ENGINEERING REVIEW & ANALYSIS

Excel - USA

SAMPLE DESC: Ch 4404

REFRIGERANT

The refrigerant sample tested high in moisture, oil, and non-condensables. The moisture level is at 527 PPM, which is significantly higher than the action threshold limit of 150 PPM for a system of this type. The Total Acid Number (TAN) of 0.115 in the lubricant sample with an iron element content of 15 PPM is an indication that this moisture combined with the higher than normal oil content, and compounded by non-condensable gases is showing early signs of system deterioration. Oil in systems of this type normally operate between 1 and 3%. The oil content of 7.43% is reducing heat transfer, and therefore reducing system capacity while increasing operating cost. In addition, the non-condensable gases of 6.26% are penalizing system capacity significantly while contributing to degradation of the refrigerant and system.

LUBRICANT CONDITION

Due to the extremely high silicon content, this sample is rated CRITICAL (DOUBLE CHECKED). Typically, silicon can be present in the lubricant in small quantities as an antifoaming agent, but the reference sample did not indicate any presence of silicon. Due to the abnormal wear particles found in the equipment condition report, there may be some sand/dirt, which are generating wear particles from either the bearings or thrust washers. The other possible source of the silicon is possibly from a minor tube or tube sheet leak. An oil change is highly recommended.

EQUIPMENT CONDITION

Consider changing the oil in this unit to remove abnormal wear particles. Resample 3 days after the maintenance action so that we may determine if this equipment continues to generate abnormal wear particles. The sample contains abnormal wear particles listed as OTHER. These particles range up to 30 microns in size and are composed of low alloy steel.
NOTE: The image depicts low alloy steel abnormal wear particles.

PERFORMANCE EVALUATION

Based on the data collected, the chiller system is operating at close to design tonnage (360 RT) but at a 15% higher kW/ton than design. All the system mass and energy balances have checked out in the analysis and are within the required tolerances. Analysis of the individual components shows that the evaporator fouling factor has increased, resulting in a degradation in heat transfer. This is probably due to the high oil content (7.43%) that was found in the refrigerant sample. Potential energy savings of

8.5% can be achieved by removing the excess oil from the refrigerant. Analysis on the condenser shows 6.4% non-condensables present in the system. This again confirms the refrigerant gas sample analysis. Removal of non-condensables form the system can result in operating cost savings of 7.1%. The compressor efficiency is showing a slight degradation but it maybe due to the higher lift conditions as a result of the non-condensables and the evaporator fouling.

RECOMMENDATIONS

1. Recover and purify the liquid refrigerant from oil.
2. Evacuate the system and remove non-condensable gases
3. Determine the source of introduction of the silicon into the lubricant.
4. Leak test the vessels for possible water leaks.
5. Evacuate and leak test the refrigerant side.
6. Perform an oil change on this unit.
7. Resample 3 days after the maintenance action so that a baseline can be established in order to determine the rate at which the equipment continues to generate abnormal wear particles and contaminants.
8. Begin sampling at regular intervals.

HUDSON TECHNOLOGIES

SERIOUS

No. Samples: ONE

REFRIGERANT ANALYSIS

Refrigerant Analysis- R22 / Chlorodifluoromethane
Analysis Number: IL040381
Hudson Sales Order #: Q021105
GC Run Number: IL040381
Customer: Excel USA
Customer PO#: 65122658
Job Reference: Ch #4404
Sample Source: Evaporator
Refrigerant Temperature: 55 F
Make/Model Number: Trane/CVHF077
Serial Number:
Tracking #: 185823

TEST		ARI-700 STANDARD	07/30/04 SAMPLE ONE	SAMPLE TWO	SAMPLE THREE
Moisture	PPM by weight	10 PPM	527 PPM		
Chloride	no turbidity to pass	Pass	Pass		
Acidity	PPM as HCL	<1.0 PPM	<1.0 PPM		
High Boiling Residue	% by volume	<0.01%	7.43%		
Purity	% by weight	99.50%	99.89%		
Non-condensable Gases	% by volume	1.50%	6.26		
Particulate	Pass / Fail	Pass	Pass		

COMMENTS:

SEE ATTACHMENTS NO

Laboratory Supervisor: David Watson

"The results and conclusions reported herein are based solely upon the integrity of the refrigerant sample, and assu
that all information provided is accurate and that proper sampling procedures were observed."

HUDSON TECHNOLOGIES

Pearl River, NY

LUBRICANT CONDITION REPORT

EXCEL - USA

CRITICAL

CUSTOMER PO#:	65122658
JOB REFERENCE:	Chiller #4407
MANUFACTURER:	Trane
MODEL NUMBER:	CVHE077
SERIAL NUMBER:	
TYPE OF CHILLER:	Centrifugal
LUBRICANT:	Trane #22 Oil
RESERVOIR CAP:	Not Provided

SAMPLE DATE:	Jul 14, 2004
REC'D DATE:	Jul 29, 2004
REPORT DATE:	Aug 02, 2004
1st SAMPLE:	Jul 14, 2004
PREV SAMPLE:	N/A
NO. SAMPLES:	1
PROGRAM:	R132

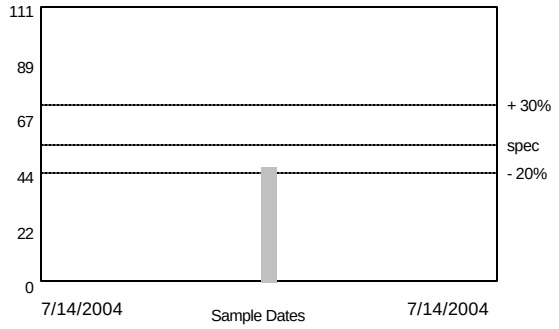
RECOMMENDATIONS:

Due to the extremely high silicon content, this sample is rated CRITICAL (DOUBLE CHECKED). An oil change is highly recommended.

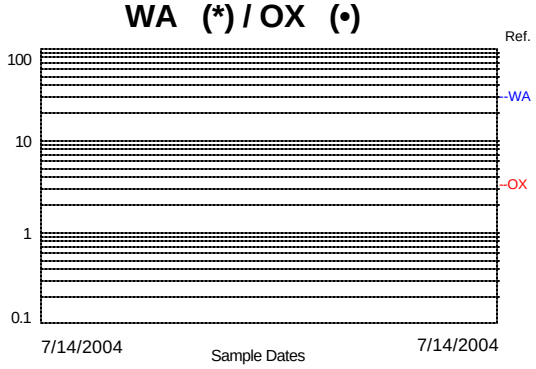
Physical Properties:

Sample Date	7/14/2004				Reference	Limits
Visc (cSt@40C)	46.70				59.10	> 44.24 < 71.89
Visc (cSt@100C)					6.50	> 5.85 < 7.80
Crackle	Negative				N/A	
Water (Abs/cm)					27.50	
Oxidation (Abs/cm)					3.20	
TAN	0.115				0.068	
TBN						
ISO 4406						

Viscosity (Spec. 55.3cSt @ 40C)



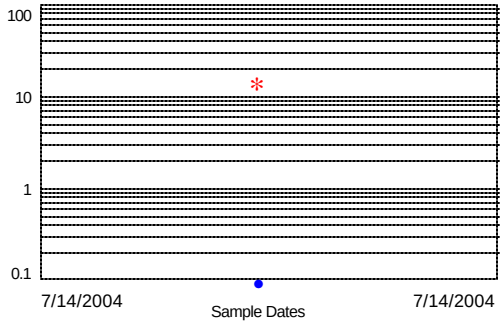
WA (*) / OX (•)



TRACE ELEMENTS: (ppm)

Equipment	Iron	15				0	
	Chromium	0				0	
	Aluminum	0				0	
	Copper	0				0	
	Lead	1				1	
	Tin	0				0	
	Silver	0				0	
	Nickel	0				0	
Contaminants	Silicon	1080				0	
	Sodium	3				0	
	Potassium	6				5	
	Boron	0				0	
Additives	Molybdenum	0				0	
	Magnesium	0				0	
	Calcium	0				0	
	Barium	0				0	
	Phosphorus	0				0	
	Zinc	4				0	
Other	Cadmium	0				0	
	Vanadium	0				0	
	Titanium	0				0	

Fe(*) / Cu(•)



HUDSON TECHNOLOGIES
Pearl River, NY

EQUIPMENT CONDITION REPORT

EXCEL - USA

MARGINAL

CUSTOMER PO#:	65122658
JOB REFERENCE:	Chiller #4407
MANUFACTURER:	Trane
MODEL NUMBER:	CVHF077
SERIAL NUMBER:	
TYPE OF CHILLER:	Centrifugal
LUBRICANT:	Trane #22 Oil
RESERVOIR CAP:	Not Provided

SAMPLE DATE:	Jul 14, 2004
REC'D DATE:	Jul 29, 2004
REPORT DATE:	Aug 02, 2004
1st SAMPLE:	Jul 14, 2004
PREV SAMPLE:	N/A
NO. SAMPLES:	1
PROGRAM:	R132

RECOMMENDATIONS:

Consider changing the oil in this unit to remove abnormal wear particles. Resample 3 days after the maintenance action so that we may determine if this equipment continues to generate abnormal wear particles.

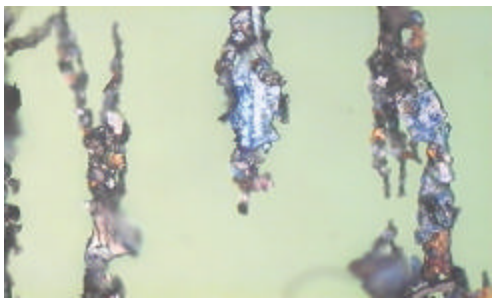
NOTE: PLEASE REVIEW THE CRITICAL LUBRICANT CONDITION RESULTS.

Discussion Of Results:

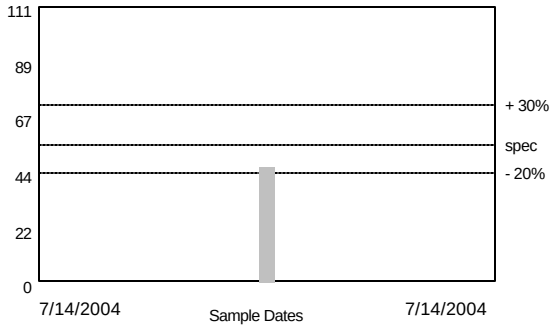
This sample contains abnormal wear particles listed as OTHER.. These particles range up to 30 microns in size and are composed of low alloy steel.

NOTE: This image depicts low alloy steel abnormal wear particles.

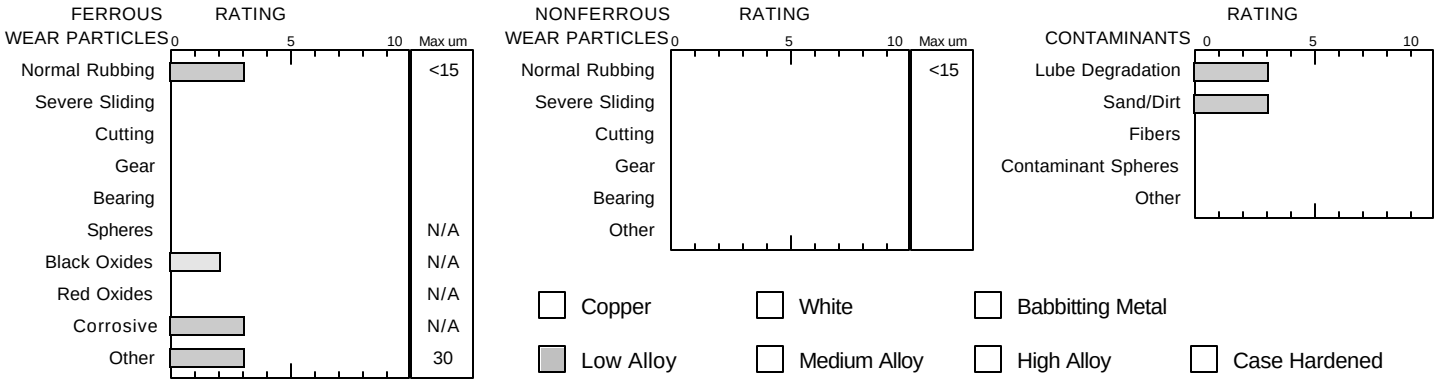
Image (Taken at 500X magnification)



Viscosity (Spec. 55.3cSt @ 40C)



ANALYTICAL RESULTS:



HUDSON TECHNOLOGIES

Performance Monitoring & Optimization

Two Stage Chiller Model

Design Data Input

Operating Data Input

Summary of Results

Evaporator

Condenser

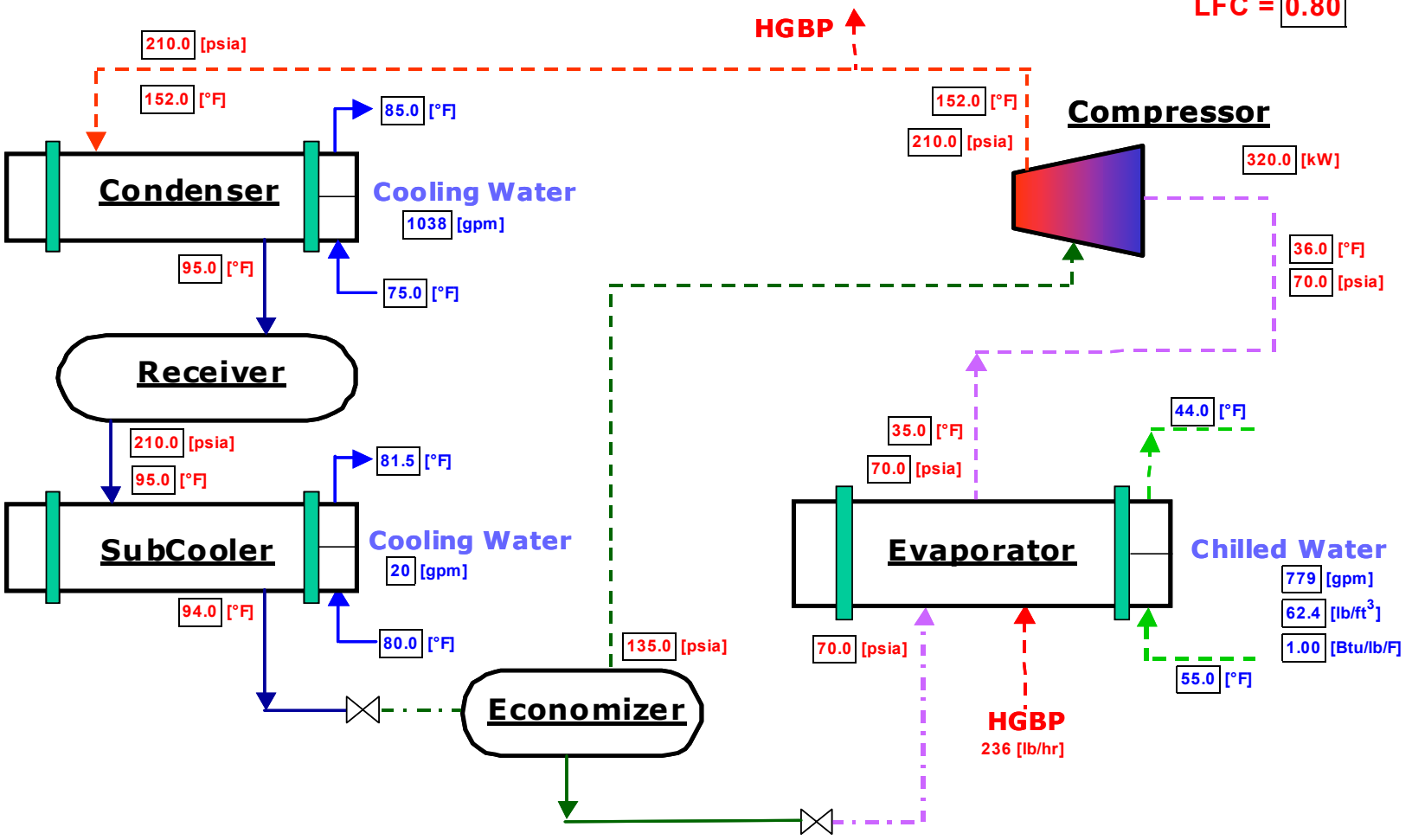
SubCooler

Compressor

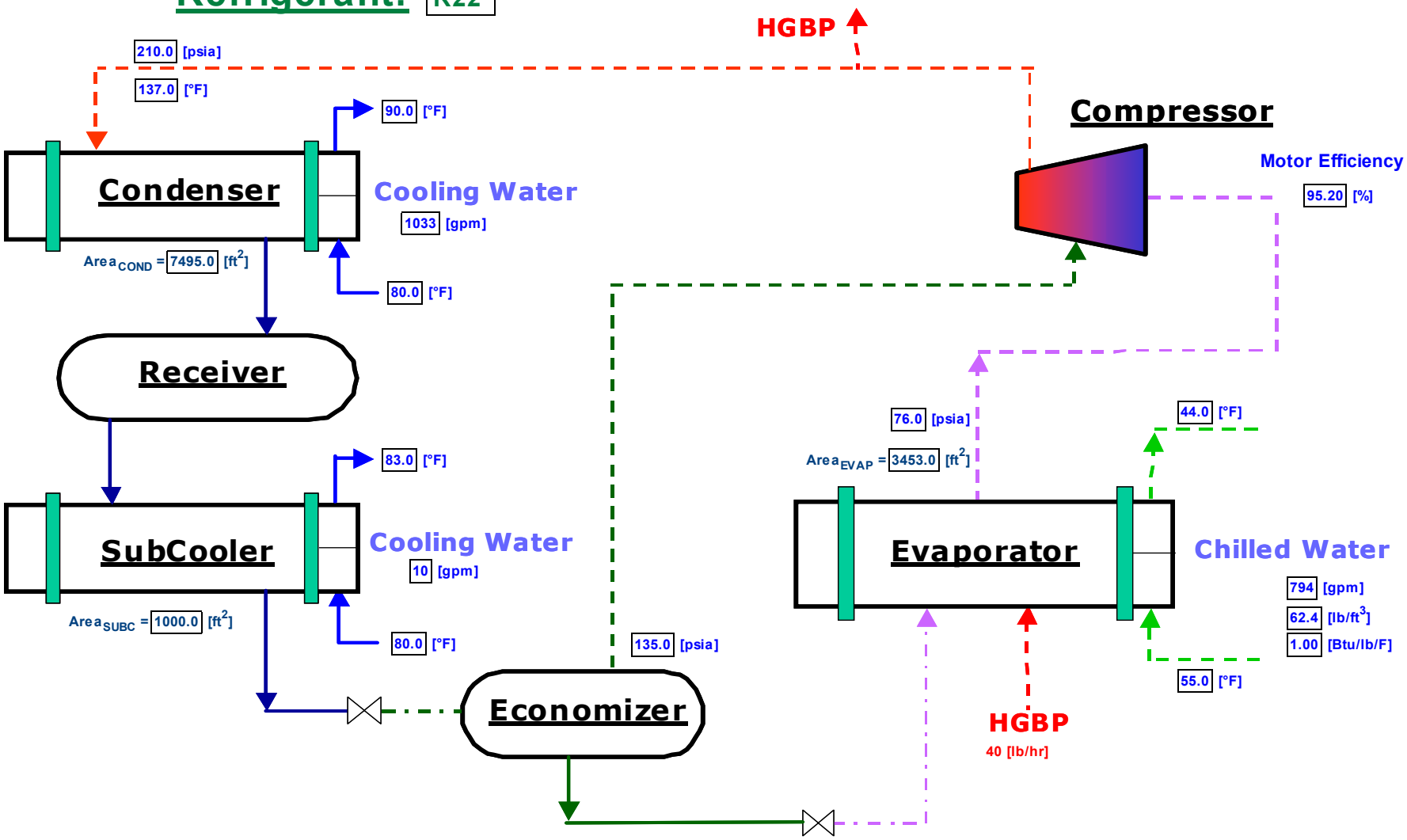
Operating Data

Refrigerant: R22

Hours = 8760
EnergyCost = 0.050 [$/kWh]
LFC = 0.80



Design Data


Refrigerant: R22
HGBP
210.0 [psia]
137.0 [°F]
90.0 [°F]
Condenser
Cooling Water
1033 [gpm]
Area COND = 7495.0 [ft2]
80.0 [°F]
Compressor
Motor Efficiency
95.20 [%]
Receiver
76.0 [psia]
44.0 [°F]
Area EVAP = 3453.0 [ft2]
83.0 [°F]
SubCooler
Cooling Water
10 [gpm]
Area SUBC = 1000.0 [ft2]
80.0 [°F]
135.0 [psia]
Evaporator
Chilled Water
794 [gpm]
62.4 [lb/ft3]
1.00 [Btu/lb/F]
55.0 [°F]
Economizer
HGBP
40 [lb/hr]

SUMMARY of RESULTS & COST SAVINGS

Total System

	Design
Tons = 357.4 [RT]	364.3 [RT]
compkW = 320.0 [kW]	268.0 [kW]
kWton = 0.895 [kW/ton]	0.736 [kW/ton]

NC% = 6.4 [%]

$Balance_{System}$ = -0.2 [%]

Component Balances

$Balance_{Evap}$ = 0.0 [%]

$Balance_{SubCooler}$ = 20.7 [%]

Annual Energy Costs

EnergyCost = 0.050 [$/kWh]

Hours = 8760

LFC = 0.80

Cost ($)	NC Penalty ($)
112128	8249

Refrigerant

Design: R22

Currently Used: R22

Superheat Capacity Penalties

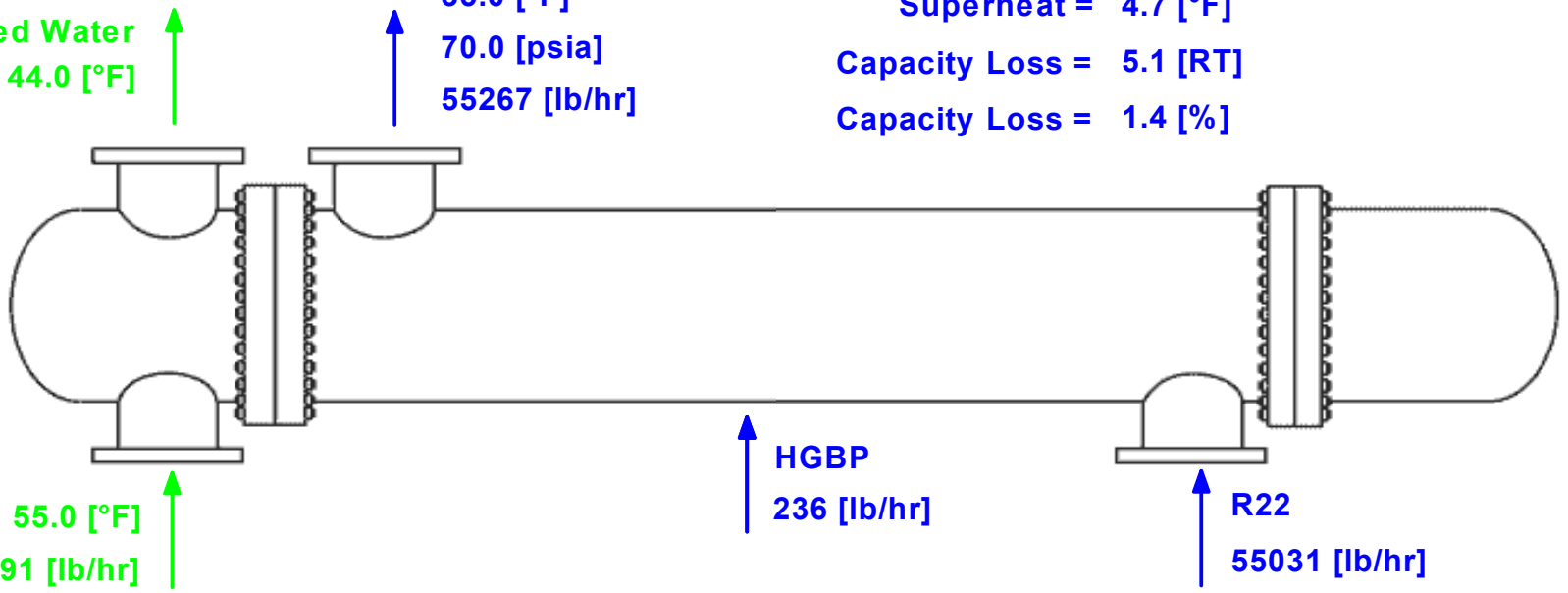
	Capacity Loss (RT)	%
Evaporator	5.1	1.4

Potential Savings Opportunities

Pressure Ratio (current): 3.0

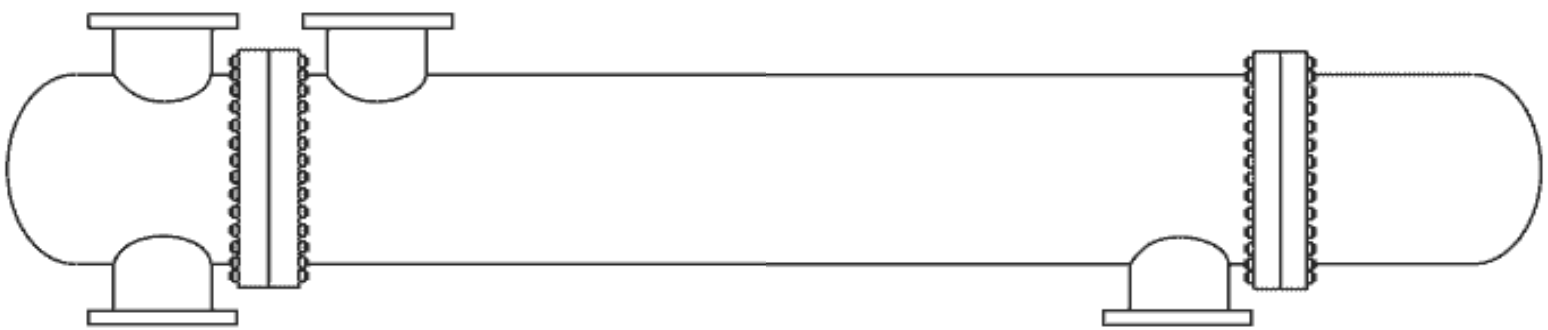
	Evaporator	Condenser	System
New Ratio	2.8	2.8	2.6
Savings (%)	8.5	7.1	15.4

Evaporator



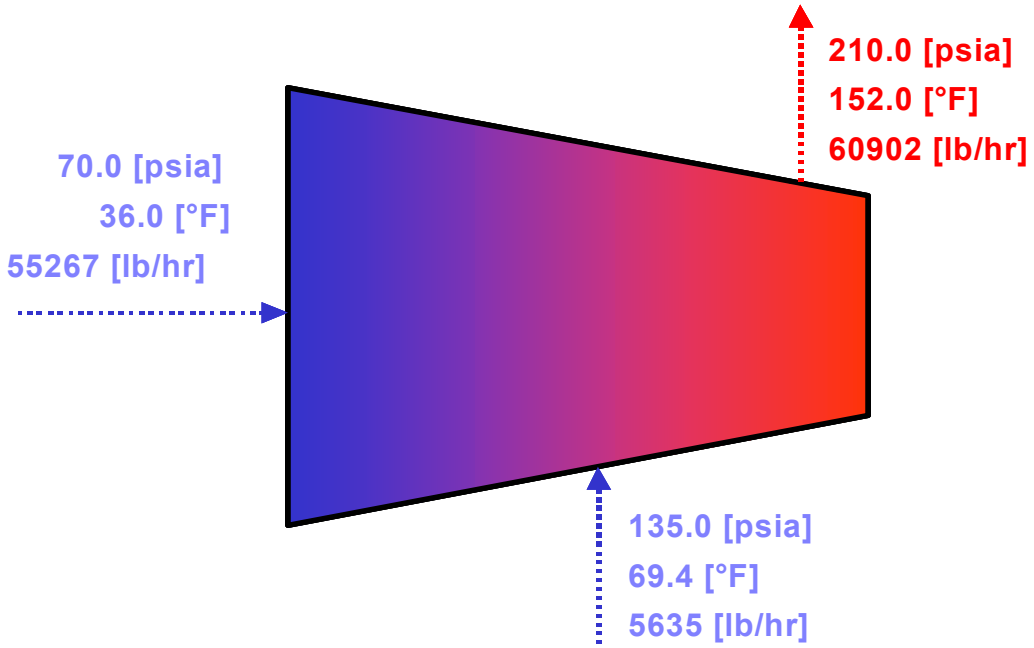
	Design	Actual
Heat Duty (MBtu/hr)	4371.4	4288.8
Refrigeration Tons (RT)	364.3	357.4
LMTD (°F)	14.0	16.7
Overall U (Btu/hr/ft^2/°F)	90.6	74.5
Heat Flux (Btu/hr/ft^2)	1266.0	1242.0
Fouling Factor Increase		0.0022

Condenser



	Design	Actual
Heat Duty (MBtu/hr)	5156.7	5181.7
LMTD (°F)	14.2	14.4
Overall U (Btu/hr/ft^2/°F)	48.5	47.9
Heat Flux (Btu/hr/ft^2)	688.0	691.4
Fouling Factor Increase		0.0003

Compressor



	Design	Actual
Power (kW)	268.0	320.0
Refrigeration Tons (RT)	364.3	357.4
Compressor Efficiency (%)	83.77	77.03
Ideal Discharge Temp (°F)		137.1
Design Discharge Temp (°F)		157.4
Motor Efficiency (%)	95.20	82.59

Suction Superheat = 4.7 [°F]

Capacity Loss = 5.1 [RT]

Capacity Loss = 1.4 [%]