Preparation of an experiment tool for energy conversion to be used in high school physics classes

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Abstract. An experiment tool for realizing the Joule's experiment was provided for allowing students to actually experience energy conversion from mechanical energy into thermal energy. Materials are easily available through commercial purchase, and the tool can be easily constructed at relatively low cost. About 10 minutes work with the tool realized certain temperature rise. Thus, students can actually confirm that mechanical energy can be converted into thermal energy, as taught in textbooks with refercnce to the famous historical Joule's experiment.

1 Introduction

Lack of interests for learning physics has become a major problem in recent Japanese science education. It has been often said that actual experiences of physics phenomena through experiments will be effective for attracting or stitumating students' interests towards learning physics. However, in present actual situations of high school education scene, experiments are not sifficiently conducted in daily classes.

From another perspective, the research results by American National Training Institute indicate that learning retention rates can be expressed in the form of a learning pyramid, and conventional classroom-style lectures exhibit the lowest effectiveness [1]. The learning pyramid model indicates that the learning retention rates can increase when more actual activities and teaching experiences are involved.

In view of the above background situations, in this study, Joule's experiment, which converts mechanical energy into thermal energy, was picked up, as one of experiments that are not likely to be actually conducted in classrooms although being famous and found in textbooks. An experiment tool for realizing the Joule's experiment was provided for allowing to actually experience the energy conversion. About 10 minutes work with the tool realized certain temperature rise.

2 Experimental tool for energy conversion and the measured results

Fig.1 shows the experimental tool provided in this study for converting mechanical rotation energy into thermal energy. A commercially available mop dehydrator was used as a rotary table for causing rotating motion. Melamine sponge and cushions were employed to accommodate a beaker containing liquid. Two types of stainless-steel plates as shown in Fig.2 were prepared as a stirring part, one being unprocessed while the other being processed into a predetermined shape. A predetermined amount of water or silicone oil was put into the beaker, which was then installed inside the tool.

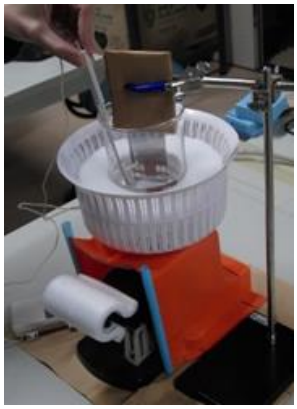

Fig.1 Experiment tool

Fig.2 Two types of stirring plates

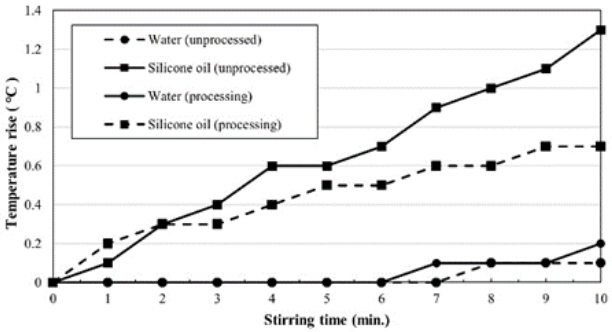

Fig.3 Measured temperature rise

The stainless-steel plate of either type was fixed so as to be positioned inside the liquid in the beaker. The rotary table was rotated for a certain period of time at almost constant rotating speed of 1 rps, which causes relative motions between the stainless-steel plate as the stirring part and the liquid in the beaker. The liquid temperature was measured at every 1 minute from the beginning of the motions.

Fig.3 shows changes in the liquid temperatures over 10 minute rotation for water and silicone oil with the two types of stirring plates, respectively. The observed temperature rises indicate actual conversion from mechanical energy into thermal energy. Silicone oil was confirmed to exhibit larger temperature increase than water, due to differences in their specific heat. In addition, the processed plate was confirmed to be more effective to realize rapid temperature rise, as compared to unprocessed type.

3 Conclusion

An experiment tool for realizing the Joule's experiment was provided for allowing to actually experience the energy conversion from mechanical energy into thermal energy. Temperature rise of liquid was confirmed to be realized through mechanical relative rotating motions. As further studies, energy conversion rates are required to be checked. In addition, possible lesson plan involving certain experiments with the tool and possible achievable educational effects will be studied.

References

[1] Y. Morita, K. Okuda, K. Sugihara, J. Nakamichi, H. Ikeoka, K. Hanada, Proposal of self-study process and analysis of learning effect, *IPSJ Research Report*, vol.2016-CE-143 No7 (2016).