Research on experimental equipment for energy conversion as experimental teaching material for high school physics

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【Introduction】

In the current situation of science education at Japanese high schools and junior high schools, unwillingness for learning physics has become a big problem. As shown in Fig. 1, many students are likely to have negative impression towards physics. On the other hand, as shown in Fig. 2, the learning retention rate can be expressed in the form of a learning pyramid, and it is said that the learning retention rate can increase through actual experiences and/or opportunities to explain to others. However, in Japanese high schools, only a few experimental classes are actually held, and students are not likely to have experiment experiences. In view of the above, in this study, experimental teaching material that allows students to actually experience conversion from mechanical energy into thermal energy was prepared, based on the famous Joule's experiment.

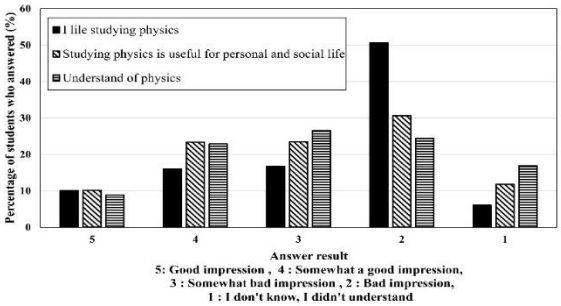

Fig.1 Students Impressions for physics

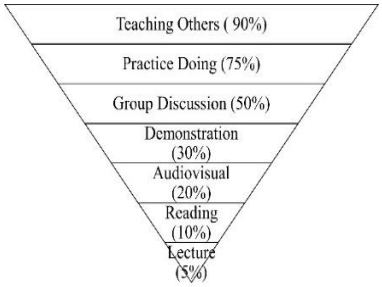

Fig.2 Learning pyramid (Percentages indicate the learning retention rates.)

【Experimental procedures and results】

An experimental tool was prepared using commercially available materials, and the liquid temperature was measured every 1 minute, while rotary motion was applied at the rate of 1 Hz. The amount of manual work required to raise the liquid temperature by 0.1 ° C was measured, in order to calculate the energy conversion efficiency.

Fig. 3 shows the changes in the liquid temperature while stirring, and Fig. 4 shows the energy conversion efficiency. From Fig.3, it was confirmed that mechanical energy was actually converted into thermal energy. In addition, it was also confirmed that the range of temperature rise was increased by using a stainless-steel plate processed into a predetermined shape. As a possible reason, it can be inferred that by using a processed stainless-steel plate, the amount of air held by the liquid while stirring may be reduced, resulting in suppression of loss. Fig. 4 shows that the energy conversion efficiency was less than 5%.

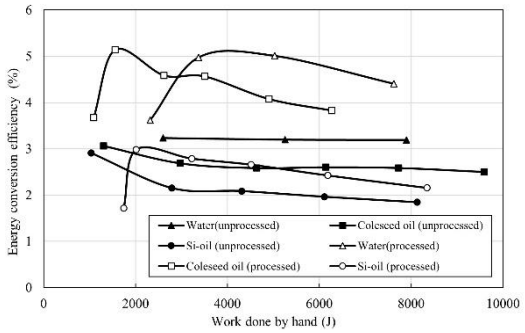

Fig.3 transition of the liquid temperature

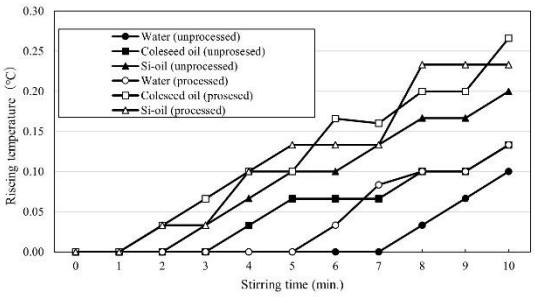

Fig.4 Energy conversion efficiency

【Conclusion】

Even in simple procedures using commercially available inexpensive materials, conversion from mechanical energy into thermal energy can be confirmed to actually happen. Thus, the relatively simple experimental tool prepared in this study can allow students to actually experience energy conversion process with simple operations.

Regarding the low energy conversion rates, heat insulation must be improved, and mechanical energy losses have to be also taken into account. At the same time, the low energy conversion rates can be a good trigger for allowing students to be aware of energy loss issue and think of some solutions for avoiding such energy loss.