Charlie Nitschelm

10/1/18

Thermal Systems HW #4

# Quantify and Compare Refrigeration Cycles

# Table of Values

|  |  |  |  |
| --- | --- | --- | --- |
| COP\_Summer | COP\_Winter | Mass\_Flow\_Summer (kg/s) | Mass\_Flow\_Winter (kg/s) |
| 4.82 | 10.5 | .030 | .025 |

|  |  |
| --- | --- |
| Compressor\_Power\_Summer (J/s) | Compressor\_Power\_Winter (J/s) |
| 1,037 | 475.4 |

## Description of Values

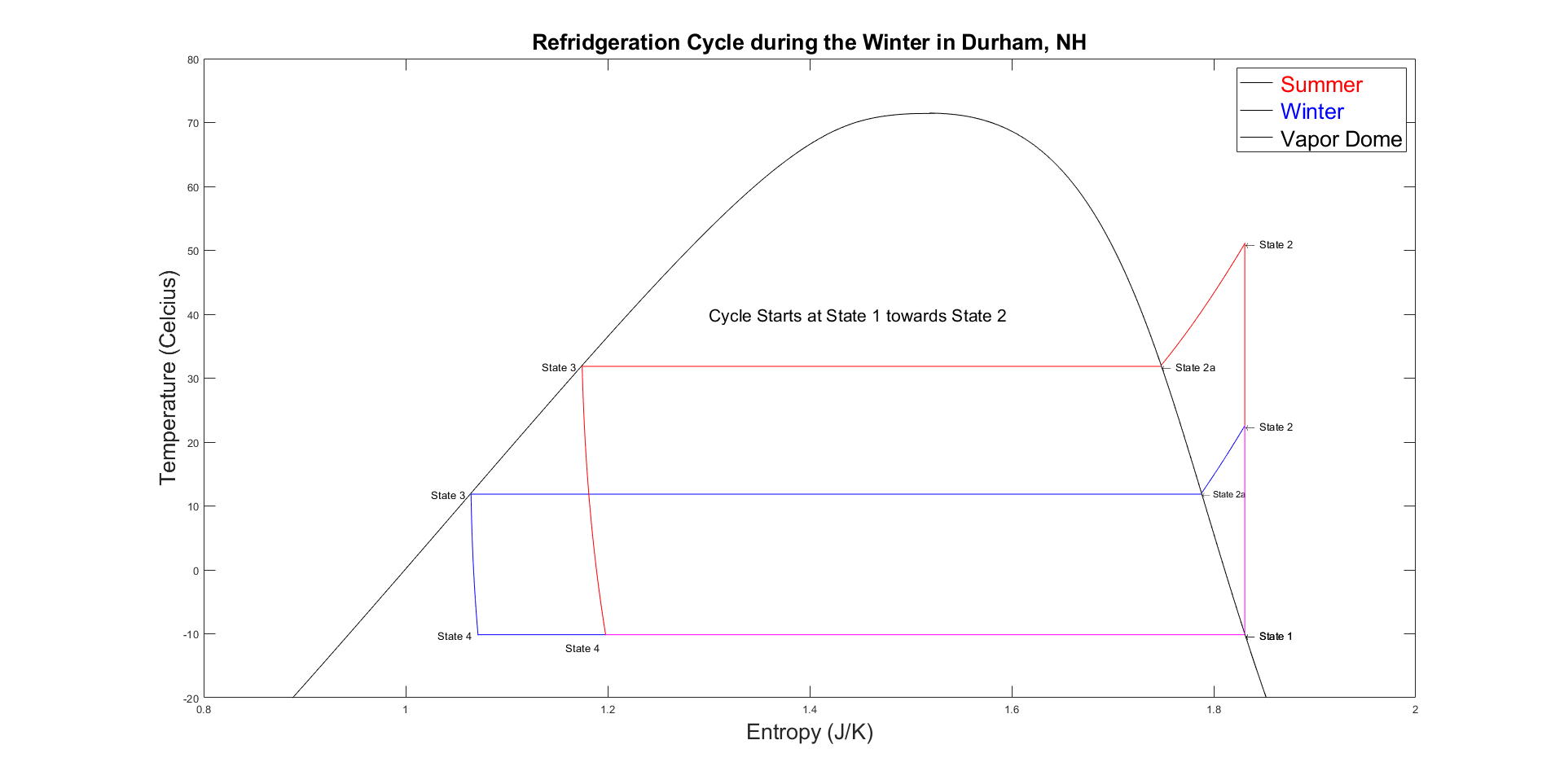
From the values calculated above, we are able to analyze the outcome of the refrigeration cycle during the Summer and Winter months in Durham, NH. The outside environment during the summer months was calculated to be 303 Kelvin, while the winter was 283 Kelvin. From this difference in outside temperature, it changed the overall refrigeration cycle, altering heavily the COP, Mass Flow Rate needed, and the compressor power. The data shows that the COP from the summer to the winter more than doubles when the outside temperature is closer to the temperature desired for cooling. By having a better COP, it is expected that the mass flow rate needed decreases to still maintain the same desired cooled temperature. This also alters the required power the compressor needs to experience, allowing the amount of J/s to decrease in the winter months due to less of a temperature difference from the outside environment. The graphs below detail the overall cycle change for the variation of outside temperatures Durham, NH could encounter during a whole year.  
  
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Figure 1- The Temperature vs. Entropy graph for two different refrigeration cycles during the Summer and Winter months in Durham, NH.

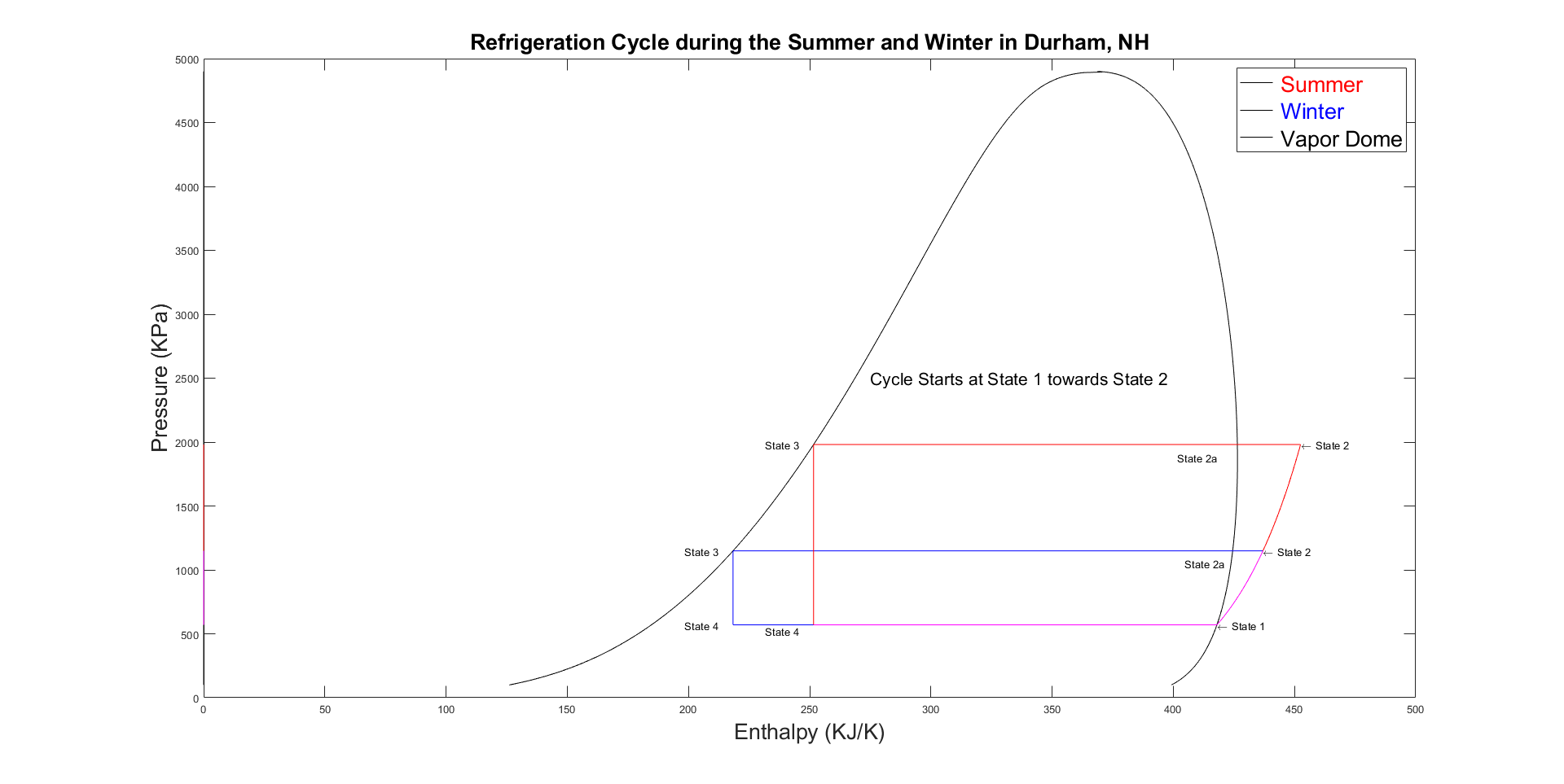


Figure 2- The Pressure vs. Enthalpy graph for two different refrigeration cycles during the Summer and Winter months in Durham, NH.

# MATLAB CODE

clear all; close all

clc;

%Problem Statement

% %A refrigerator in a meat warehouse located in Durham, NH has a cooling capacity of 5kW. It must maintain

% the cold space at -15?C throughout the entire year. Quantify and compare the flow rate required, compressor

% power, and coefficient of performance (COP) for the best and worst case scenarios, assuming an ideal, standard

% vapor compression refrigeration cycle with ?TL = 5?C and ?TH = 2?C. Plot the two scenarios on both a T-s

% and a P-h diagram (include the vapor dome). Label the state points and indicate the cycle direction. Note that

% ?TL and ?TH refer to the temperature differences between the cycle and environments needed for the heat transfer.

% Please submit a single pdf file with the solution. You need to include all the figures and the entire code in the file.

% The code should follow the solution.

%%%%%%%%%%%%%

% Constants for the Refridgeration Cycle for Durham, NH

%%%%%%%%%%%%%

T\_L = 5; % Kelvin - Amount of temperature away from the Evaporator Process

T\_H = 2; % Kevlin - Amount of temperature away from the second part of the Condensor Process

Cold\_Space = 273-15; % Kelvin - Temperature of Cold Space of Refridgerator

Hot\_Space\_Summer = 273 + 30; % Hottest recorded temperature of Durham NH in the Summer

Hot\_Space\_Winter = 273 + 10; % Hottest recorded temperature of Durham NH in the Winter

T\_Outside = linspace(250,Hot\_Space\_Summer,1000); % Kelvin - Record high and low temperatures in Durham that the outside temperature would reach, 1000 Length Array

%%%%%%%%%%%%%

% Location 1 - Between Evaporator and Compressor

%%%%%%%%%%%%%

% Finding all values of the fluid at location 1

Q\_1 = 1; % Saturated Vapor

T\_1 = Cold\_Space + T\_L; % Temperature from 4 to 1

P\_1 = CoolProp.PropsSI('P', 'T', T\_1, 'Q', Q\_1, 'R410a');

H\_1 = CoolProp.PropsSI('H', 'T', T\_1, 'Q', Q\_1, 'R410a');

U\_1 = CoolProp.PropsSI('U', 'T', T\_1, 'Q', Q\_1, 'R410a');

S\_1 = CoolProp.PropsSI('S', 'T', T\_1, 'Q', Q\_1, 'R410a');

%%%%%%%%%%%%%

% Location 3 - Between Condensor and Expansion Valve - Saturated Liquid

%%%%%%%%%%%%%

% Finding all values of the fluid at location 3

Q\_3 = 0; % Saturated Liquid

T\_3\_Summer = Hot\_Space\_Summer + T\_H; % Temperature from 4 to 1

P\_3\_Summer = CoolProp.PropsSI('P', 'T', T\_3\_Summer, 'Q', Q\_3, 'R410a');

H\_3\_Summer = CoolProp.PropsSI('H', 'T', T\_3\_Summer, 'Q', Q\_3, 'R410a');

U\_3\_Summer = CoolProp.PropsSI('U', 'T', T\_3\_Summer, 'Q', Q\_3, 'R410a');

S\_3\_Summer = CoolProp.PropsSI('S', 'T', T\_3\_Summer, 'Q', Q\_3, 'R410a');

T\_3\_Winter = Hot\_Space\_Winter + T\_H; % Temperature from 4 to 1

P\_3\_Winter = CoolProp.PropsSI('P', 'T', T\_3\_Winter, 'Q', Q\_3, 'R410a');

H\_3\_Winter = CoolProp.PropsSI('H', 'T', T\_3\_Winter, 'Q', Q\_3, 'R410a');

U\_3\_Winter = CoolProp.PropsSI('U', 'T', T\_3\_Winter, 'Q', Q\_3, 'R410a');

S\_3\_Winter = CoolProp.PropsSI('S', 'T', T\_3\_Winter, 'Q', Q\_3, 'R410a');

%%%%%%%%%%%%%

% Location 2 - Between Condensor and Expansion Valve Super-Heated Vapor

%%%%%%%%%%%%%

% Finding all values of the fluid at location 2

S\_2\_Summer = S\_1; % Constant Entropy

P\_2\_Summer = P\_3\_Summer; % Constant Pressure Isobar

T\_2\_Summer = CoolProp.PropsSI('T', 'P', P\_2\_Summer, 'S', S\_2\_Summer, 'R410a');

H\_2\_Summer = CoolProp.PropsSI('H', 'P', P\_2\_Summer, 'S', S\_2\_Summer, 'R410a');

U\_2\_Summer = CoolProp.PropsSI('U', 'P', P\_2\_Summer, 'S', S\_2\_Summer, 'R410a');

P\_2\_Winter = P\_3\_Winter; % Constant Pressure Isobar

S\_2\_Winter = S\_1; % Constant Entropy

T\_2\_Winter = CoolProp.PropsSI('T', 'P', P\_2\_Winter, 'S', S\_2\_Winter, 'R410a');

H\_2\_Winter = CoolProp.PropsSI('H', 'P', P\_2\_Winter, 'S', S\_2\_Winter, 'R410a');

U\_2\_Winter = CoolProp.PropsSI('U', 'P', P\_2\_Winter, 'S', S\_2\_Winter, 'R410a');

%%%%%%%%%%%%%

% Location 2a - On Vapor Dome During the process 2 to 3 in condensor

%%%%%%%%%%%%%

% Finding all values of the fluid at location 2a

Q\_2a=1; % On Vapor Dome as Saturdated Vapor

P\_2a\_Summer = P\_2\_Summer; % Isobar = Constant Pressure

T\_2a\_Summer = T\_3\_Summer; % Constant Temperature from T3

S\_2a\_Summer = CoolProp.PropsSI('S', 'P', P\_2a\_Summer, 'Q', Q\_2a, 'R410a');

H\_2a\_Summer = CoolProp.PropsSI('H', 'P', P\_2a\_Summer, 'Q', Q\_2a, 'R410a');

U\_2a\_Summer = CoolProp.PropsSI('U', 'P', P\_2a\_Summer, 'Q', Q\_2a, 'R410a');

P\_2a\_Winter = P\_2\_Winter; % Isobar = Constant Pressure

T\_2a\_Winter = T\_3\_Winter; % Constant Temperature from T3

S\_2a\_Winter = CoolProp.PropsSI('S', 'P', P\_2a\_Winter, 'Q', Q\_2a, 'R410a');

H\_2a\_Winter = CoolProp.PropsSI('H', 'P', P\_2a\_Winter, 'Q', Q\_2a, 'R410a');

U\_2a\_Winter = CoolProp.PropsSI('U', 'P', P\_2a\_Winter, 'Q', Q\_2a, 'R410a');

%%%%%%%%%%%%%

% Location 4 - Mixture between the expansion valve and evaporator

%%%%%%%%%%%%%

% Finding all values of the fluid at location 4

T\_4 = T\_1; % Constant Temperature from 4 to 1 Process

H\_4\_Summer = H\_3\_Summer; % Expansion Valve is ~ constant enthalpy process

P\_4\_Summer = P\_1; % Isobaric Process

U\_4\_Summer = CoolProp.PropsSI('U', 'P', P\_4\_Summer, 'H', H\_4\_Summer, 'R410a');

S\_4\_Summer = CoolProp.PropsSI('S', 'P', P\_4\_Summer, 'H', H\_4\_Summer, 'R410a');

H\_4\_Winter = H\_3\_Winter; % Expansion Valve is ~ constant enthalpy process

P\_4\_Winter = P\_1; % Isobaric Process

U\_4\_Winter = CoolProp.PropsSI('U', 'P', P\_4\_Winter, 'H', H\_4\_Winter, 'R410a');

S\_4\_Winter = CoolProp.PropsSI('S', 'P', P\_4\_Winter, 'H', H\_4\_Winter, 'R410a');

%%%%%%%%%%%%%

% Calculations of the Vapor Dome for the Refridgeration Cycle

% Will be plotted as a T-s and P-h Diagram

% Two curves will be plotted for each graph, one for the Saturated Liquid and one for Saturdated Vapor Sections

%%%%%%%%%%%%%

% Constant Variables and Pressure Array to Calculate Graph Values

Q\_SL = 0; % Saturated Liquid

Q\_SV = 1; % Saturated Vapor

P\_SL\_SV = linspace(100000,4900000,1000); % Pressures for the Saturated Liquid Curve

T\_SL = zeros(length(P\_SL\_SV));

S\_SL = zeros(length(P\_SL\_SV));

H\_SL = zeros(length(P\_SL\_SV));

T\_SV = zeros(length(P\_SL\_SV));

S\_SV = zeros(length(P\_SL\_SV));

H\_SV = zeros(length(P\_SL\_SV));

% Looping 1000 times to provide values for the Vapor Dome Curves for T, s and h. P array will be graphed with them

for index=1:1000

T\_SL(index) = CoolProp.PropsSI('T', 'P', P\_SL\_SV(index), 'Q', Q\_SL, 'R410a') -273;

S\_SL(index) = CoolProp.PropsSI('S', 'P', P\_SL\_SV(index), 'Q', Q\_SL, 'R410a');

H\_SL(index) = CoolProp.PropsSI('H', 'P', P\_SL\_SV(index), 'Q', Q\_SL, 'R410a');

T\_SV(index) = CoolProp.PropsSI('T', 'P', P\_SL\_SV(index), 'Q', Q\_SV, 'R410a') -273;

S\_SV(index) = CoolProp.PropsSI('S', 'P', P\_SL\_SV(index), 'Q', Q\_SV, 'R410a');

H\_SV(index) = CoolProp.PropsSI('H', 'P', P\_SL\_SV(index), 'Q', Q\_SV, 'R410a');

end

%%%%%%%%%%%%%

% Calculations of Every Point during the Refridgeration Cycle

%%%%%%%%%%%%%

% Compressor Points - Points 1 to 2 - Constant Entropy

S\_Compressor = S\_1; % Constant Entropy Process

P\_Compressor\_Summer = linspace(P\_1,P\_2\_Summer,1000);

P\_Compressor\_Winter = linspace(P\_1,P\_2\_Winter,1000);

T\_Compressor\_Summer = zeros(length(P\_Compressor\_Summer));

T\_Compressor\_Winter = zeros(length(P\_Compressor\_Summer));

S\_Compressor\_Summer = zeros(length(P\_Compressor\_Summer));

S\_Compressor\_Winter = zeros(length(P\_Compressor\_Summer));

H\_Compressor\_Summer = zeros(length(P\_Compressor\_Summer));

H\_Compressor\_Winter = zeros(length(P\_Compressor\_Summer));

for index = 1:1000

T\_Compressor\_Summer(index) = CoolProp.PropsSI('T', 'P', P\_Compressor\_Summer(index), 'S', S\_Compressor, 'R410a') - 273;

T\_Compressor\_Winter(index) = CoolProp.PropsSI('T', 'P', P\_Compressor\_Winter(index), 'S', S\_Compressor, 'R410a') - 273;

S\_Compressor\_Summer(index) = CoolProp.PropsSI('S', 'P', P\_Compressor\_Summer(index), 'S', S\_Compressor, 'R410a');

S\_Compressor\_Winter(index) = CoolProp.PropsSI('S', 'P', P\_Compressor\_Winter(index), 'S', S\_Compressor, 'R410a');

H\_Compressor\_Summer(index) = CoolProp.PropsSI('H', 'P', P\_Compressor\_Summer(index), 'S', S\_Compressor, 'R410a');

H\_Compressor\_Winter(index) = CoolProp.PropsSI('H', 'P', P\_Compressor\_Winter(index), 'S', S\_Compressor, 'R410a');

end

% Condensor - Points 2 to 2a - Constant Pressure

P\_Condensor\_Summer = P\_2\_Summer; % Constant Pressure Process

P\_Condensor\_Winter = P\_2\_Winter; % Constant Pressure Process

T\_Condensor\_Summer = linspace(T\_2\_Summer,T\_2a\_Summer+.25,1000); % Added constant .5 so it does not go to the mixture

T\_Condensor\_Winter = linspace(T\_2\_Winter,T\_2a\_Winter+.25,1000); % Added constant .5 so it does not go to the mixture

S\_Condensor\_Summer = zeros(length(P\_Condensor\_Summer));

S\_Condensor\_Winter = zeros(length(P\_Condensor\_Summer));

H\_Condensor\_Summer = zeros(length(P\_Condensor\_Summer));

H\_Condensor\_Winter = zeros(length(P\_Condensor\_Summer));

for index = 1:1000

S\_Condensor\_Summer(index) = CoolProp.PropsSI('S', 'T', T\_Condensor\_Summer(index), 'P', P\_Condensor\_Summer, 'R410a');

S\_Condensor\_Winter(index) = CoolProp.PropsSI('S', 'T', T\_Condensor\_Winter(index), 'P', P\_Condensor\_Winter, 'R410a');

H\_Condensor\_Summer(index) = CoolProp.PropsSI('H', 'T', T\_Condensor\_Summer(index), 'P', P\_Condensor\_Summer, 'R410a');

H\_Condensor\_Winter(index) = CoolProp.PropsSI('H', 'T', T\_Condensor\_Winter(index), 'P', P\_Condensor\_Winter, 'R410a');

end

% Condensor - Points 2a to 3 - Constant Pressure - Straight Line inside Vapor Dome

T\_Condensora\_Summer = [T\_2a\_Summer,T\_3\_Summer]; % Constant Temperature

T\_Condensora\_Winter = [T\_2a\_Winter,T\_3\_Winter]; % Constant Temperature

P\_Condensora\_Summer = [P\_2a\_Summer,P\_3\_Summer];

P\_Condensora\_Winter = [P\_2a\_Winter,P\_3\_Winter];

S\_Condensora\_Summer = [S\_2a\_Summer,S\_3\_Summer];

S\_Condensora\_Winter = [S\_2a\_Winter,S\_3\_Winter];

H\_Condensora\_Summer = [H\_2a\_Summer,H\_3\_Summer];

H\_Condensora\_Winter = [H\_2a\_Winter,H\_3\_Winter];

% Expansion Valve - Points 3 to 4 - Constant Enthalpy

H\_Valve\_Summer = H\_3\_Summer; % Constant Enthlpy Process

H\_Valve\_Winter = H\_3\_Winter; % Constant Enthlpy Process

P\_Valve\_Summer = linspace(P\_3\_Summer,P\_4\_Summer,1000); % Added constant .5 so it does not go to the mixture

P\_Valve\_Winter = linspace(P\_3\_Winter,P\_4\_Winter,1000); % Added constant .5 so it does not go to the mixture

S\_Valve\_Summer = zeros(length(P\_Valve\_Summer));

S\_Valve\_Winter = zeros(length(P\_Valve\_Summer));

T\_Valve\_Summer = zeros(length(P\_Valve\_Summer));

T\_Valve\_Winter = zeros(length(P\_Valve\_Summer));

for index = 1:1000

S\_Valve\_Summer(index) = CoolProp.PropsSI('S', 'H', H\_Valve\_Summer, 'P', P\_Valve\_Summer(index), 'R410a');

S\_Valve\_Winter(index) = CoolProp.PropsSI('S', 'H', H\_Valve\_Winter, 'P', P\_Valve\_Winter(index), 'R410a');

T\_Valve\_Summer(index) = CoolProp.PropsSI('T', 'H', H\_Valve\_Summer, 'P', P\_Valve\_Summer(index), 'R410a');

T\_Valve\_Winter(index) = CoolProp.PropsSI('T', 'H', H\_Valve\_Winter, 'P', P\_Valve\_Winter(index), 'R410a');

end

% Evaporator - Points 4 to 1 - Constant Temperature - Straight Line inside Vapor Dome

T\_Evaporator\_Summer = [T\_4,T\_1]; % Constant Temperature

T\_Evaporator\_Winter = [T\_4,T\_1]; % Constant Temperature

P\_Evaporator\_Summer = [P\_4\_Summer,P\_1];

P\_Evaporator\_Winter = [P\_4\_Winter,P\_1];

S\_Evaporator\_Summer = [S\_4\_Summer,S\_1];

S\_Evaporator\_Winter = [S\_4\_Winter,S\_1];

H\_Evaporator\_Summer = [H\_4\_Summer,H\_1];

H\_Evaporator\_Winter = [H\_4\_Winter,H\_1];

%%%%%%%%%%%%%

% Graphing the T-s and P-h Graphs with Vapor Dome and Labels

%%%%%%%%%%%%%

% T-s Graph for the Summer

figure(1)

% Vapor Dome

plot(S\_SL/1000,T\_SL,'k',S\_SV/1000,T\_SV,'k')

hold on

% Processes

% Winter

plot(S\_Compressor\_Winter/1000,T\_Compressor\_Winter,'b',S\_Condensor\_Winter/1000, T\_Condensor\_Winter-273.15,'b',S\_Condensora\_Winter/1000, T\_Condensora\_Winter-273.15,'b',S\_Valve\_Winter/1000,T\_Valve\_Winter-273.15,'b',S\_Evaporator\_Winter/1000, T\_Evaporator\_Winter-273.15,'b')

text(S\_1/1000,T\_1-273.15, '\leftarrow State 1')

text(S\_2\_Winter/1000,T\_2\_Winter-273.15, '\leftarrow State 2')

text(S\_2a\_Winter/1000,T\_2a\_Winter-273.15, '\leftarrow State 2a','FontSize', 8)

text(S\_3\_Winter/1000-.04,T\_3\_Winter-273.15, 'State 3')

text(S\_4\_Winter/1000-.04,T\_4-273.15, 'State 4')

% Summer

plot(S\_Compressor\_Summer/1000,T\_Compressor\_Summer,'r',S\_Condensor\_Summer/1000, T\_Condensor\_Summer-273.15,'r',S\_Condensora\_Summer/1000, T\_Condensora\_Summer-273.15,'r',S\_Valve\_Summer/1000,T\_Valve\_Summer-273.15,'r',S\_Evaporator\_Summer/1000, T\_Evaporator\_Summer-273.15,'m')

plot(S\_Compressor\_Winter/1000,T\_Compressor\_Winter,'m') % plotting winter 1 to 2 for color correction

text(S\_1/1000,T\_1-273.15, '\leftarrow State 1')

text(S\_2\_Summer/1000,T\_2\_Summer-273.15, '\leftarrow State 2')

text(S\_2a\_Summer/1000,T\_2a\_Summer-273.15, '\leftarrow State 2a')

text(S\_3\_Summer/1000-.04,T\_3\_Summer-273.15, 'State 3')

text(S\_4\_Summer/1000-.04,T\_4-273.15-2, 'State 4')

text(1.3,40,'Cycle Starts at State 1 towards State 2','FontSize',16)

title('Refrigeration Cycle during the Summer in Durham, NH')

xlabel('Entropy (KJ/K)')

ylabel('Temperature (Celcius)')

xlim([.8 2])

ylim([-20 80])

hold off

% Syntax

title('Refridgeration Cycle during the Winter in Durham, NH','FontSize',20)

xlabel('Entropy (J/K)','FontSize',20)

ylabel('Temperature (Celcius)','FontSize',20)

lgd = legend('\color{red} Summer','\color{blue} Winter','\color{black} Vapor Dome');

lgd.FontSize = 20;

xlim([.8 2])

ylim([-20 80])

hold off

% P-h Graph for the Summer

figure(2)

% Vapor Dome

plot(H\_SL/1000,P\_SL\_SV/1000,'k',H\_SV/1000,P\_SL\_SV/1000,'k')

hold on

% Processes

%Winter

P\_Condensor\_Winter = [P\_2\_Winter,P\_2a\_Winter];

H\_Condensor\_Winter = [H\_2\_Winter,H\_2a\_Winter];

P\_Valve\_Winter = [P\_3\_Winter,P\_4\_Winter];

H\_Valve\_Winter = [H\_3\_Winter,H\_4\_Winter];

plot(H\_Compressor\_Winter/1000,P\_Compressor\_Winter/1000,'b',H\_Condensor\_Winter/1000, P\_Condensor\_Winter/1000,'b',H\_Condensora\_Winter/1000, P\_Condensora\_Winter/1000,'b',H\_Valve\_Winter/1000,P\_Valve\_Winter/1000,'b',H\_Evaporator\_Winter/1000, P\_Evaporator\_Winter/1000,'b')

text(H\_1/1000,P\_1/1000, '\leftarrow State 1')

text(H\_2\_Winter/1000,P\_2\_Winter/1000, '\leftarrow State 2')

text(H\_2a\_Winter/1000-20,P\_2a\_Winter/1000-100, 'State 2a')

text(H\_3\_Winter/1000-20,P\_3\_Winter/1000, 'State 3')

text(H\_4\_Winter/1000-20,P\_4\_Winter/1000, 'State 4')

% Summer

P\_Condensor\_Summer = [P\_2\_Summer,P\_2a\_Summer];

H\_Condensor\_Summer = [H\_2\_Summer,H\_2a\_Summer];

P\_Valve\_Summer = [P\_3\_Summer,P\_4\_Summer];

H\_Valve\_Summer = [H\_3\_Summer,H\_4\_Summer];

plot(H\_Compressor\_Summer/1000,P\_Compressor\_Summer/1000,'r',H\_Condensor\_Summer/1000, P\_Condensor\_Summer/1000,'r',H\_Condensora\_Summer/1000, P\_Condensora\_Summer/1000,'r',H\_Valve\_Summer/1000,P\_Valve\_Summer/1000,'r',H\_Evaporator\_Summer/1000, P\_Evaporator\_Summer/1000,'m')

plot(H\_Compressor\_Winter/1000,P\_Compressor\_Winter/1000,'m') % plotting winter 1 to 2 for color correction

text(H\_2\_Summer/1000,P\_2\_Summer/1000, '\leftarrow State 2')

text(H\_2a\_Summer/1000-25,P\_2a\_Summer/1000-100, 'State 2a')

text(H\_3\_Summer/1000-20,P\_3\_Summer/1000, 'State 3')

text(H\_4\_Summer/1000-20,P\_4\_Summer/1000-50, 'State 4')

text(275,2500, 'Cycle Starts at State 1 towards State 2','FontSize',16)

% Plot Syntax

title('Refrigeration Cycle during the Summer and Winter in Durham, NH','FontSize',20)

xlabel('Enthalpy (KJ/K)','FontSize',20)

ylabel('Pressure (KPa)','FontSize',20)

lgd = legend('\color{red} Summer','\color{blue} Winter','\color{black} Vapor Dome');

lgd.FontSize = 20;

xlim([0 500])

ylim([0 5000])

hold off

%%%%%%%%%%%%%

% Calculating Flow-Rate Required, Compressor Power and Coefficient of Performance for Summer and Winter Conditions

%%%%%%%%%%%%%

% Co-Efficient of Performance where COP = (QL/Wnet) = ((h1-h4)/(h2-h1))

COP\_Summer = (H\_1 - H\_4\_Summer)/(H\_2\_Summer - H\_1);

COP\_Winter = (H\_1 - H\_4\_Winter)/(H\_2\_Winter - H\_1);

% Mass Flow Rate where flow rate = Cooling Capacity / Q\_L

dH\_Evaporator\_Summer = H\_1 - H\_4\_Summer;

dH\_Evaporator\_Winter = H\_1 - H\_4\_Winter;

Cooling\_Capacity = 5000; % Watts

Mass\_Flow\_Rate\_Summer = Cooling\_Capacity / dH\_Evaporator\_Summer;

Mass\_Flow\_Rate\_Winter = Cooling\_Capacity / dH\_Evaporator\_Winter;

% Compressor Power

Compressor\_Power\_Summer = Mass\_Flow\_Rate\_Summer \* (H\_2\_Summer - H\_1); % [J/s]

Compressor\_Power\_Winter = Mass\_Flow\_Rate\_Winter \* (H\_2\_Winter - H\_1); % [J/s]

Final\_Data\_Names = ['COP\_Summer',' COP\_Winter',' Mass\_Flow\_Rate\_Summer',' Mass\_Flow\_Rate\_Winter',' Compressor\_Power\_Summer',' Compressor\_Power\_Winter'];

Final\_Data\_Values = [COP\_Summer,COP\_Winter,Mass\_Flow\_Rate\_Summer,Mass\_Flow\_Rate\_Winter,Compressor\_Power\_Summer,Compressor\_Power\_Winter];

disp('Final Data'), disp(Final\_Data\_Names); disp(Final\_Data\_Values)

Final Data

COP\_Summer COP\_Winter Mass\_Flow\_Rate\_Summer Mass\_Flow\_Rate\_Winter Compressor\_Power\_Summer Compressor\_Power\_Winter

1.0e+03 \*

0.0048 0.0105 0.0000 0.0000 1.0369 0.4754