Cooler Research: An evaluation of Block ice vs. Cube ice.

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 45F (7.2C). (Ref.1).

This second Cooler Research article evaluates cube ice compared to block ice.

Methods and Materials

The experimental setup and protocol was described in a previous article (Ref 2.) and remains the same. Experiments were conducted at a room temperature of 107.2F.

24.0 kilograms of ice were used in each cooler, 47% of the manufacturers stated capacity of 113 pounds. The block ice was prepared as described in a previous publication (Ref 2.). The cube ice was purchased commercially and consisted of cubes approximately 1.25 inches tall by 1.1 inches in diameter.

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.

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. For both coolers there is an initial period (Phase1) of ~10 hours when the freezer temperature ice is warming up. The legend in the lower right 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 horizontal blue line shows the freezing point of water.

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

The temperature at the bottom sensor of the Drained Blocks cooler stays below the Commercial Operators Limit of 45 F for 32.5 hours. The temperature is below 45 F limit for 92 hours for the Un-Drained Blocks cooler and for 85 hours for Un-Drained Cubes.

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

The temperature at the Mid-Low sensor of the Drained Blocks cooler stays below the Commercial Operators Limit of 45 F for 9 hours. The temperature is below 45 F limit for 65 hours for the Un-Drained Blocks cooler and for 52 hours for Un-Drained Cubes.

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

The temperature at the High sensor of the Drained Blocks cooler stays below the Commercial Operators Limit of 45 F for ~7hours. The temperature is below 45 F limit for ~7 hours for the Un-Drained Blocks cooler and for 17 hours for Un-Drained Cubes.

Fig 1.

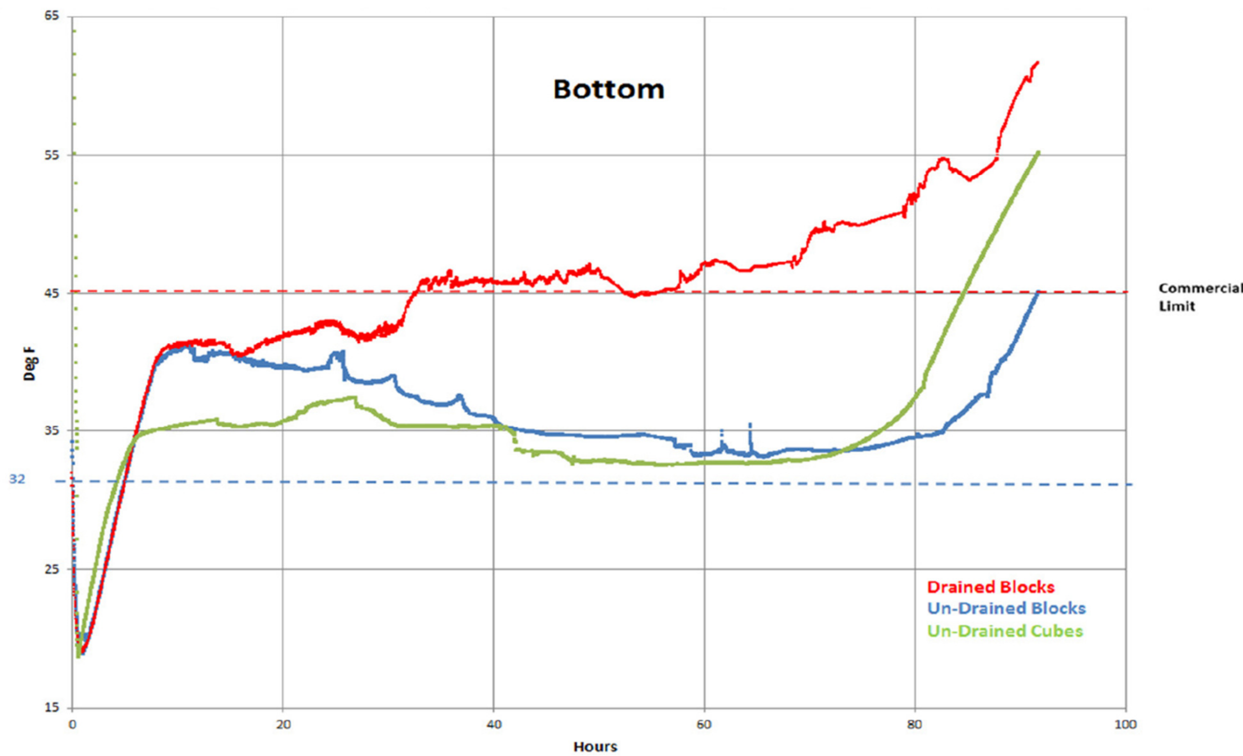


Fig 2.

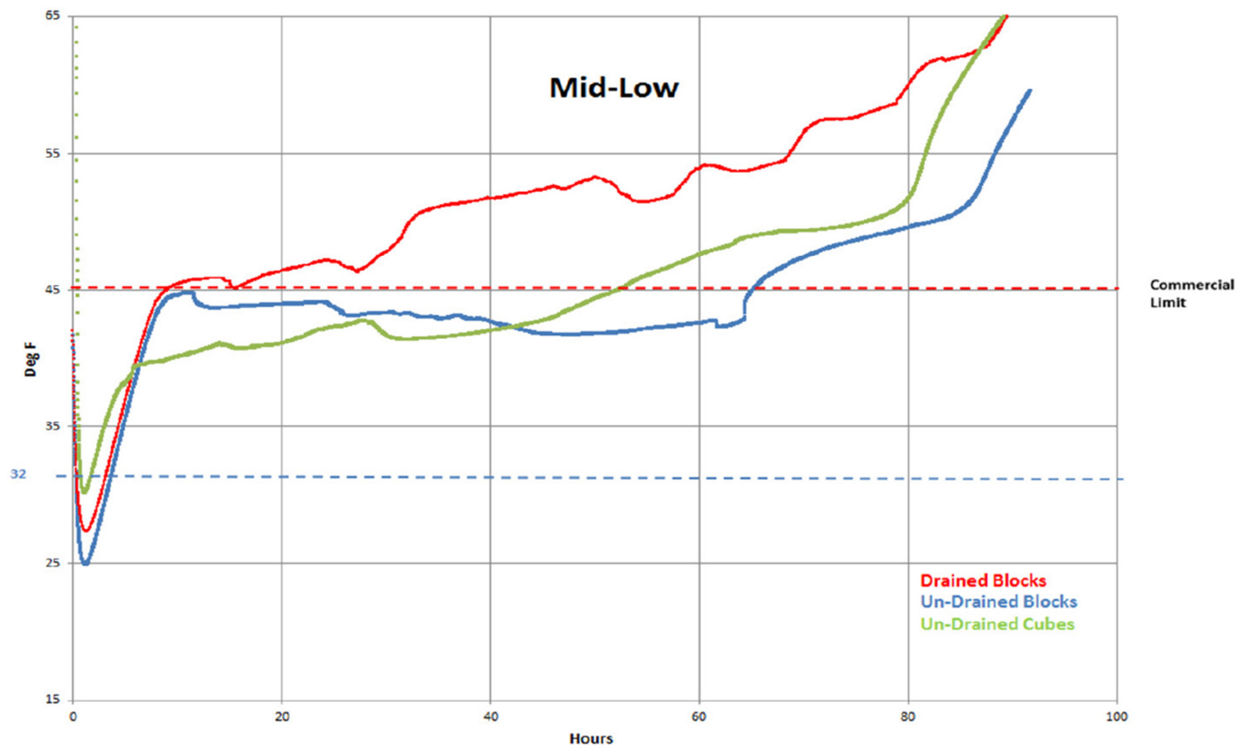
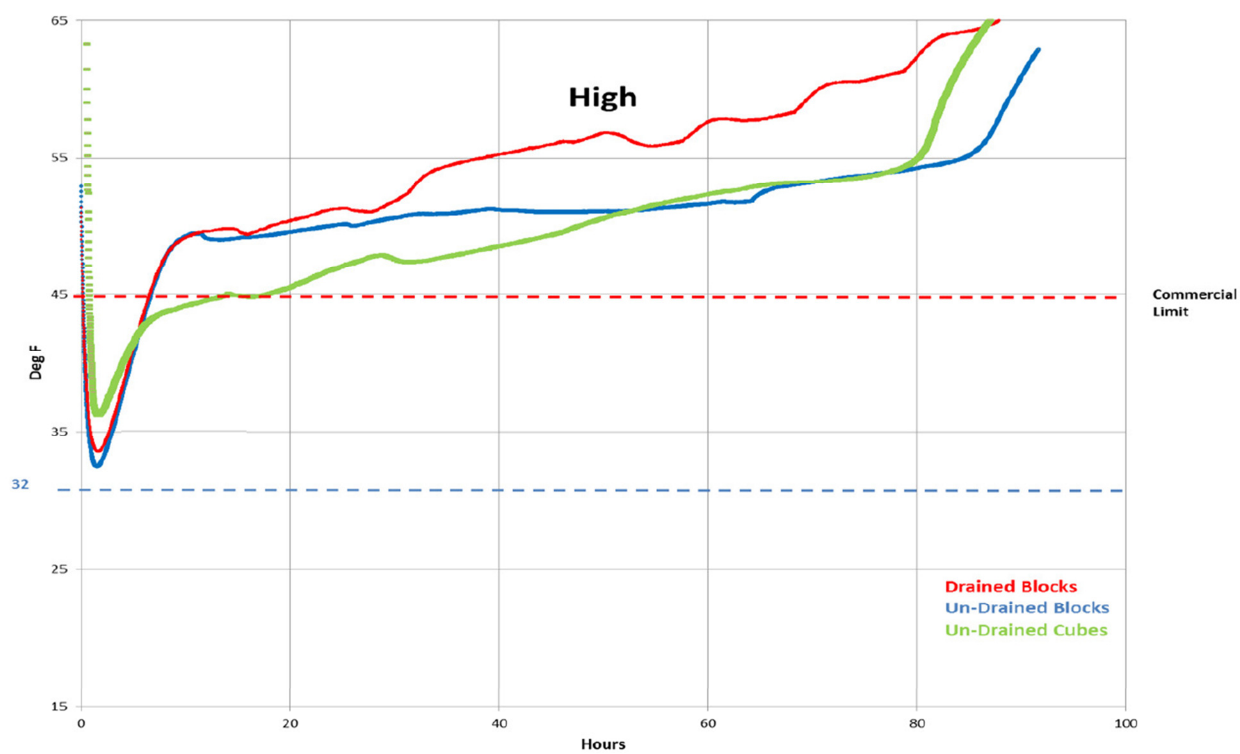

Mid-Low
Deg F
Hours
Commercial Limit
32
Drained Blocks
Un-Drained Blocks
Un-Drained Cubes
65
55
45
35
25
15
0
20
40
60
80
100

Fig 3.


High
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55
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15
0
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100

Discussion

The Table below summarizes the results.

	Drained Blocks	Un-Drained Blocks	Un-Drained Cubes
Sensor Location	**Hours below Commercial Limit**	**Hours below Commercial Limit**	**Hours below Commercial Limit**
High	~7	~7	17
Mid-Low	9	65	52
Bottom	32.5	92	85

It is the conversion of ice to water that is primarily responsible for the cooling effect. It takes 80 calories of heat energy to melt one gram of ice. In an ideal well stirred environment, the temperature of a water and ice mixture will remain constant at 32 degrees F until all of the ice has melted. Only then can the temperature of the water increase. It is the total amount of influx heat and the total mass of the ice that determines when this occurs. It is the mass (weight) of the ice and not its density that determines its efficacy.

With the same mass of ice in cubes and blocks, the difference in the results is due to secondary factors. The cubes, being smaller, have more complete contact with the lower sides of the cooler and more readily convert any inbound heat to meltwater. This is effect is most apparent in the Bottom Data. The cubes maintain a lower initial temperature than the blocks. This persists until enough meltwater has formed and the performance of the cubes and blocks converge. Temperature and longevity are tradeoffs. The colder initial temperature for the cubes results in quicker melt and shorter ice lifetime compared to blocks.

Conclusion

The results of this study show that Un-Drained Cubes provide lower cooler temperature than Un-Drained Blocks for the initial hours.

However, at the bottom of the cooler, the temperature with the Un-Drained Blocks stays below the Commercial limit seven hours longer than with the Un-Drained Cubes.

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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.

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