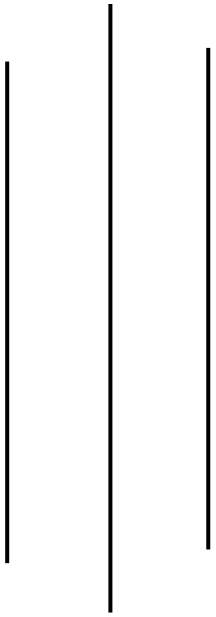
“To study the performance of refrigeration system as per the given system component and identify the energy saving opportunity in a system by optimizing the performance cycle.”



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The component specification in a system:

1) Compressor

   Name Plate specification:

   Refrigerant: NH_3 (R717)

   Swept Volume: 550 m^3 / hr

   Speed: 970 RPM

   Working Pressure: 18 Bar

   Measured quantities:

   Suction Pressure: 1.4 Bar

   Discharge Pressure: 9 Bar

   Important definition:

   i) Compressor capacity = Suction volume
   (Volume of air sucked by the compressor during its suction stroke)

   Swept Volume

   $Vp = (pi\ D^4/\ 4)* L$

   D = Diameter of Cylinder

   L = Length of piston stroke

2) Condenser
3) Evaporators
4) Expansion valve

   Temperature before expansion valve in chiller = 24.5 c

   Temperature before Expansion valve in EXV1 and EXV2 = (4 – 6) c

Calculation of the cooling load on heat Exchanger at water chiller in present conditions:

refilled water Temperature	16	^{0}C
outgoing temp	1.7	^{0}C
Mean Temperature	8.85	^{0}C
density at given mean temperature	999.74	Kg/ m3
In flow volume rate	1	m3 /Min (As per the given spec in inlet motor)
Specific Heat capacity	4.18	kJ/Kg/K
heat exchanging rate	59758.46	KJ /Min
mass of refrigerant flow in chiller section	51.96388	Kg /Min
Total cooling load	284.56	TOR

Calculation of additional heat exchange required in heat exchanger in cooler to meet the demand criteria:

Required Additional Heat exchange rate (i.e decreasing water temperature from 1.7 - 0.5)^0 C

Change in temperature = 1.2

Additional Heat Exchange rate required for water = 5.016 KJ / Kg of water

Total heat exchange required in a minute = 5014.696 KJ/ min

Additional cooling capacity to be increased in heat exchanger in chiller =23.879 TOR

Total heat that needs to be rejected in condenser = 5014.96 KJ

From pressure enthalpy chart required heat rejection at condenser = 96.49 KJ / Kg

From pressure enthalpy chart; required additional temperature drop in condenser = 21.4 ^{0} C

Calculation of the load on evaporator in refrigeration room:

Milk ingoing temp	6.8	^{0}C
outgoing temp	4	^{0}C
Temp difference	2.8	^{0}C
Specific Heat capacity of milk	3.93	KJ/Kg/K
Density of milk	1028	Kg/ m^3
Volume of Milk to be cooled	83	M^3
Time for Cooling	11.5	Hr
heat exchanging rate	1360.73	KJ /Min
Cooling load in refrigeration room	6.479	TOR
Required enthalpy change in refrigerant	1200	KJ / Kg
Mass of refrigerant flow in evaporator of refrigeration room	1.135	Kg /Min

Condenser performance Analysis:

Heat exchanging capacity of condenser at present = 61119.05 KJ / Min

Required additional heat exchange required at condenser = 5014.96 KJ / Min

Total mass of refrigerant flowing in condenser = (51.96 + 1.135) Kg / Min

= 53.095 Kg / Min

Total additional heat rejection at condenser = 5014/53.095

= 94.434 KJ / Min / Kg of refrigerant

Calculation of enthalpy of refrigerant entering in the compressor:

Enthalpy = (51.96*1500 +1.135*1450)/ (51.96+1.135) = 1498 KJ /Kg

Calculation of COP:

In present status:

Work Done by Compressor = (1850-1498) KJ /Kg * 53.095 Kg/Min = 18689.44 KJ /Min

= 88.997 TOR

Total Refrigeration effect being produced in the system = 291.039 TOR

COP =3.27

After improving performance in Condenser

Work done by compressor = 88.997 TOR

Total refrigeration effect being produced in system =314.918 TOR

COP = 3.53

Result

The condenser should be running optimally to make the additional heat rejection rate of 94.434 KJ/ min/ Kg of refrigerant i.e additional 23.879 TOR be created in system.

The COP of the system will improve from 3.27 to 3.53