No Good Refrigerant

LEAKS !!!

Refrigerants VS System Performance

Frick RWFII 177 (1800 RPM)

	Tons (TR)	HP/Ton	100% (HP/Ton)
Ammonia	95.3	1.373	100
R22	108.0	1.342	98
R507	127.3	1.422	104
Propane	100.3	1.361	99

- R507 4% less efficient than Ammonia but 27% more capacity
- Propane 1% more efficient than Ammonia with 5% more capacity
- R22 2% more efficient than Ammonia with 8% more capacity
- R507 Greatest Tonnage

Vilters 440 16 cylinder increasing suction pressure from 10.31 psi (-20˚F) to 13.32 psi (-15˚F) improves HP/Ton by 8%
2 – 4% improvement by changing refrigerant is not important in system performance

Refrigerant	Toxicity and Flammability
Ammonia	B2L
R507 & R22	A1
Propane	A3
R1234	A2L

Ammonia:	Toxic and somewhat flammable Too regulated
Propane:	Not toxic but flammable Not yet too regulated
HFCs:	Not toxic some flammable Toxic fumes if burned Environmental issues Regulated – Kigali
HFOs:	Not toxic somewhat flammable Very expensive Poor for low temperatures -12.8˚F boiling point Very high CFM/ton
CO2:	Potentially attractive HP/Ton unknown Equipment not yet available Very High Pressure Critical Temperature 88˚F

SAMPLE OF 29 PUBLIC REFRIGERATED WAREHOUSES

(Hank Bonar)

	Average	Range
Size (cubic feet)	5.3	0.31 - 26.5
Tonnage (tons)	557	67 - 2200
No. of Compressors	8	3 - 24
Average Age of 5 Worst (years)	32	18 - 50
Average Age of 5 Best (years)	25	18 - 50
kWh/ cubic feet	1.54	0.5 - 4.21

- Efficiency varies tremendously – almost 8.5 to 1
- If above 1.6 kWh/ cubic foot – look for improvements
- Older plants not significantly less efficient

Best Solution

- Minimize amount of refrigerant
  - Package Systems
  - Secondary refrigerants
- No Leaks – System design and Maintenance
- Automated control system with monitoring and shutdown

Charge Size

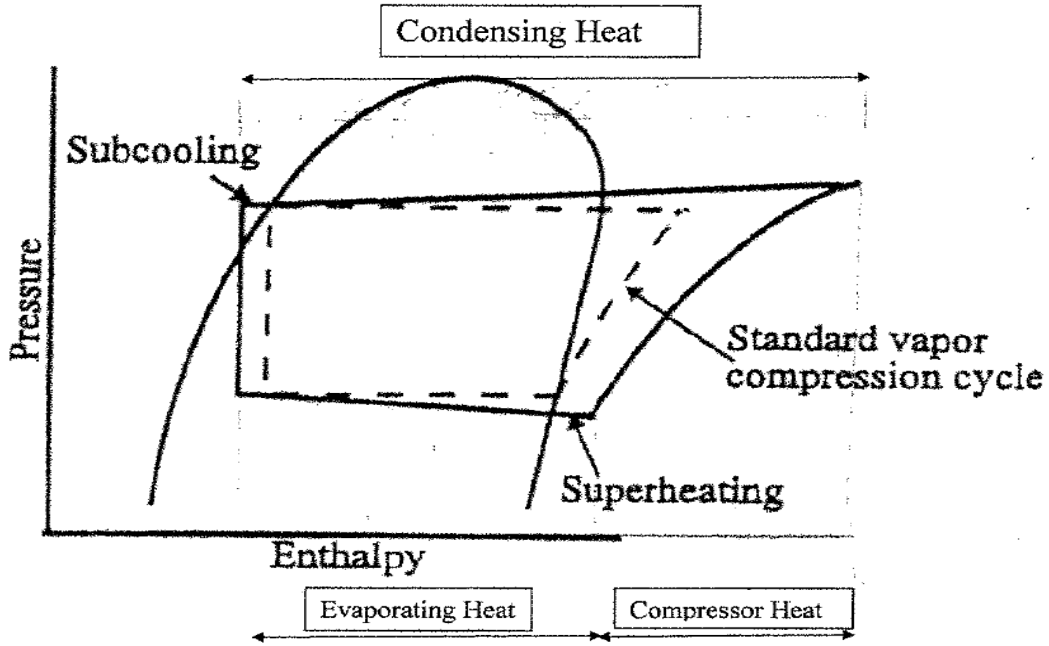
- Refrigeration system uses:
  Volume (FT^3) not LBS
  - Compressor
  - Pipes
  - Heat Exchangers
  - Vessels
  - Etc.

- Density (LB/Gal) determined charge size

Refrigerant Density – Liquid

	LB/Gallons	LB/FT^3	%
Propane	4.13	50.8	100
Ammonia	5.05	37.7	122
R507	8.84	66.0	214
R22	10.00	75.0	243

Propane reduces system charge by 22% from Ammonia and 143% from R22



Condensing Heat = Evaporating + Compressor

Vilter 440 = 79 Tons + 31.2 Tons
= 72% + 28%

Compressor COP = $\frac{79 \text{ Tons}}{31.2 \text{ Tons}}$ = 2.53X

- Key: Good condensers
  Good evaporators

Perfect Cycle

$$COP = \frac{T_E}{T_C - T_E} = \frac{477}{550-445} = \frac{477}{105} = 4.54$$

Evaporating temp = -15˚F =477R

Condensing temp = +90˚F =582R

Efficiency of compression = $\frac{2.53}{4.54}$ = 56%

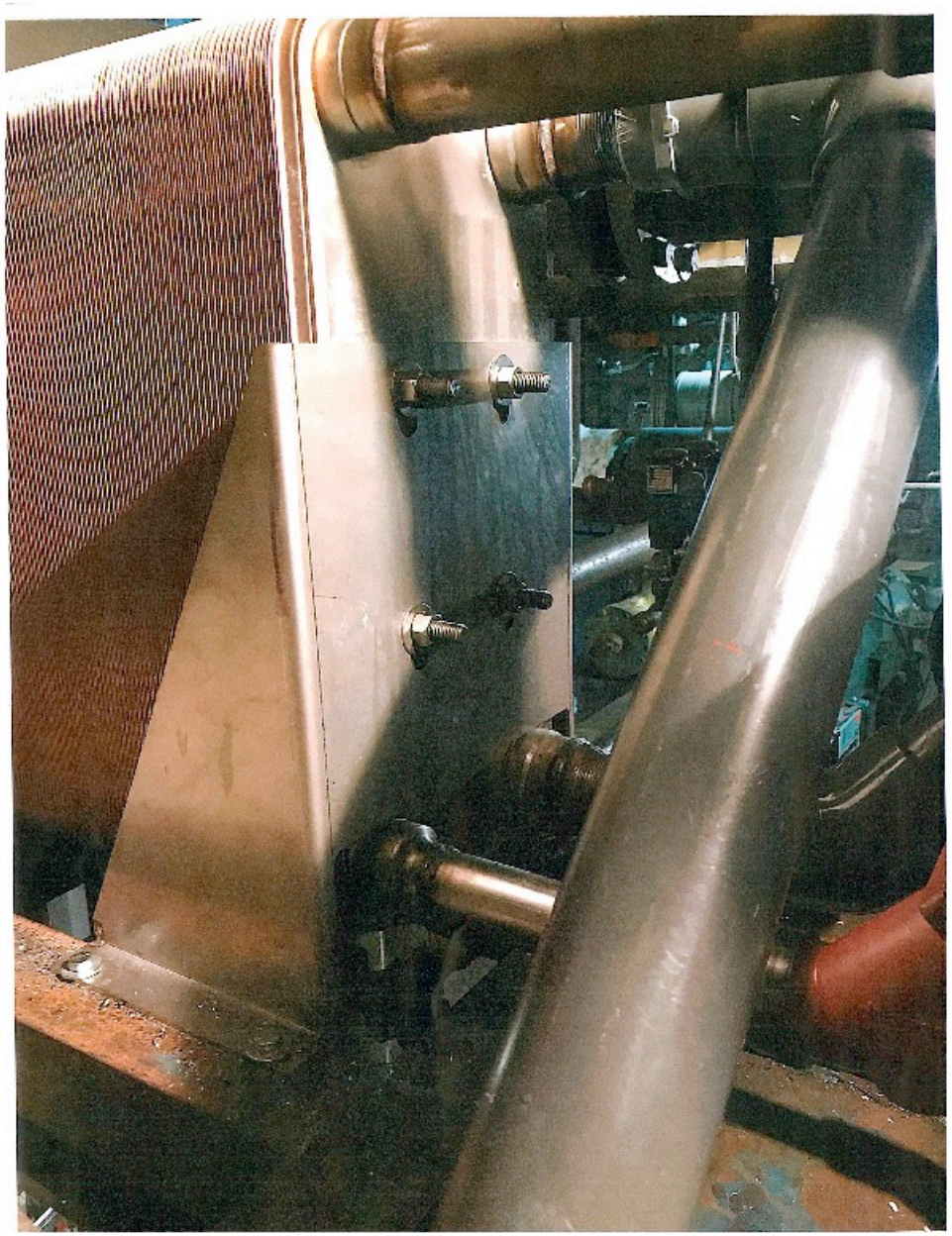
Lower head = 4.54 = 77%

(3 condensers vs. 1 condenser)

Difference between condensing temperature and evaporating temperature determine efficiency.

Brazed Condensers

Kelvion C/O X 20-160 Charge



AMERICA ATMO sphere


VALLEY STEEL
PRODUCTS CO

Summary of Performance

1) Price Each $6,600

X 3

Cost of Three $19,800

1) Plus Valves, Fittings, Mounting Bracket, and installation.

1) Performance Condensing Pressure

A) One 83F 150 PSI

TD 83˚F-67˚F = 16˚F

A) Three 70˚F 122 PSI

70˚F – 67˚F = 3˚F

Heat rejected to water = 1,680,000 BTU/HR

Water Flow (LBS/HR) 350 GPM X 8.345 LB/GAL X 1 BTU/LB X 60

9.59˚F = 10˚F

Well water into condenser (57˚F) exits at 67˚F

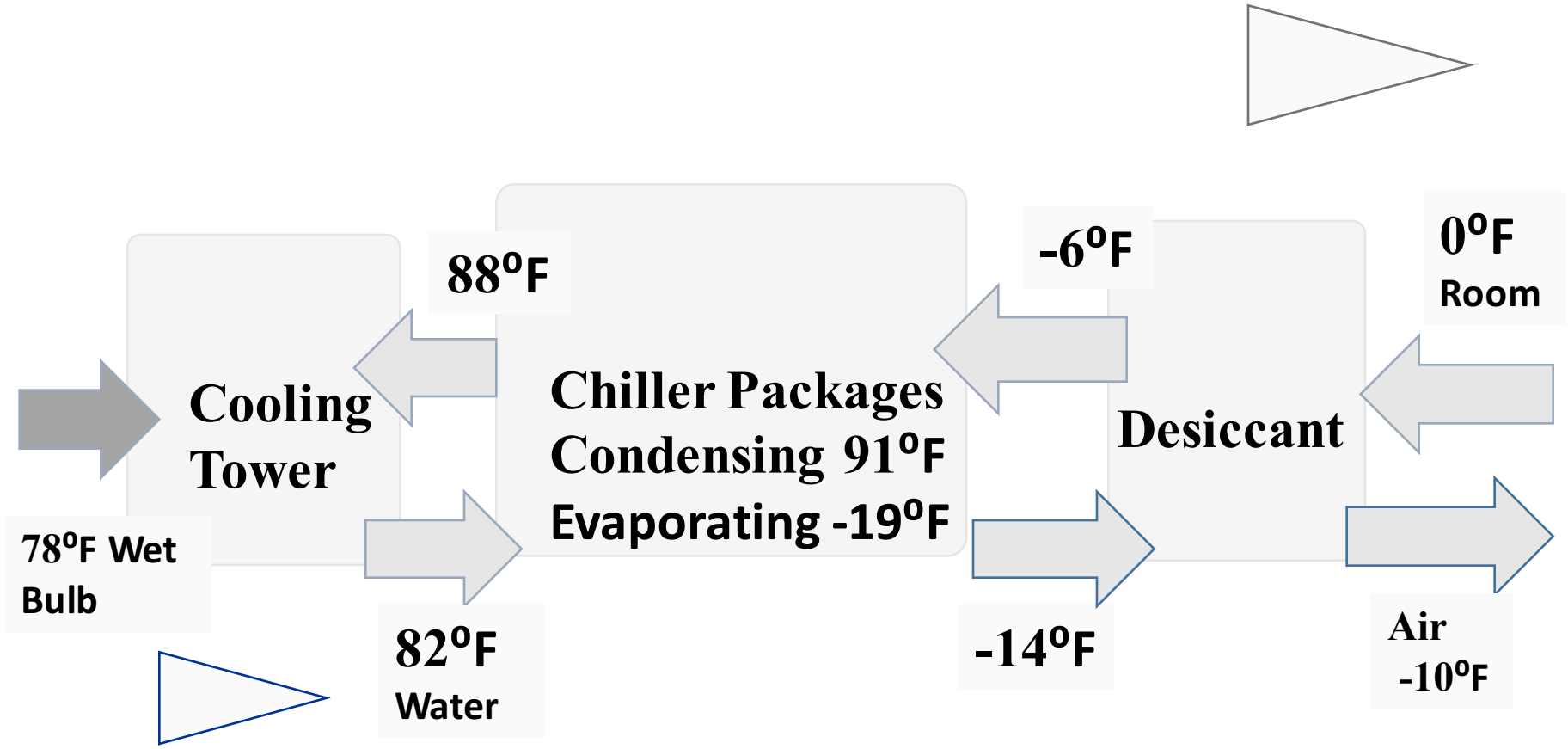
	FT^3
Volume of Refrigerant/Heat Exchange	.821
X 3 Heat Exchangers	X3
Volume of Three Heat Exchangers	2.463
Volume of Vapor X 88% Year	2.167
Volume of Liquid X 12%	.296

Weight of R22: .296 X $75LBS/FT^3$ X 2.167 X $2.56LBS/FT^3$ = 27.7 ≅ 28 LB Charge

Summary

Cost	$19,800
Charge	28 LBS
TD (3)	3˚F
No Gaskets	
Redundancy	

Air Conditioning Style Refrigerant System



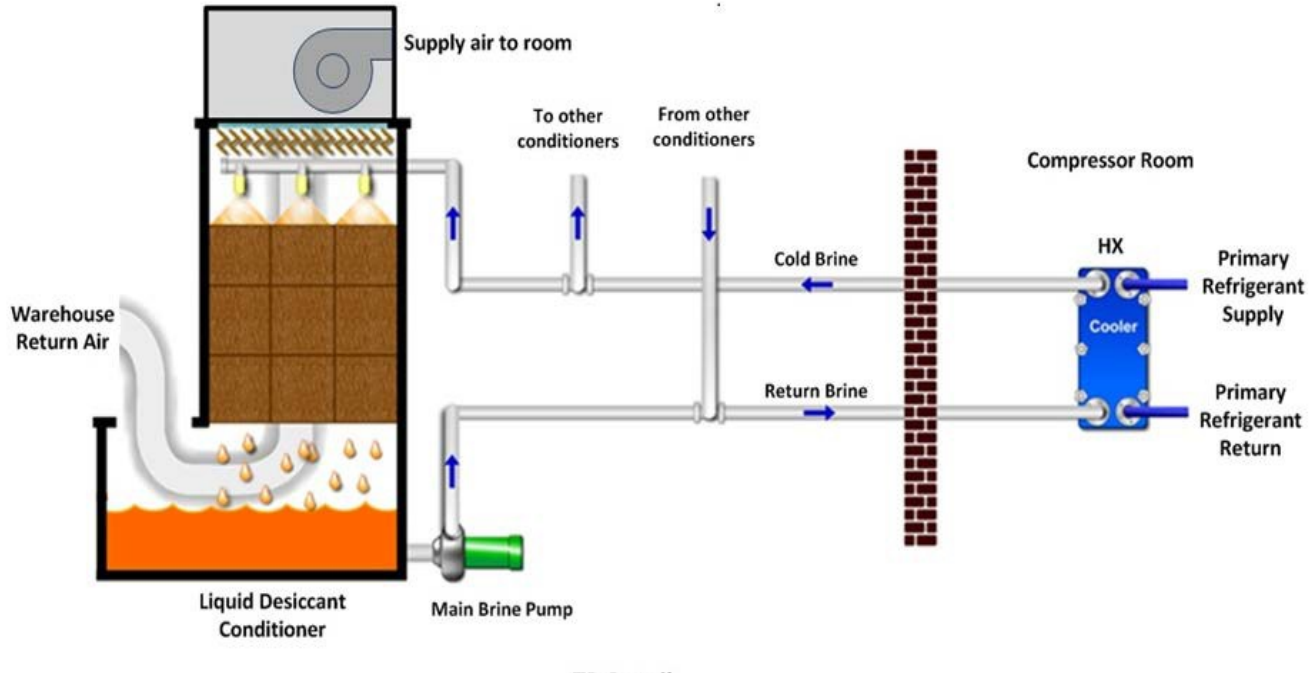
New Warehouse

ATMO sphere AMERICA

Liquid Desiccant Equipment


NOTICE

Liquid Desiccant Refrigeration System Basic Schematic



Propane's Comeback
André Patenaude
Accelerate America
March 2017

Cons:

>>Subject to local authorities having jurisdiction (fire and building codes)

Regulations make the decisions