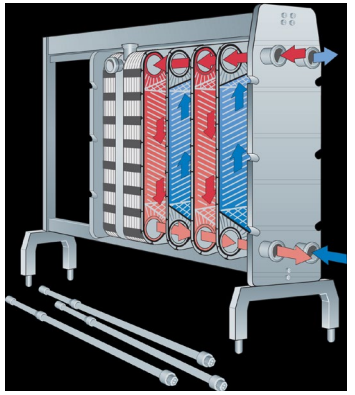

MILK COOLING CALCULATIONS

Because Math is Fun?

NYSAFP Annual Conference 2019

Chris Cherry

The Grade “A” Pasteurized Milk Ordinance, 2009 Revision ITEM 18r. states:
Raw milk for pasteurization shall be cooled to 10°C (50°F) or less within 4 hour or less, of the commencement of the first milking, and to 7°C (45°F) or less within two (2) hours after the completion of milking. Provided, that the blend temperature after the first milking and subsequent milkings does not exceed 10°C (50°F).

The 3-A Sanitary Standards for Farm Milk Cooling and Holding Tanks, Number 13-10 is a second standard that deals with cooling milk on dairy farms. Section E1.1 deals with cooling. This standard states:
Cool the product to 50°F (10°C) or less within 4 hours or less of the commencement of the first milking and to 40 F (4.4 C) or less within 2 hours after the completion of milking. Provided, that the blend temperature after the first milking and subsequent milkings does not exceed 50 °F (10 °C).

COOLING METHODS

- Bulk Tank. Can be thought of as floating down a lazy river
- Chiller to Storage or Trailer. Like floating down a river… but with rapids

COOLING LINGO YOU NEED TO KNOW

- BTU – British Thermal Unit – The amount of energy to Change one pound of water one degree F.
- Ton of Refrigeration – Ton(s) – The amount of energy to melt one ton of ice in a 24 Hours. 288,000 BTU/Day or 12,000 BTU/Hr.
- BTU/Hr – Term used to standardize the steady state capacity of a system… The Rate.
- Delta T – Change in Temperature
- *But what about HP?*

FLOW RATE: Part of the Puzzle

- This is the speed the car is going.

- Examples and Assumptions 2,000 Milking @ 90 Lbs/Cow.
  - 2,000 X 90 = 180,000 Lbs/ Day
  - 180,000 Lbs/Day / 24 Hrs = 7,500 Lbs/Hr
  - 180,000 Lbs/Day / 21 Hrs = 8,571 Lbs/Hr *Whoops forgot wash*
  - 180,000 Lbs/Day / 20 Hrs = 9,000 Lbs/Hr *Whoops forgot treated time*

  - *7,500/9,000 It is only a 16% Error*
  - *Same as asking our haulers to pickup 85,000 Lbs when they show up!*

FLOW RATE: Part of the Puzzle

- But wait… there is more
- If you average the entire milk over the 24HR period… you miss morning milking
- What about the “High Producing” Group (s)?
- Undersized Balance Tank?
- Suddenly 9,000 Lbs/Hr is really 10,800 Lbs/Hr for our Cooling System

- Well that is only… 7,500/10,800 = 30% off

DELTA T : How Big the Difference in Temperature

- This is how steep the hill the car is going up.
- The Water Pass is probably the most variable part of the equation.
- Where is the water coming from and what is the flow rate?
- What is the Temperature?
- I always use the warmest temperature at the lowest practical flow rate. This is not the time for optimism.
- 2:1 Ratio or more is desired.
- The Temperature never can match! 8F – 3F depending on design of the plate cooler.

DELTA T : How Big the Difference in Temperature

- Typical Calculation
  - 98F Milk (Yes I know… but it cools in the lines)

    55F Well Water

    + 8F Thermal Transfer Loss

    We can assume the milk is exiting at 63F (55+8)

    35 DETLA T (98-63)
  - This is the amount of Temperature Drop of the Milk in the First Part of the System
  - 35F x 10,800Lbs/Hr = 378,000 BTU/Hr or 31.5 Tons of Cooling

  - Water is a big deal and worth figuring out correctly!

DELTA T : Cooling Side

- Typical Calculation
  - 63F Milk From Previous Step

  - 38F Target Temperature

  25 DETLA T
  - This is the amount of Temperature Drop of the Milk in the Second Part of the System
  - 25F x 10,800Lbs/Hr = 262,500 BTU/Hr or ~22 Tons of Cooling

Horsepower Right?

- There is no correlation between tons of cooling and HP that is meaningful unless we are going to use them to haul the blocks of ice.
- General rules apply but most of it is based on system design and ambient temperatures.
- Working backup in divisible increments. i.e.
- BTU/Hr vary with Ambient Temperature and Temperature of the Coolant.