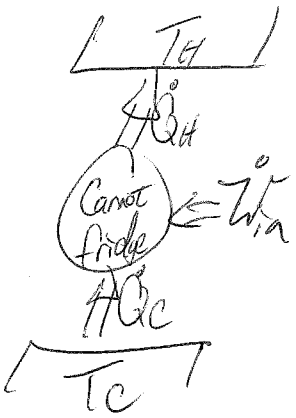
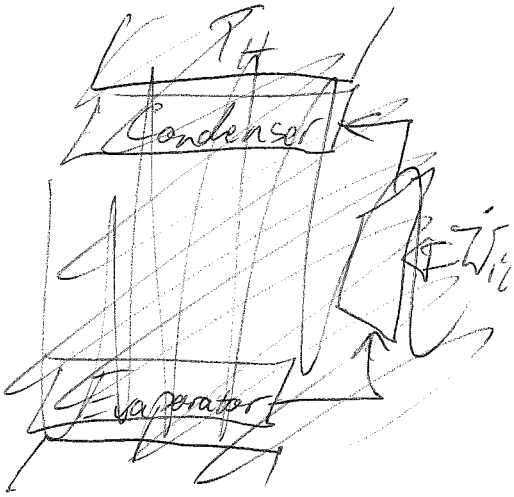
Heat Pumps

Back when we introduced the Carnot ~~R~~ Cycle for refrigeration we realized that we could do something useful with the heat rejected from the Condensor:

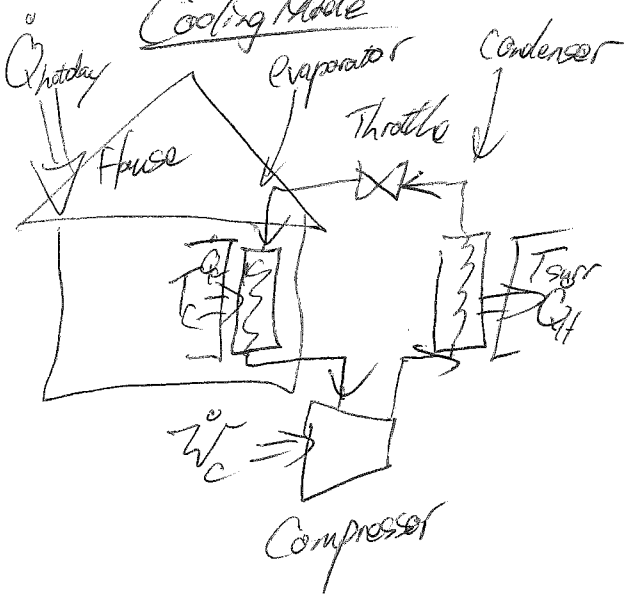


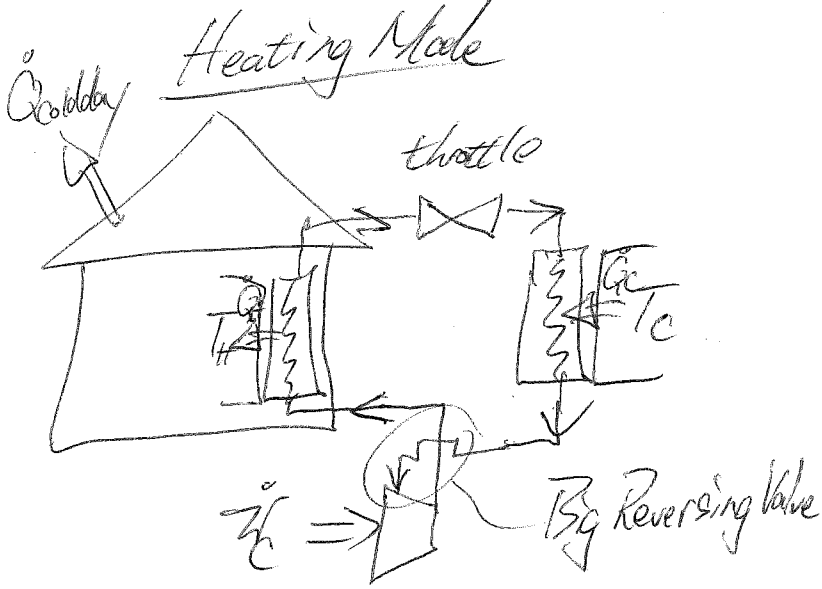
$$COP_R = \frac{\text{What you want}}{\text{What you payed}} = \frac{\dot{Q}_C}{\dot{W}_{in}}$$

$$COP_{HP} = \frac{\text{Want}}{\text{Payed}} = \frac{\dot{Q}_H}{\dot{W}_{in}}$$



The cycle is the same for both types of systems. Vapor Compression Refrigerators are commonly reversed to run as a heat pump. This is how residential heat pumps operate. While most houses have a natural gas fired furnace & a vapor compression Air Conditioner, the VCAC could do both!!!





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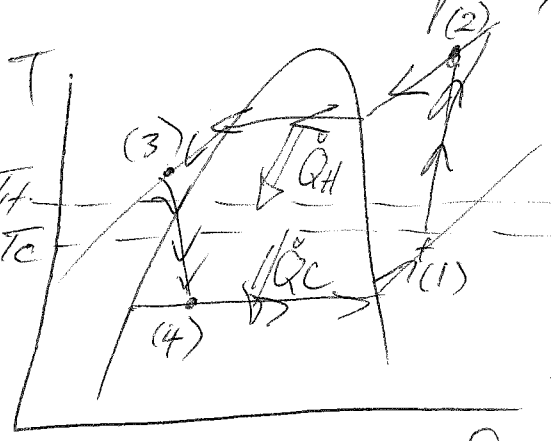
→ Best way to think about this: Refrigerating the outdoors, nobody cares if the winter gets slightly colder.

Example: Single family home requiring $\dot{Q}_{heat} = 90{,}000$ Btu/hr which is pretty typical for a single family home with $T_{out} = 5°C$, $T_{in} = 20°C$



I'll use the code I put together last time for the refrigeration system.

→ Change T_H, T_C, match smaller ΔT's so have each of the ΔTs of approach.

→ Change COP $= \frac{\dot{Q}_H}{\dot{W}_{net}}$ $COP_{Max} = \frac{T_H}{T_H - T_C}$

→ Comment out displacement & set $\dot{Q}_{cond} = \dot{Q}_{HLoad} = 90{,}000$ Btu/hr

→ Check 3 use T_C instead of T_H

$COP_{HP} = 5.016$ => this is amazing! "5 units of energy for every 1 unit I have to pay for!" Compared to a furnace where every 1 unit < 1 I get!!

→ Problems? => usually compressors run @ fixed displacement. $\dot{Q}_{cond}$ with T_C