

# Improving Thermal Retention in Reusable Heat Packs

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## 1. Introduction

Today, we usually use chemical warmers. But we found a reusable heat pack, which we can use many times by reheating it. It's not so popular because it loses its heat easily, and the temperature is not high enough. Therefore, we have decided to conduct the research to make it keep its heat longer by adding thickeners to the solution inside the pack.

## 2. Background

### Reusable Heat Packs

- Can reuse them by boiling them in water
- Can use them by giving a trigger, which leads to an exothermic reaction
- The substance in them is a sodium acetate solution
- Compared to conventional chemical warmers, they can be used for a shorter period



## 3. Hypothesis

We hypothesized that we could boost their ability to keep their heat and retain heat of reusable heat packs for a longer period by being thick.

## 5. Experiment I -Testing the Hypothesis-

### 〈Objective〉

To see the solution keep their heat longer by increasing their viscosity.

### 〈Method〉

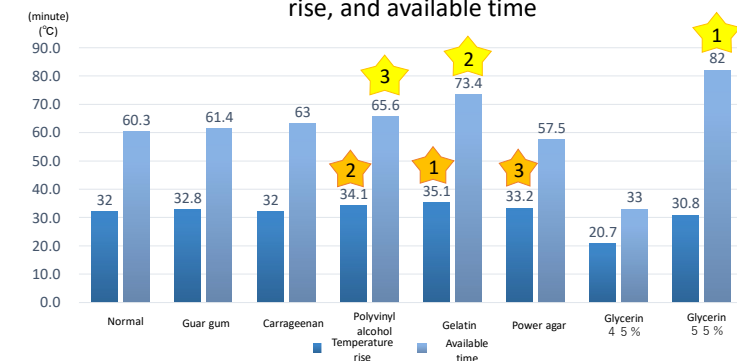
1.Add 1.00g of Guar gum, Carrageenan, Polyvinyl alcohol, Gelatin and Powder agar into each of five sodium acetate solutions or use Glycerin instead of water.

2.Compare those 7 solutions and without additives.

3.We investigated two things.

- ①How high the highest temperature is.
- ②How long it takes for the temperature to go down from the highest temperature to 40°C.

〈Results〉 The relationship between thickener, temperature rise, and available time



## 7. Discussion

- Even if we add thickeners to solutions, we can use reusable heat packs.
- By adding thickeners, thermal conductivity of solutions decreases, and they keep heat for a longer period.
- Gelatin contains protein. The other thickeners in the experiments contain carbohydrates. Protein may affect solidifications.

## 8. Future Research

- We will uncover why glycerin and gelatin were more effective than other thickeners.
- We will search for better thickeners.

## References

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## 4. Preliminary Experiment

### 〈Objective〉

To decide the concentration of the sodium acetate solution which is closest to that of the commercially available heat packs'.

### 〈Methods〉

Compare the temperature rise of 45%, 50%, 55% sodium acetate solutions and commercially available heat packs.

### 〈Result〉

	Temperature rise	Difference with commercial item
Commercial item (NECOカイロ)	20.3°C	
50% solution	17.25°C	- 3.05°C
55% solution	23.03°C	+ 2.73°C

### 〈Observations〉

The temperature rise of the 55% solution is higher than that of the commercially available item by 2.73°C and the reaction of 55% solution is stable. Therefore, we decided to use 55% solution for our experiment.

## 6. Experiment II -Comparing Gelatin and Glycerin-

### 〈Objective〉

To compare Gelatin and Glycerin, which gave good results and to verify reproducibility of the results.

### 〈Method〉

1.Add 1.00g of Gelatin into each of 55% sodium Acetate solution or use Glycerin instead of water.

2.Cause coagulation reactions in the incubator set of 15°C.

3.Compare those two kinds of solutions and the one without additives.

4.We investigated two things.

- ① How high the highest temperature is.
- ② How long it lasts from the highest temperature to 40°C.

### 〈Results〉

