STUDY OF THE HEAT RETAINING CAPACITIES OF INSULATED JUGS

1. PROJECT: Heat Retaining Capacities of Insulated Jugs.

   a. Authority - Letter Commanding General, Headquarters Armored Force, Fort Knox, Kentucky, 400.112/6 CNOHD, date September 24, 1942

   b. Purpose - To determine the effectiveness of thermos containers, vacuum and insulated, in keeping food hot during cold weather operations.

2. DISCUSSION:

   a. Methods - The following Stanley type, thermos containers manufactured by Landers, Frary and Clark were tested:

   One (1) - 1.7 qt. vacuum bottle
   One (1) - 3.5 qt. insulated, semi-vacuum jug
   One (1) - 7.6 qt. insulated jug with spigot
   One (1) - 18.2 qt. insulated jug with spigot

   All containers were preheated by filling them with water at 100°F one-half hour before use. At the end of the preheating period the water was poured out, the containers filled with the test material and placed in the cold room at -30°F. (A few tests were carried out at 46°F.) The temperatures of the contents of the containers were followed for periods of from 7 to 8 hours by means of thermocouples. Details of procedure and analysis of results are given in the appendix.

3. CONCLUSIONS:

   a. An insulated thermos jug of 13.2 quart capacity will keep food hot for at least 4 hours and adequately warm for periods up to eight hours. The rate of fall in temperature of the food contained is approximately 0.3°F per quart per hour, the rate being in part dependent upon the temperature of the food at the time it is placed in the container.

   b. Vacuum bottles also have excellent heat-retaining properties but due to their fragility and cost are not as suitable for transportation of hot food as the more durable insulated jugs.

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Insulated jugs are effective in keeping food hot and provide an excellent means for the transportation of foods during extreme cold weather.

The larger insulated jug, 18.2 quart, is more efficient than the smaller jugs of 3.5 and 7.6 quart capacity.

To provide for most efficient performance, thermos containers should be filled completely.

RECOMMENDATIONS:

a. Insulated thermos jugs up to five-gallon capacity be purchased for test in the field during winter operations.

b. That manufacturers be contacted regarding the possibility of constructing an insulated thermos jug on the general plan of the present water container.

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The need for making available to men not only food but hot food as well has been emphasized in many reports from battle-front areas. In the case of outposts, patrols and other small units engaged in operations which separate them from company kitchens, and in situations where fires are not permissible or time is not available to build them, special provisions for food and drink are required. The necessity for hot food for men engaged in cold weather operations is quite obvious. Thermos containers would seem to provide a solution to the problem. Cold weather also poses a big problem in the transportation of perishable foods, such as fresh fruit, without freezing and resulting spoilage.

Four thermos containers, a 1.7 quart vacuum bottle, a 3.5 quart semi-vacuum and insulated jug, a 7.5 quart insulated jug, and an 18.2 quart insulated jug, the latter two having bottom spigots, were subjected to test to determine their suitability for transporting hot foods to or with troops in the field. The thermos containers were preheated by filling with water at approximately 100°F. After about one-half hour the water was poured out and the food to be tested was placed in the containers. These were then taken into the cold room (+6 or -30°F), and thermocouples inserted at several levels. The temperature was recorded at intervals during the six or eight hour exposure to cold. In some experiments the jugs were agitated every half hour while in others they were left untouched throughout the duration of the experiment. Water, coffee, beef stew (Field Ration), Cream of Wheat, oatmeal gruel, scrambled eggs, and fresh apples were used in the tests.

RESULTS:

The data obtained from experiments conducted under the most severe of the two conditions, -30°F, are summarized in Table I. As a unit, the vacuum bottle, No. 1, is the most efficient, although the large insulated jug approaches it in efficiency in all but one experiment. As units, Jugs 2 and 3 are approximately identical. From a practical standpoint the insulated jug with a capacity of 18.2 quarts, is the best. A comparison of the rate of cooling of oatmeal gruel in the two best thermos containers, 1 and 4, is shown in Figure 1. The jugs were not agitated during the test. More rapid cooling of the surface resulted from the incomplete seal around the thermocouples which entered the jug through the cover. The cooling curves for water in the containers are shown in Figure 2. The similarity in behavior between the vacuum bottle and the largest insulated jug is striking. The two remaining jugs (2 and 3) cooled off at approximately identical rates.

In one experiment the 18.2 quart insulated jug was only one-fourth filled with oatmeal gruel. The temperature fell much more rapidly than in another experiment in which the jug was completely filled. The gradual infiltration of cold air under the rim of the lid resulted in more rapid cooling of the contents of the jug having the greatest air space. The
necessity for completely filling the jugs is evident. Beef stew was kept hot for five hours and remained moderately warm for 3 additional hours (Figure 3). When this was eaten after being at -30°F for 8 hours, it was very palatable, although a layer of fat, about one-half inch thick had solidified on top of the stew. The stew was then left at room temperature (20°C) for sixteen hours and when sampled at that time, had become slightly rancid and was inedible. As may be anticipated, these thermos containers will not preserve food for long periods of time.

Several experiments were conducted with coffee in the jugs. The jugs proved to be excellent for keeping coffee hot. During mealtime at Headquarters Company Mess the temperatures of cups of coffee was obtained prior to the time the men would start to drink them. The average initial drinking temperature was found to be 138°F. If coffee is placed in 18.2 quart jugs at around 200°F, at the expected rate of cooling, the coffee would still be above the average drinking temperature ten hours later.

The possibility of safe transportation of perishable foods during extreme cold was investigated. Apples were used in these experiments. In a typical experiment with one of the least efficient jugs (number 2) the apples were in excellent condition after 24 hours of exposure to -30°F. The apples on the top were frozen to a depth of 1/8 to 1/4 of an inch. The ones beneath were in perfect condition. The cover was replaced and the jug returned to the cold for another twelve hours. As before, the top few were slightly frozen, but the bottom ones were not harmed. Even though slightly frozen at the periphery the fruit was edible and of good flavor. The apples were then left in a warm room and at the end of several hours became slightly mushy on the surface. They were edible but did not have the flavor of the apples when eaten in the cold. Experiments using the other two insulated jugs followed the same pattern.

These experiments indicate that hot foods and certain perishable foods can be transported by insulated thermos jugs to or with groups who will be out of contact with field kitchens for periods of time up to eight hours. A field trial of these jugs is necessary. Several minor alterations, involving shape, fit of lid, and spigot arrangement, would make these jugs more efficient and allow for better stowage in Armored Vehicles.
The page contains a table with columns and rows of data. The table headers include rows for different measurements and columns for various time intervals. The data appears to be related to temperature readings or some form of scientific experiment. The text at the top of the page indicates that these are results from a calorimeter test.

The table includes columns for different intervals of time (T1, T2, etc.) and rows for different conditions or measurements (P, O, I, etc.). The values in the table are numerical, likely representing temperature readings or other experimental data.

Additionally, there are notes at the bottom of the page that mention "All temperatures are in °F." and "Rate of Cooling of Calories in Room at 70°F." These notes suggest that the data is used to calculate cooling rates or related properties in a controlled environment.

The table is labeled as "Table I," which implies it is part of a larger study or research project.

Overall, the page provides detailed scientific data in a structured table format, suitable for analysis or further investigation in a scientific context.
Cooling Curves of Oatmeal Gruel

Outside Temperature -30°F

Key
- Middle of 18.2 Qt. Jug
- Surface of 18.2 Qt. Jug
- Middle of 1.7 Qt. Jug
- Surface of 1.7 Qt. Jug (Fig. 1)
Cooling Curves of Water in Thermos Jugs

Key
- 18.2 qt. insulated jug
- 17 qt. vacuum jug
- 3.5 & 7.6 qt. insulated jug

Outside temperature -30°F

(Fig. 2)
Cooling Curves of Beef Stew

Field Ration

Outside Temperature -30°F

Key
- 18.2 Qt. Insulated Jug - First run
- 18.2 Qt. Insulated Jug - Second run
* 1.7 Qt. Vacuum Jug (Fig. 3)