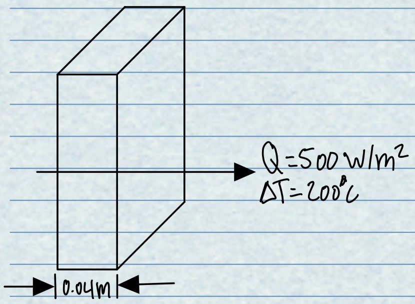
Problem 1-7

The heat flow Through a 4-cm Thick Insulation layer for a Temperature difference of 200°C across The Surface is 500 W/m². What is The Thermal Conducivity of The Insulating Material?



$\Delta T = 200°C$

$Q = 500\ W/m^2$

$L = 0.04m$

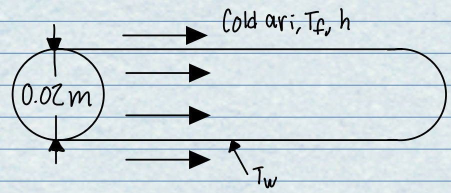
$q = k\dfrac{\Delta T}{L}$

$500\dfrac{W}{m^2} = k\left(\dfrac{200°C}{0.04m}\right)$

$\boxed{k = 0.1\dfrac{W}{m \cdot C}}$

Problem 1-16 Ch1: 7, 16, 25, 29

Cold air at 10°C flows over 2-cm OD Tube. The OutSide Surface of The Tube is maintained at 110°C. If The heat Transfer Coefficient between The outSide Surface of The Tube and The air is is 100 W/(m²·°C). determine the rate of heat flow to the air over 5-m length of The tube.



$OD - 2cm = 0.02m$

$L = 5m$

$h = 100\ W/(m^2 \cdot C)$

$T_f = 10°C$

$T_w = 110°C$

$Q = hA(T_w - T_f)$

$Q = 100(0.3142)(110-10)$

$\boxed{Q = 3141.59W}$

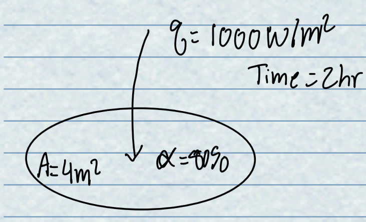
$A = 2\pi r l$

$A = 2\pi(.01)5$

$A = 0.3142m^2$

Problem 1-25

A radiation flux of 1000 W/m² is incident upon a Surface That absorbs 80% of The incident radiation. Calculate The amout of radiation energy absorbed by a 4m² area of The Surface over a Period of 2h.



$q_{abs} = \alpha q_{inc} A t$

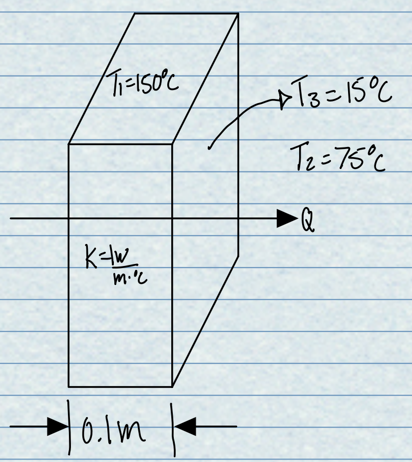
$q_{abs} = 0.8(1000\ W/m^2)(4m^2)\left(\dfrac{2hr}{1} \times \dfrac{60min}{1hr} \times \dfrac{60sec}{1min}\right)$

$q_{abs} = 23040000\ J$

$\boxed{q_{abs} = 23.04\ MJ}$

Problem 1-29

The inside surface of an insulation layer is maintained at 150°C and the outside surface dissipates heat by convection into air at 15°C. The insulation layer has a thickness of 10 cm (0.1m) and a thermal conductivity of 1W/(m·°C). What is the minimum value of the heat transfer coefficient at the outside surface, if the temperature at the outside surface should not exceed 75°C? Calculate the increase in its emissive power.



$$hA(T_2-T_3)=\frac{kA(T_1-T_2)}{L}$$

$$h(75°C-15°C)=\frac{1\frac{W}{m\cdot°C}(150°C-75°C)}{0.1m}$$

$$h(60°C)=750\frac{W}{m^2}$$

$$\boxed{h=12.5\frac{W}{m^2°C}}$$

As a group we found the project to be interesting at first. After discussing amongst each other we began questioning why something similar to this had not been created already. As we began doing research we found some similar products but they were not cooling cans in a span as short as 5 minutes. The products we were able to find were more similar to a portable refrigerator.

What ideas do you have in mind that you can try.

- Portability is a key feature/requirement for our product. Weight should be an important factor in design. Wheels are necessary for final design.
- Connectivity to some sort of solar/battery array for off grid use.
- Old school ice cream making techniques that utilize a salt/ice bath may be an option for initial design.
- Potentially use a gel type component that is cooled via a freezer and used to precool liquid.
- Refrigerant choice is a key component for working design.
- It's gotta look good.
- Affordability, value engineering.
- Can orientation for optimal cooling effect. (air density allows for better heat transfer)
- Design should account for both aluminum can and glass bottle applications.
- Design delivered temperature should be ≈ 41ºC.
- Design initial temperature assuming to be 75ºC.
- Compressor should be as small as possible and can be powered by both Grid power and dc batteries/solar
- Contact materials will need to meet proper heat transfer requirements at both the heat sink and heat exchanger locations.
- Design should work in harsh environmental conditions such as found at beach setting ie, direct sunlight, water, dirt.
- Design may need to have a boost mode and maintenance mode for cooling.

What question do you have?

- Glass vs. aluminum can requirements.
- Temp range requirements. For example what would the temperature of an unconditioned can/bottle be before cooling.
- Refrigerant tubing requirements.