Cooler Research: An Evaluation of a Damp Towel Cooler Cover.

Introduction:

Coolers or “ice chests” are commonly used to store food and beverages when electricity is not available. Refrigerated storage helps prevent sickness due to foodborne microorganisms. The National Park Service “2016 Commercial Operating Requirement” states that commercial operators must keep “potentially hazardous” food at or below 45 °F (7.2 °C). (Ref. 1)

This fourth Cooler Research article evaluates the performance of a cooler containing frozen water bottles when covered with a wet towel.

Methods and Materials:

The experimental setup and protocol was described in a previous article (Ref. 2) and remains the same. Room temperature was continuously monitored and maintained at 107.2 °F (41.8 °C) with a standard deviation of 0.09 °F (0.05 °C) over a typical five day run.

24.0 kilograms of ice were used in each cooler which is 47% of the manufacturers stated capacity of 113 pounds. The bottle ice was formed in 12 two liter soft drink bottles, each filled with two liters water. Experiments were initiated by removing the ice from a freezer, loading it immediately into coolers and closing the coolers. Each cooler lid was held down using two NRS-9 tie-down straps around the lid and cooler.

The test cooler had the top and sides covered with a snug fitting bag made of sewn together Terrycloth towels. The bottom of the cooler was not covered. The bag was kept wet by periodically irrigating the towel at the top of the cooler. Excess water was recaptured and returned to the source reservoir at the bottom of the test chamber. A large de-humidifier was added to the test chamber in order to promote evaporation. Relative Humidity was monitored and held to 35% or less.

Results:

The results for each cooler are described below and the data presented in graphs. The temperature at the Bottom, Mid-Low and High sensors is plotted vs the hours since closing the cooler. There is an initial period (Phase1) of ~10 hours when the freezer temperature ice is warming up. The header of the graph identifies the vertical position of each sensor in the cooler: (High, Mid-Low, Bottom). A red dotted horizontal line shows the Park Service upper limits for Commercial Operators. A blue dotted horizontal line shows the freezing point of water. In the graphs and summary table, we included the data for Drained and Un-Drained Blocks and Vertical Bottles from our previous articles (Ref. 2, Ref. 3) for comparison.

Bottom: The results for the temperature at the Bottom are plotted in Fig 1.

Mid-Low: The results for the Mid-Low temperature are plotted in Fig 2.

High: The results for the High temperature are plotted in Fig 3.

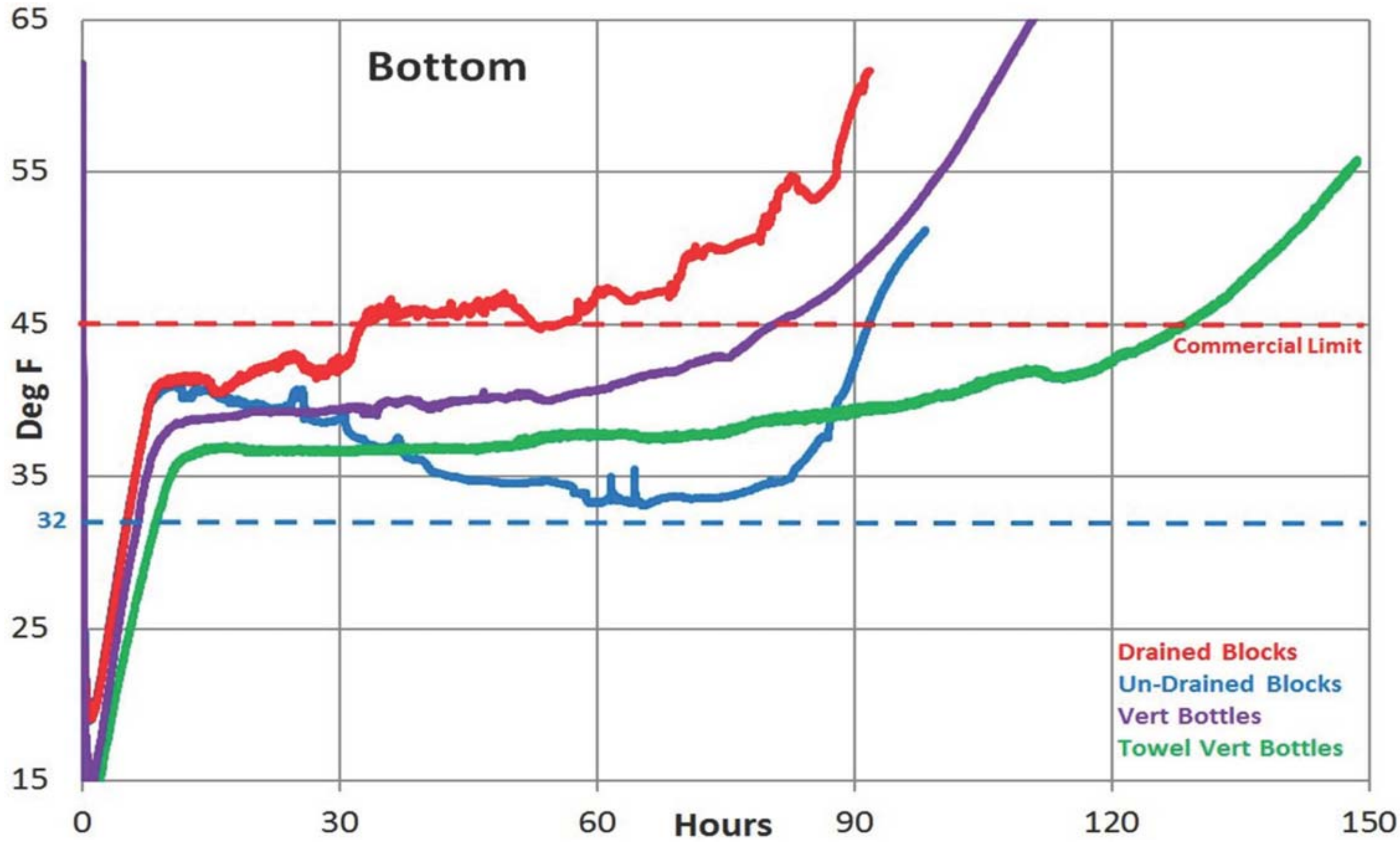

Fig 1.

The temperature stays below the Commercial Operators Limit of 45 °F for 128 hours for the Towel Vertical Bottles.

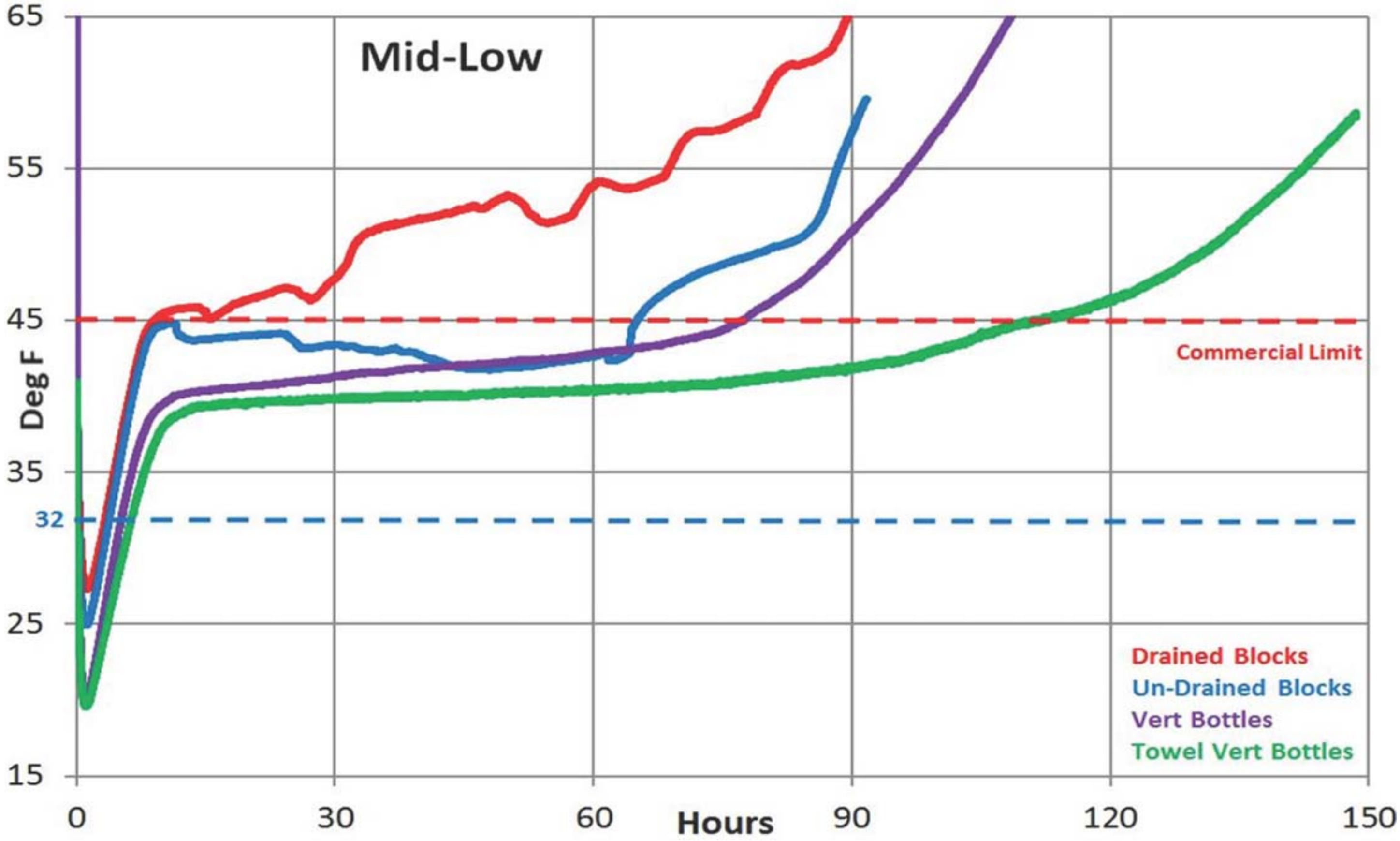

Fig 2.

The temperature stays below the Commercial Operators Limit of 45 °F for 111 hours for the Towel Vertical Bottles.

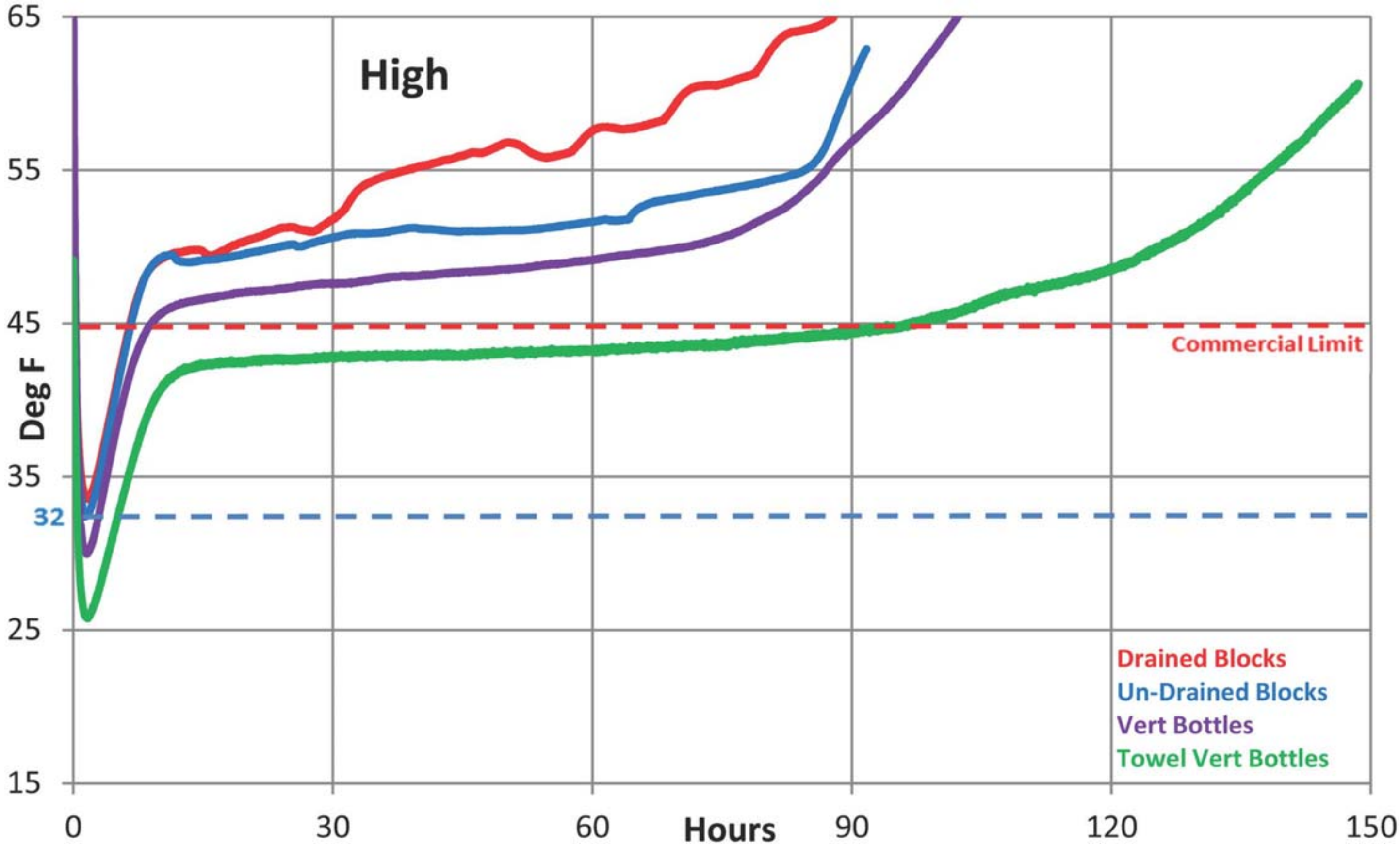

Fig 3.

The temperature stays below the Commercial Operators Limit of 45 °F for 96 hours for the Towel Vertical Bottles.

The Table below summarizes the results.

	Drained Blocks	Un-Drained Blocks	Vertical Bottles	Towel Vertical Bottles
Sensor Location	**Hours below Commercial Limit**	**Hours below Commercial Limit**	**Hours below Commercial Limit**	**Hours below Commercial Limit**
High	~7	~7	9	96
Mid-Low	9	65	77.3	111
Bottom	32.5	91.6	80.6	128

Discussion:

In order to discuss the mechanism and effects of using a wet towel to enhance the performance of a Cooler, we need to define a few terms.

When Coolers are exposed to high temperatures, energy is transferred from the high external temperature to the lower internal temperature of the Cooler. This transfer of energy is called Heat and is measured in calories. One calorie is the amount of energy transfer (Heat) required to raise the temperature of cubic centimeter of water by one degree Celsius. It takes 80 calories of Heat to melt one gram of ice. And it takes 540 calories to evaporate one gram of water at 100 °C and convert it to to one gram of water vapor.

Temperature is a measure of the average Kinetic Energy of the molecules of a body, such as the air surrounding a Cooler or the air inside. Since Temperature is an average, some of the molecules are more energetic than the average and some are less energetic.

When we place a wet towel around a Cooler, we are exposing water to the surrounding air. The more energetic molecules in the water will have sufficient energy to convert into water vapor. For each gram of water that evaporates, 540 calories of heat are removed from the towel and transferred into the air.

The drier the air, the more water vapor it can hold and the more rapidly water will evaporate. The more rapidly the water evaporates, the more heat that is transferred into the air and the less heat that is available to be transferred into the Cooler to melt the ice and increase the internal temperature.

In our testing, we were unable to get the Relative Humidity of our test chamber as low as that found in most of the Southwest United States. Were we able to accomplish that, our results would have shown even more improvement in cooling performance.

Conclusion:

The results of this study show that a wet towel draped over a cooler significantly enhances Cooler performance at all three test levels for the entire test run.

This concludes our initial investigations into various ice strategies. Subsequent work will focus on measuring the performance differences between various Cooler brands.

Acknowledgements:

The authors wish to thank Wrenchman, Inc. for providing facilities, equipment and support and Silka Werness for towel assembly and graphics assistance. Much of this work was inspired and guided by Dr. Rufus Lumry of the University of Minnesota Laboratory for BioPhysical Chemistry. Dr Lumry was one of the world's leading authorities on the physical properties of water

References:

1. 2016 Commercial Operators Requirements, Page 18, Section 2a.
2. LaCroix and Werness: Cooler Research: An evaluation of Drained versus Un-Drained coolers loaded with ice. The Journal of the Grand Canyon River Guides, Inc., Volume 31, Number 4, Winter 2018 - 2019, pages 6 - 8.
3. LaCroix and Werness: Cooler Research: An evaluation of Block Ice versus Bottle Ice. The Journal of the Grand Canyon River Guides, Inc., Volume 32, Number 2, 2019, pages 26 - 27.

Note: The authors can be contacted at CoolerResearch@gmail.com

Blakely LaCroix
President
Cooler Research Inc.

Peter Werness, Ph.D.
Vice President
Cooler Research Inc.