Run! Longer than My Life

Abstract

A dry battery is useful, but it has a limit on generating electricity. With a Japanese toy "Plarail", we did experiments to use it longer and more powerful. We tried two ways, by cooling and by running with some intervals between uses. However, cooling was bad for the battery. Alternatively, heating it is better.

Using intervals was also good for a battery. However, our experiments also showed that a long interval was not always effective. Then, we found a time to have the best effect.

We made Plarail run by these two ways. As a result, it can run longer than normal one.

Therefore, we found that heating and intervals are good ways to use a battery longer. We will consider how to use them in our lives.

1. Introduction

In Japan, we have had serious issues of electricity such as shortage of electricity. We were interested in energy, and we did experiments to find ways to use energy more efficiently. We used alkaline batteries for the experiments as energy supplies. We also used Plarail, a Japanese toy train, to use the batteries. That is, we tried to make Plarail run longer and longer! Results of the experiments would help solve issues.

We tried two ways. First, we cooled batteries to reduce emission of heat. They would not use their energy for heat, but electricity. Second, we had some intervals during using batteries. In general, people said that batteries could be used longer with interval than nothing. We tried these ways.

The brand of the batteries was Daiso. Daiso is a Japanese house improvement store. The batteries had no difference.

2. Experiment of cooling

We tried to use a battery with cooling, but contrary to expectations, the battery became unavailable at once. We considered that low temperature of a dry battery made its power to produce electricity weak. Hence, we tried to heat it to inspire that power.

3. Experiment of heating

(1) Process

We prepared three batteries. The first one is set at 25℃. The second one is set at

35℃. The third one is set at 45℃. 25℃ was regarded as standard temperature. Those batteries were used with a 1Ω resistance. We researched change of voltage at that time every 5 minutes. And how to keep a battery's temperature was using a water bath. Water bath is able to keep temperature of water. First, a battery was in zip lock bag. Next, this bag was placed in water bath. Thus, it wasn't dangerous to do this experiment.

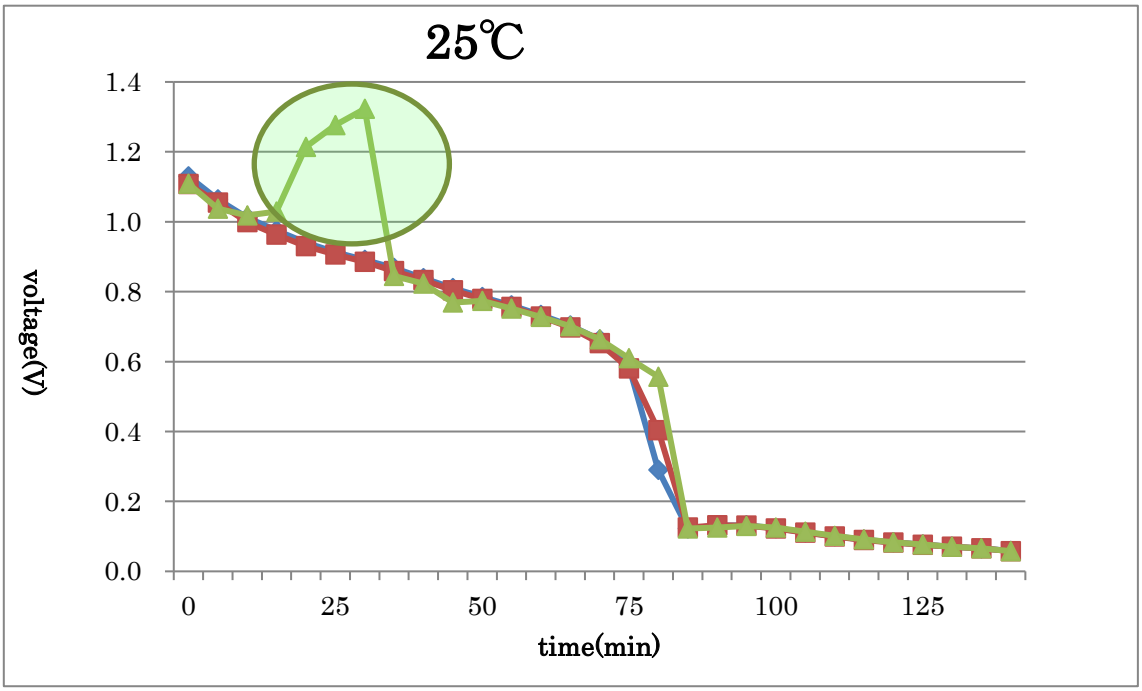
(2) Equipment

・alkaline battery ・tester ・resister(1Ω) ・battery case ・wire
・water bath ・zip lock bag

(3) Result

Figure 1 Result of 25℃

* Green circle includes tester-error. (After 35min, we changed tester.)



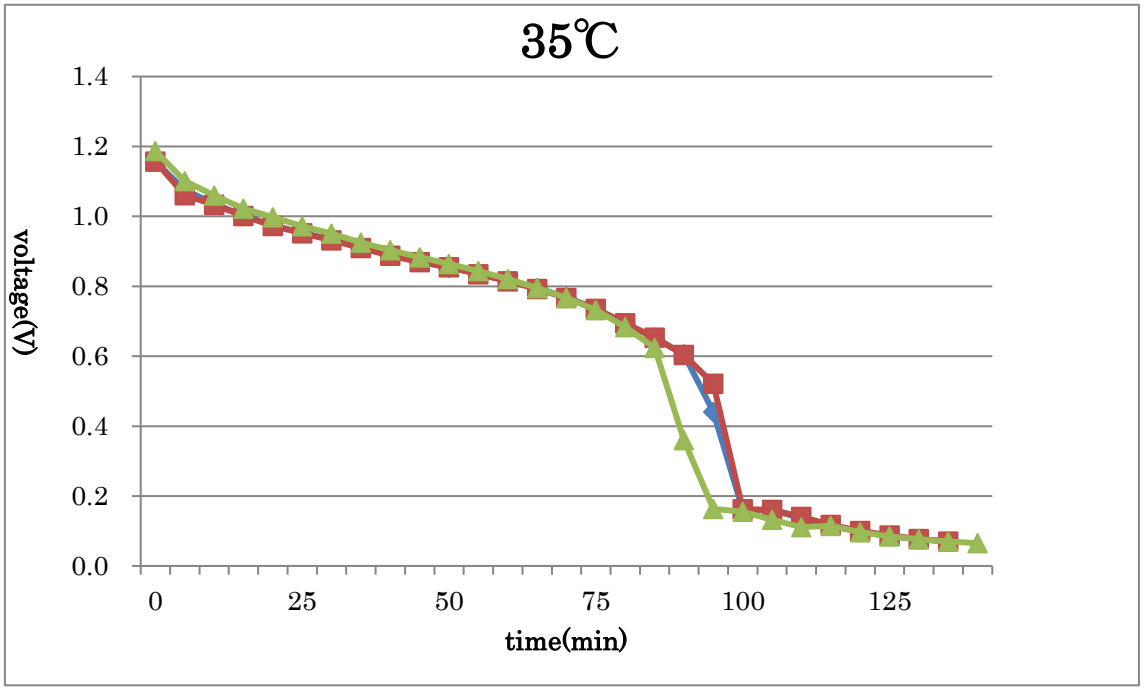


Figure 2 Result of 25℃

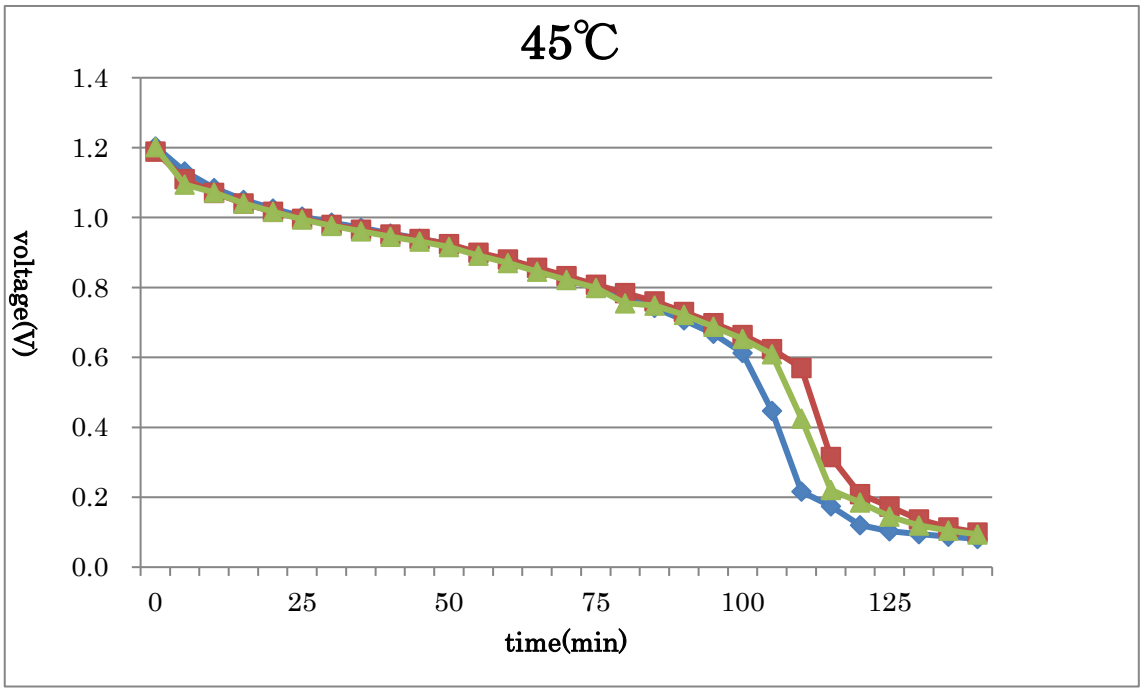


Figure 3 Result of 45℃

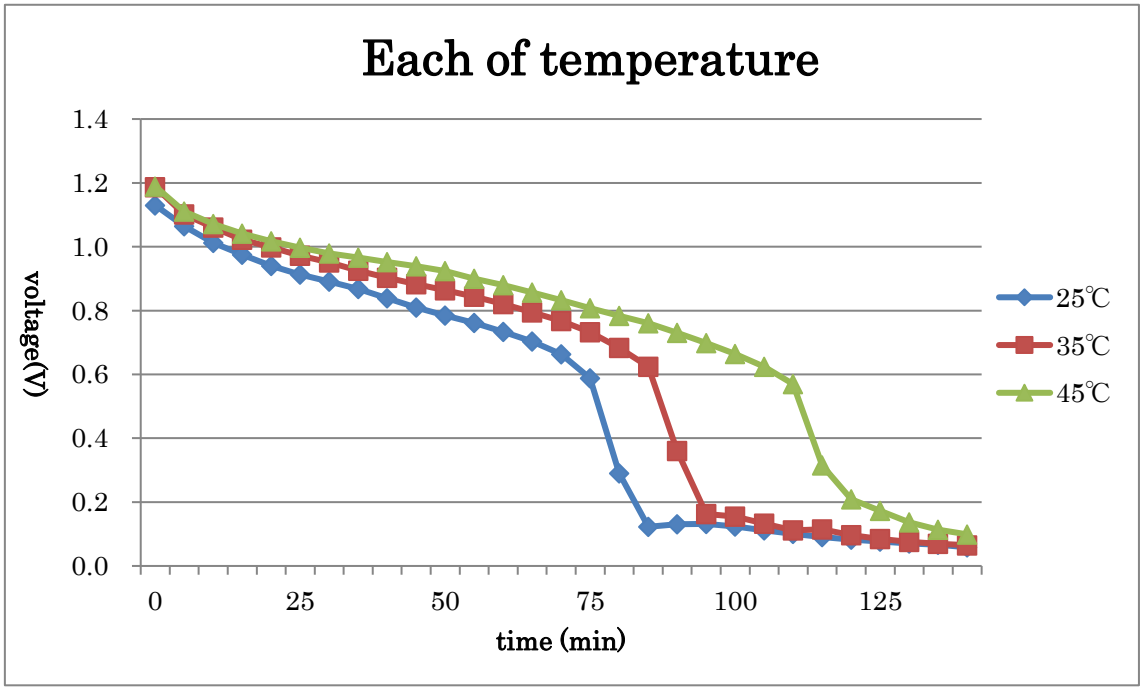


Figure 4 Comparing each temperature

Looking at Figure 4, the higher temperature of a battery, the longer the voltage is kept.

(4) Consideration

This is why heating is effective, because chemical reaction is more active than normal. However, when a battery is higher than 45℃ , it is dangerous. (This limit value is announced by Panasonic.) So, we could not heat more than that.

4. Experiment of interval

(1) Process

We compared three kinds of battery, the first one is used normally, the second one is used for 20 minutes and was left for 20 minutes (20:20) and the third one was used for 10 minutes and was left for 20 minutes (10:20). We measured each voltage like experiment of heating.

(2) Equipment

・alkaline battery ・tester ・resister(1Ω) ・battery case ・wire

(3) Result

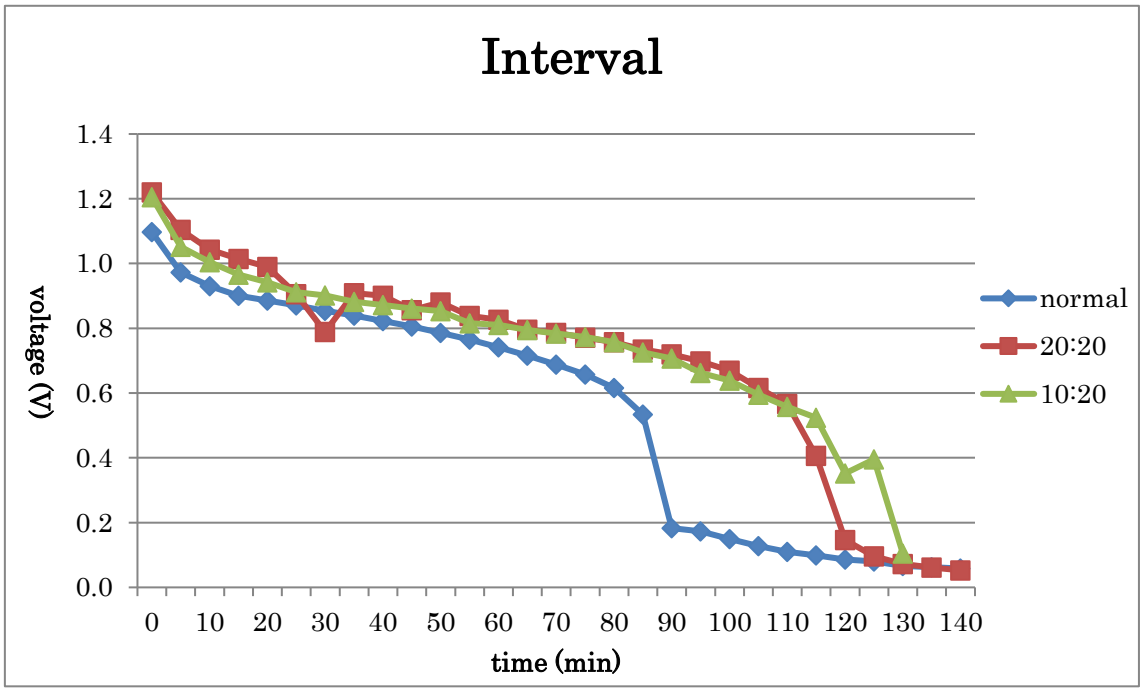


Figure 5 Result of Interval

As you can see, Figure 5 shows that Interval delays voltage drop of the battery.

(4) Consideration

Now, let me explain why interval delays voltages drop of the battery. In the process of the chemical reaction of alkaline battery, water is produced at the point where the chemical reaction occurs, and disturbs next reaction. During the interval, the water moves from the point and next reaction can occur. We thought this is the reason. Interval is effective to delay voltage drop of battery. So, we conducted next experiment.

5. Experiment of recovery

(1) Process

A battery is connected to 1 Ω of resister and used for a few minutes. After using the battery, it is kept and the voltage is recorded every five minutes. This work is continued until the rise of the voltage became less than 0.002 V in five minutes. This is one example of the results. Initial voltage of this battery is 1.610V, and we used it until the voltage became less than 1.261V. In this case, the drop of the voltage is 1.610 - 1.261 = 0.349(V), and the recovery time is 85 minutes because at that time, recovery voltage per 5 minutes was less than 0.002V.

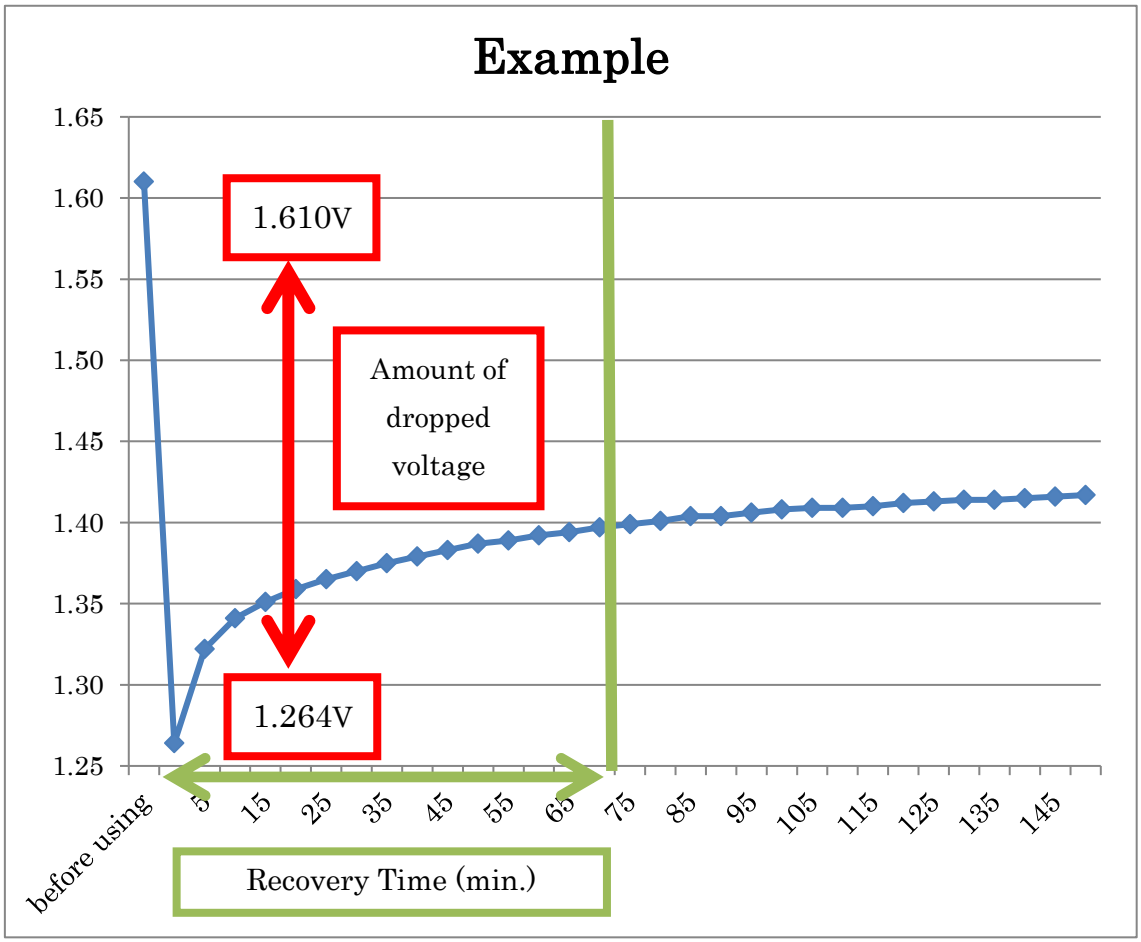


Figure 6 One example of this experiment

(2) Equipment

・ alkaline battery ・tester ・register(1Ω) ・battery case ・wire

(3) Result

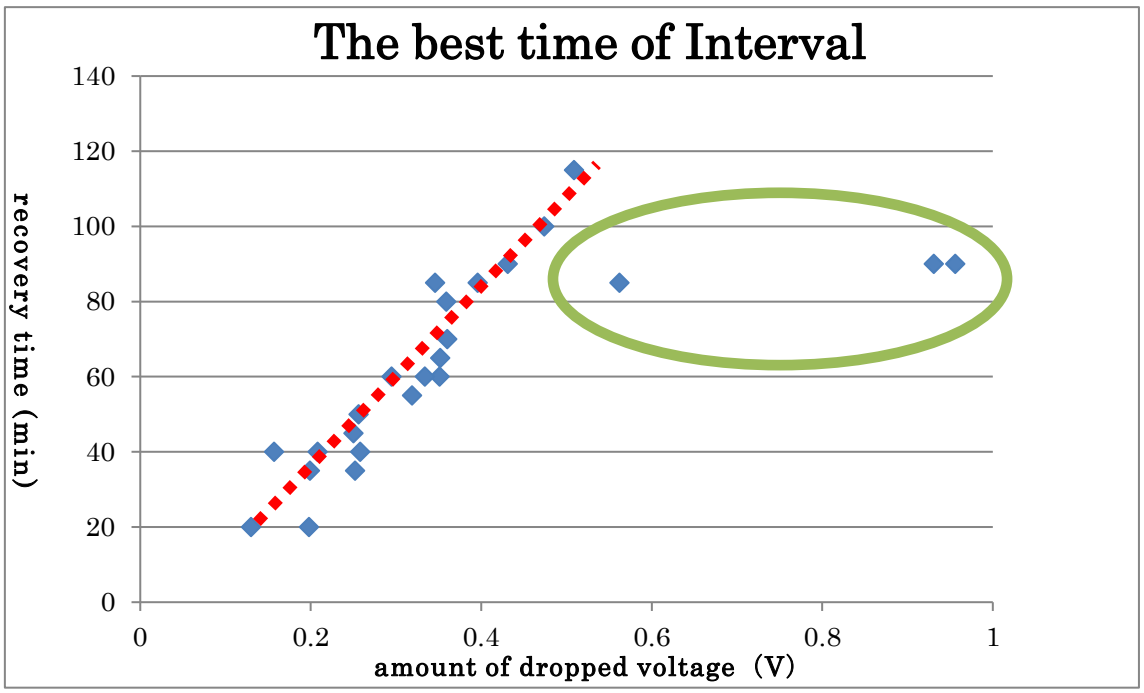


Figure 7 The best time of interval

There is a direct relationship between the amount of used voltage and the time at which the rise of voltage become smaller than 0.002 V; the more voltage of a battery decreased, the longer time the battery needed for recovery (Red dotted line).

(4) Consideration

By this relationship, the best time for the recovery is decided. But the case that a battery is used over 0.6 V is exception (inside the green circle). When the amount of the voltage is too big, it is not apply to the relationship.

6. Experiment using Plarail

(1) Process

We compared number of laps of Plarail: we set up three difficult conditions where the train runs. The first one is that the train runs at 25℃. The second one is at 45℃. The third one is that train runs with the best intervals.

(2) Equipment

・alkaline battery ・tester ・resister(1Ω) ・battery case ・wire
・Water Bath ・zip lock bag ・wooden stick ・clay ・aluminum foil
・computer ・camera

(3) Result

The following one the results of each condition, the first one runs about 1270 laps (1.7km). The second one runs about 3521 laps (4.8km). The third one runs about 5378 laps (7.3km).

(4) Consideration

This result suggests that heating batteries and having the best intervals are efficient. Especially having the best intervals is so efficient. In this way, Plarail runs four times as long as normal.

7. Conclusions

Heating batteries and running with some intervals are the best ways to use batteries efficiently. Batteries may generate more electricity by ways of both. We will consider how to make use of these ways in our lives.

8. Acknowledgements

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9. References

・Wikipedia http://www.wikipedia.org
・Panasonic http://www.panasonic.com
・Battery Association of Japan http://www.baj.or.jp