2020. http://archive3diphe.splet.arnes.si/files/2021/01/3D_VOLUME1.pdf