2016

Engineered Mushing Cooker

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Iditarod Class Cooker for Dog Mushing

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SRC EducationAlliance for Science, Engineering & Technology

INTRODUCTION:

The Iditarod is a dog sled race that spans almost 1,000 miles of Alaskan wilderness. The racers, also known as mushers, are allowed a 16 dog team at the start in Willow, AK. From there they take a little over a week to get from end to end facing temperatures of 60 below zero and elevation gains over 3,000 feet.

Iditarod Requirements:

1. One cooker capable of heating up at least 3 gallons of snowmelt at one time.
2. Must use HEET (methanol) as fuel.

Traditional Cookers:

Pros:

- Cheap
- Easy to build at home

Fig. 1: Traditional Cooker

Fig. 2: Traditional Burner

Cons:

- Inefficient (3-4+ bottles of HEET to melt 3 gallons of snow in 1 hour)
- Loses efficiency over time
- Awkward to pack (round rather than square)

Musher Requirements:

1. Pack well in sleds (preferably square design)
2. Lightweight, no excess materials
3. Durable
4. Perform at temperatures ranging from -60F to 60F
5. Easy to use
6. Minimal moving parts

COOKER DESIGN:

The current cooker design incorporates recycled and pre-engineered products.

Materials:

- Carbon felt – wicking material
- Stainless Steel – water pan and burn pan (2/3 size steam pans)
- Aluminum – stove pipe and burners bases

Fig. 3: 2016 Iditarod Cooker for Lisbet Norris

Fig. 4: Burner used in the 2016 Iditarod Cooker

TOOLS USED FOR MANUFACTURING:

- Lathe
- Mill
- Drill Press
- Spot Welder
- Hand drill
- Band saw

STANDARD TEST PROCEDURE:

- 8L water at tap temperature (~60F)
- 1 bottle of HEET (355mL) shared equally in burners

Methanol Combustion:

$2CH_3OH(l) + 3O_2 \rightarrow 2CO_2 + 4H_2O$

Energy Calculations:

Calculations for most recent cooker testing using numbers above.

$$Q_{water} = mc_p\Delta T = 8kg * 4.186\frac{kJ}{kg * K} * 78℃ = 2600kJ$$

$$Q_{methanol} = 20MJ * 792\frac{kg}{m^3} * 0.001\frac{m^3}{L} * 0.355L = 5.6MJ$$

$$Efficiency = \frac{Q_{water}}{Q_{methanol}} * 100\% = \frac{2600kJ}{5400kJ} * 100\% = 47\%$$

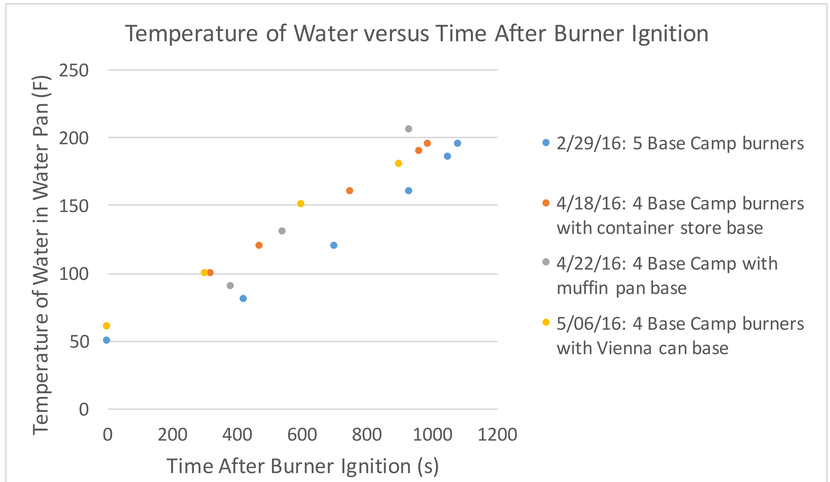


Fig. 5: 5 Base Camp Burners

Fig. 6: Base Camp Burner in Container Store Base

Fig. 7: Base Camp Burner in Muffin Pan Base

Fig. 8: Base Camp Burner with Vienna Sausage Can Base

TESTS ON MOUNT HOOD:

The graph below shows the changes in temperature of the water pan over the course of the test. Each peak is when all the snow melted to water and started warming up. All the troughs are when I added snow to the water pan to reach the maximum capacity of the pan. By the end of the test (all burners burnt out) the pan had 8.5L of snowmelt (2.25 gal) and the water temperature stabilized around 52F using 1 bottle of HEET.

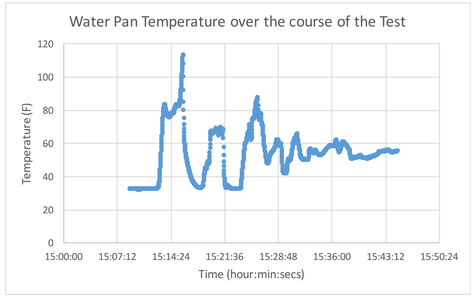
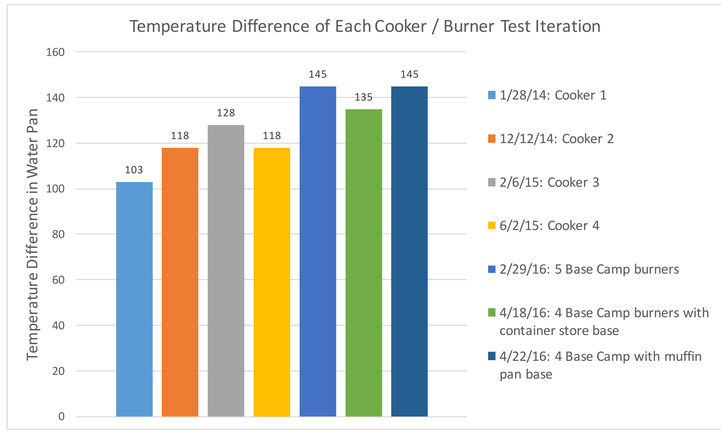


Fig. 9: Burner arrangement used during test on Mount Hood. Each burner held 100mL of HEET.

BURNER / STOVE ITERATION IMPROVEMENTS:



RESULTS FROM IDITAROD 2016:

- Carbon felt allowed for easier lighting.
- New handle design was more convenient.
- Used 2 bottles of HEET per use.
- Took 30 minutes to warm snow / cold water up to temperature.

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Resources:

Iditarod Trail Committee
Zen Stoves
MELT Team
Mike Chuning
Zdenek Zumr
Jim Wood's Cat Can Stove