Central Valley Chemical Safety Day

March 24, 2011

Bakersfield, CA

Advanced Refrigeration

Covering Large, Two Stage, Low Temp Systems with emphasis on Safe Operation and Energy Savings

By Russell Ramos, Sales Engineer, Joseph H. Schauf Co., Madera, CA

What is the Big Picture for Today's Safety Seminar?

- To do our "jobs" better.
- To get better at what we do and how we do it.
- To provide a means for all of us to gain more knowledge.

What is the Big Picture for Today's Safety Seminar?

- Because through knowledge:

  You,

  your Co-Workers,

  your Employees,

  your Plants, and eventually

  Our entire Industry becomes safer.

What is the Big Picture for Today's Safety Seminar?

- Knowledge is gained from Experience, but remember, Experience is often the result of accidents or mistakes or bad decisions.

What is the Big Picture for Today's Safety Seminar?

- For example, what current event is causing a whole industry to gain very valuable experience, even right this minute?

- Unfortunately for all of us, at an immense cost.

What is the Big Picture for Today's Safety Seminar?

- The Nuclear Power Industry

- A mega earthquake caused a Tsunami that caused a Nuclear Power plant to have some major problems.

What is the Big Picture for Today's Safety Seminar?

- But, do you think the industry and the world is learning valuable lessons?
- Do you think the next plant will be built a little differently? Yes!
- Do you think the next plant will be a little safer because of this event? Yes!

What is the Big Picture for Today's Safety Seminar?

- Today is about gaining Knowledge, even if it is at the expense of someone else's "experiences".

In Memory of Mike Chambers

HAND TOOLS

- What is the significance of this picture?
- Who is using the tools?

This is a reminder.
FACT: The overwhelming majority of accidents and releases are caused by operators and technicians who are working on the system.

We must ask ourselves this question……

“Who is using these tools”?

Operators,
Technicians,
Maintenance People,
Service men

Examples of How and When Operators may cause Accidents.

- Starting up a System.
- Lowering the System suction pressure too rapidly!
- Shutting down a System.
- Disconnecting a System.
- Simply closing or opening a single valve
- Adding ammonia to the system.

Examples of How and When Operators may cause Accidents.

- Performing Maintenance, like draining oil, servicing compressors, replacing valves or shaft seals, etc.
- During Pump Outs and Pump Downs.

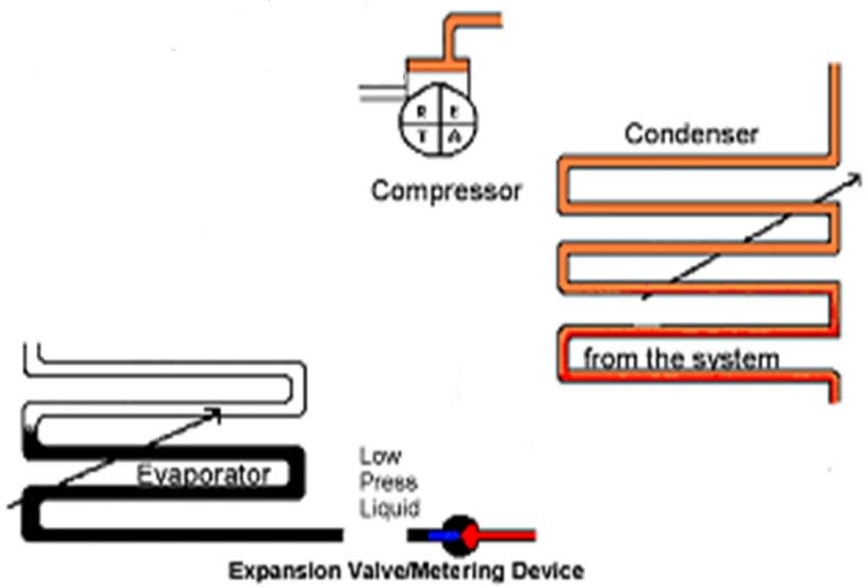
Thank you Mike

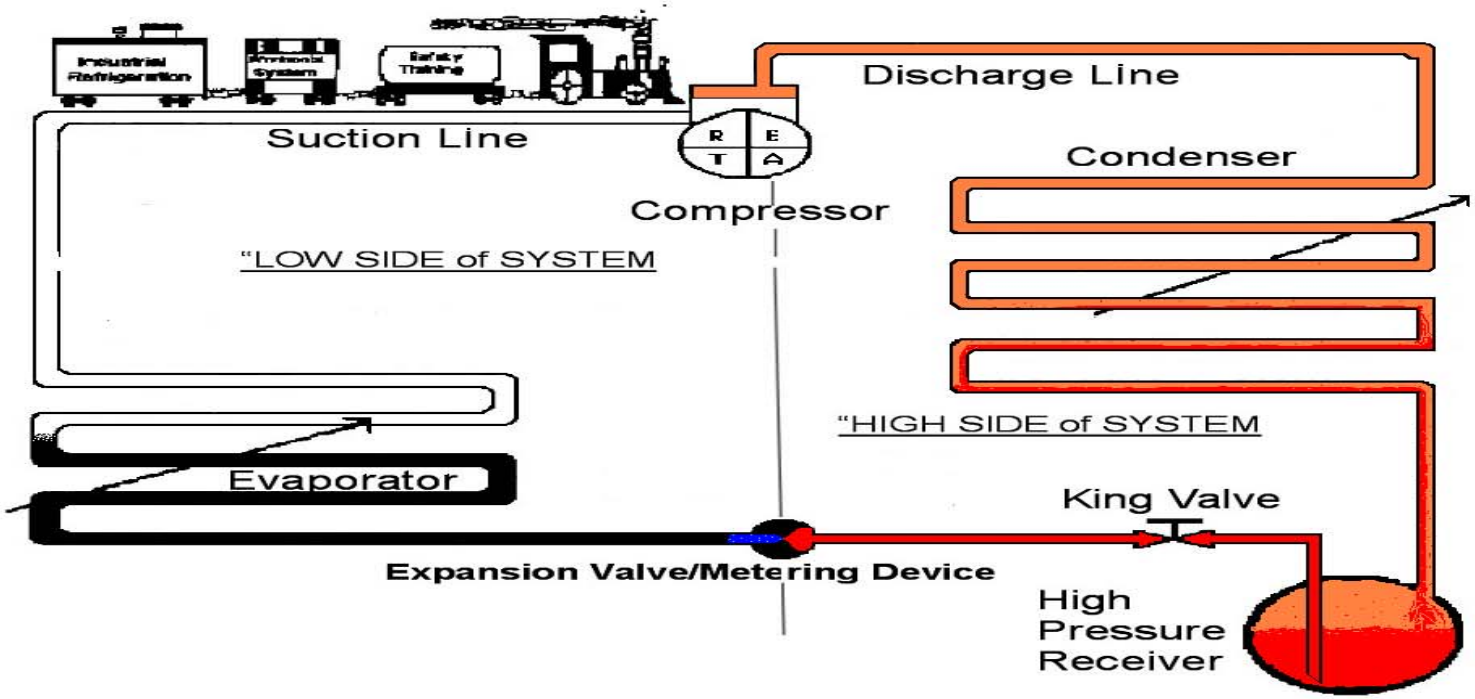
Now let’s Go Learn Something about Advanced Refrigeration!

What do you want to get out of this session?

Basic Refrigeration System

- There are 4 basic components of a mechanical refrigeration system.


Compressor
Condenser
from the system
Evaporator
Low
Press
Liquid
Expansion Valve/Metering Device


Industrial Refrigeration
Safety Training
Discharge Line
Suction Line
R
E
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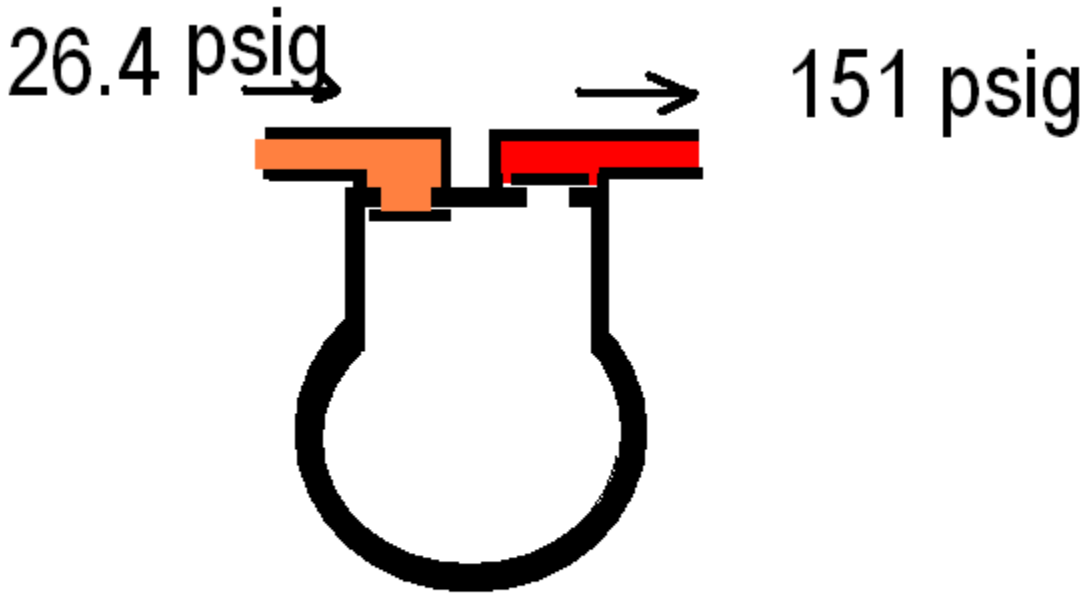
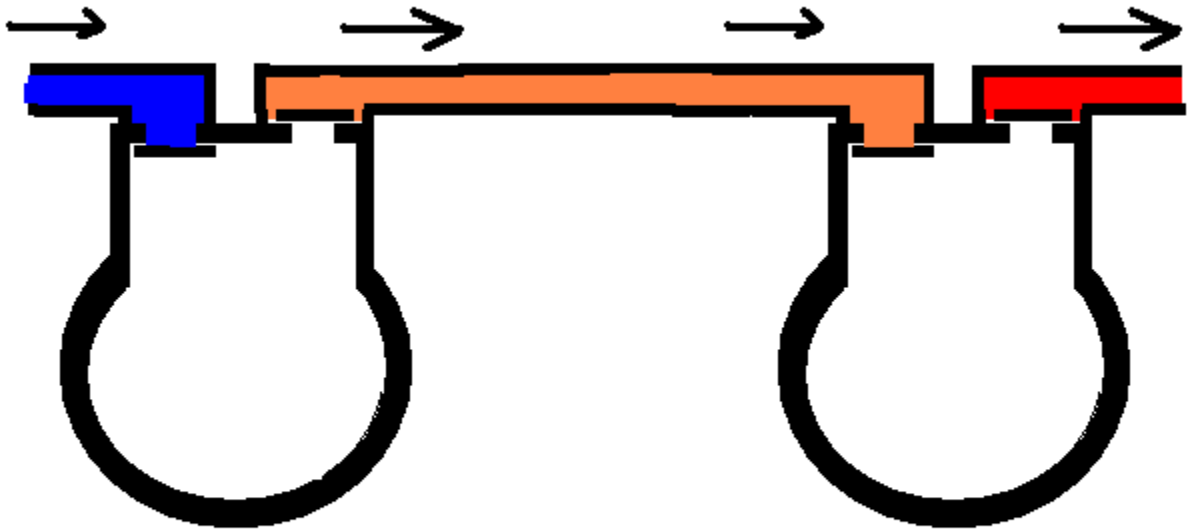
"LOW SIDE of SYSTEM
"HIGH SIDE of SYSTEM
Evaporator
King Valve
Expansion Valve/Metering Device
High
Pressure
Receiver

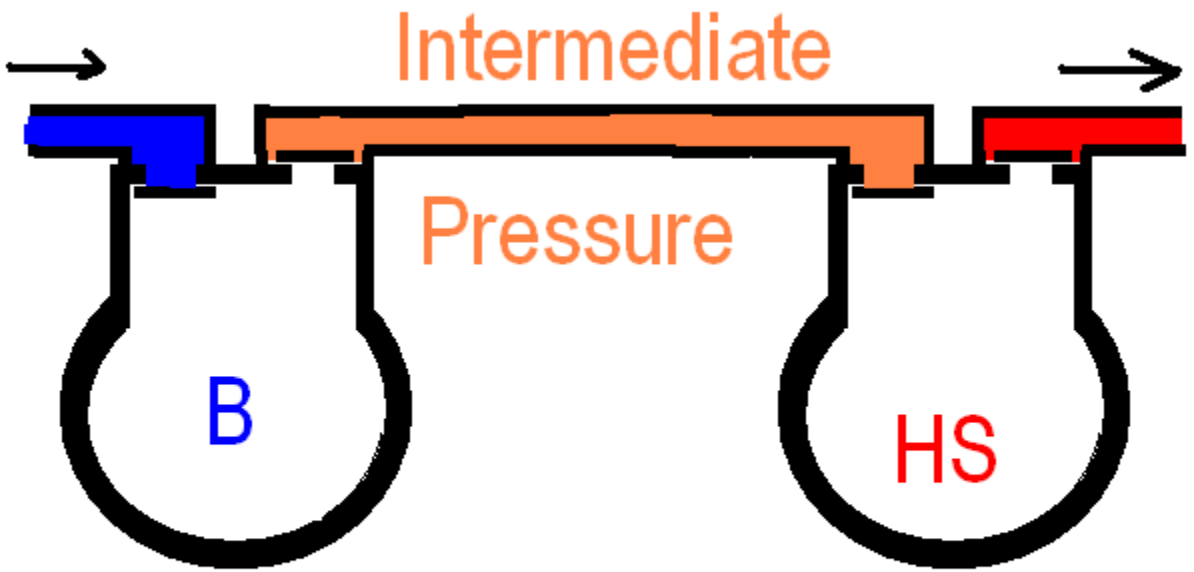
Single Stage Compressor



Two Stage System



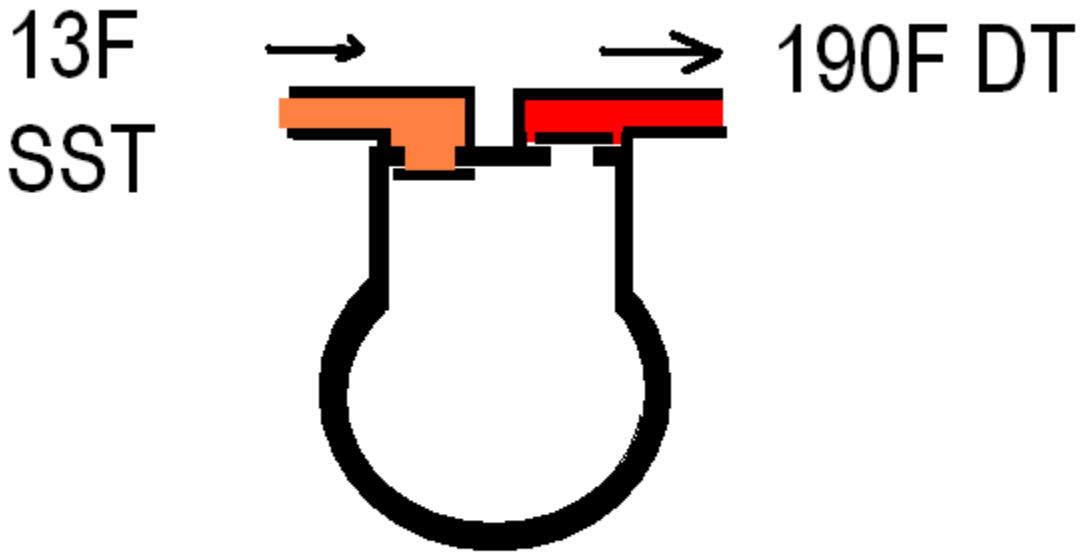
Two Stage System, Kinda..

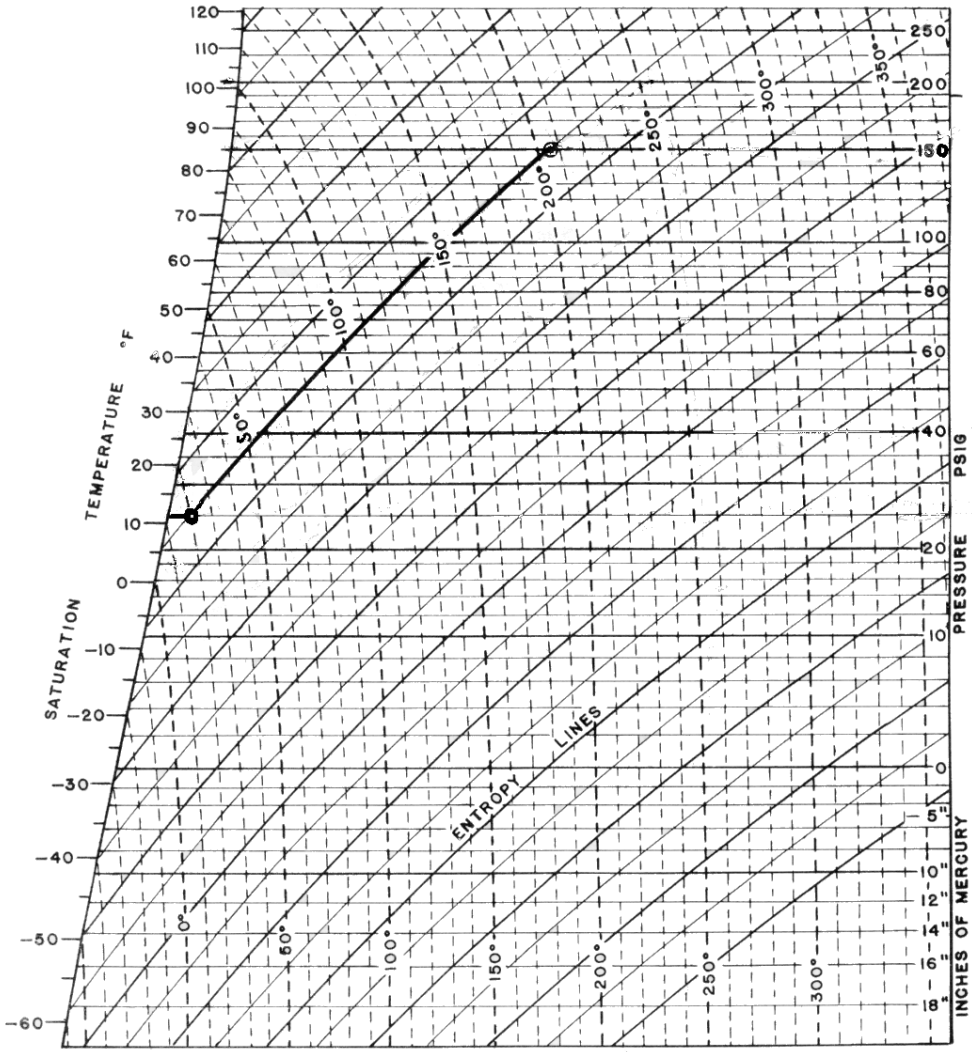


And the Problem is?

- On High Stage compressor the increase from 13F SST (26.4 psig) to 85F Condensing Temp (151psig) is 190F Discharge Temp.

Normal Single Stage



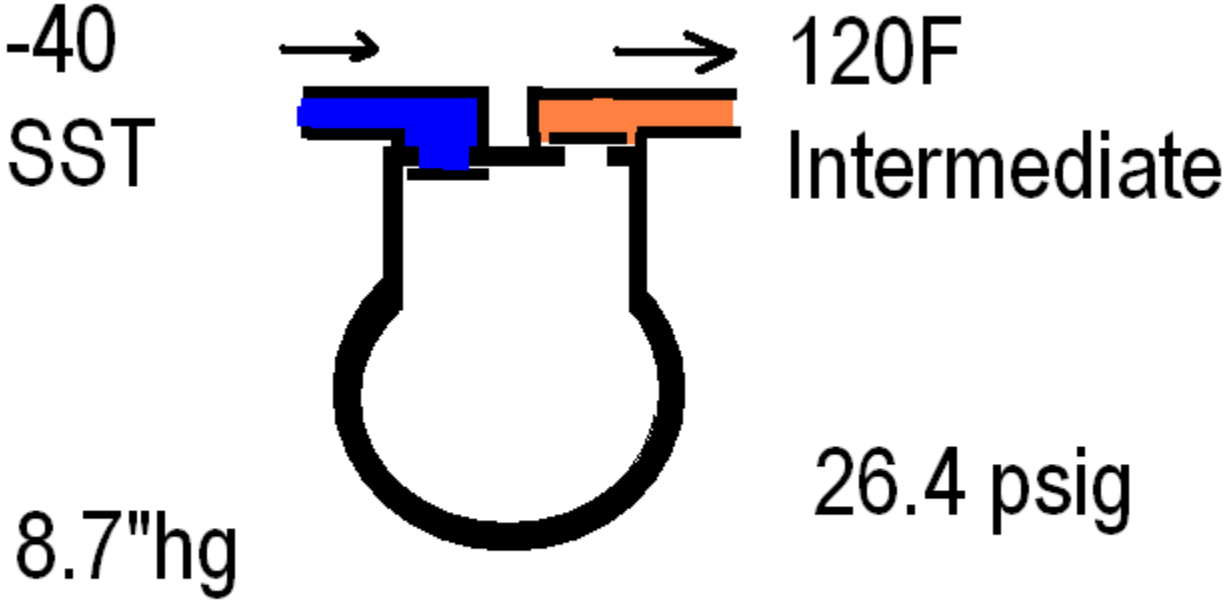


AMMONIA DISCHARGE TEMPERATURE

Booster Discharge Temp

- On the Booster compressor the increase from -40F SST to 13F intermediate temp is about 120F.

Booster Theoretical DT



And the Problem is?

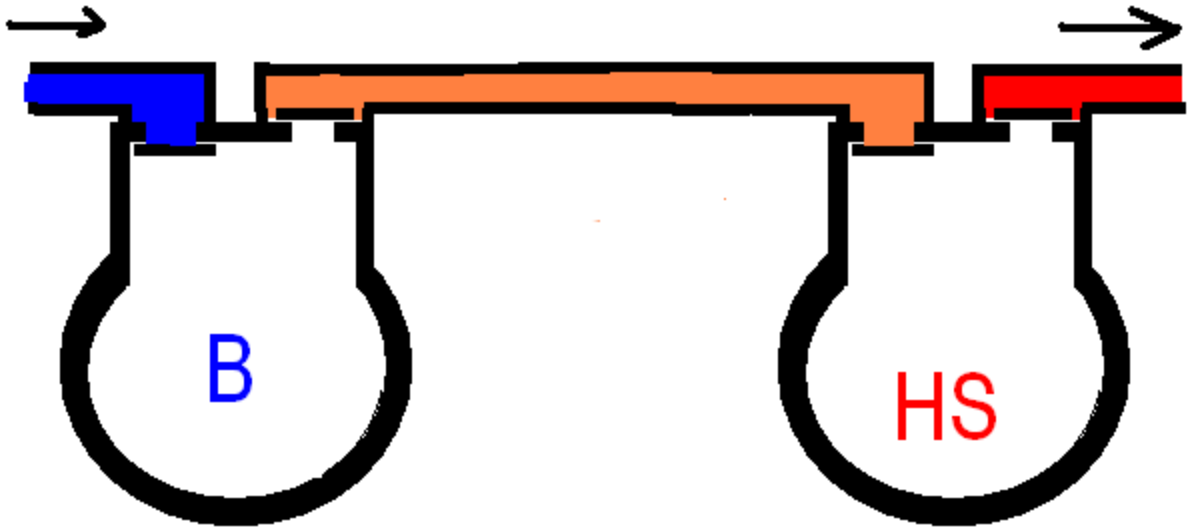
- What happens to the high stage compressor when the suction vapor temp is entering the compressor at 120F?
- High Stage Discharge Temp literally “goes off the chart” to well over 300F.
- The oil breaks down very rapidly

What happens with high oil temps?

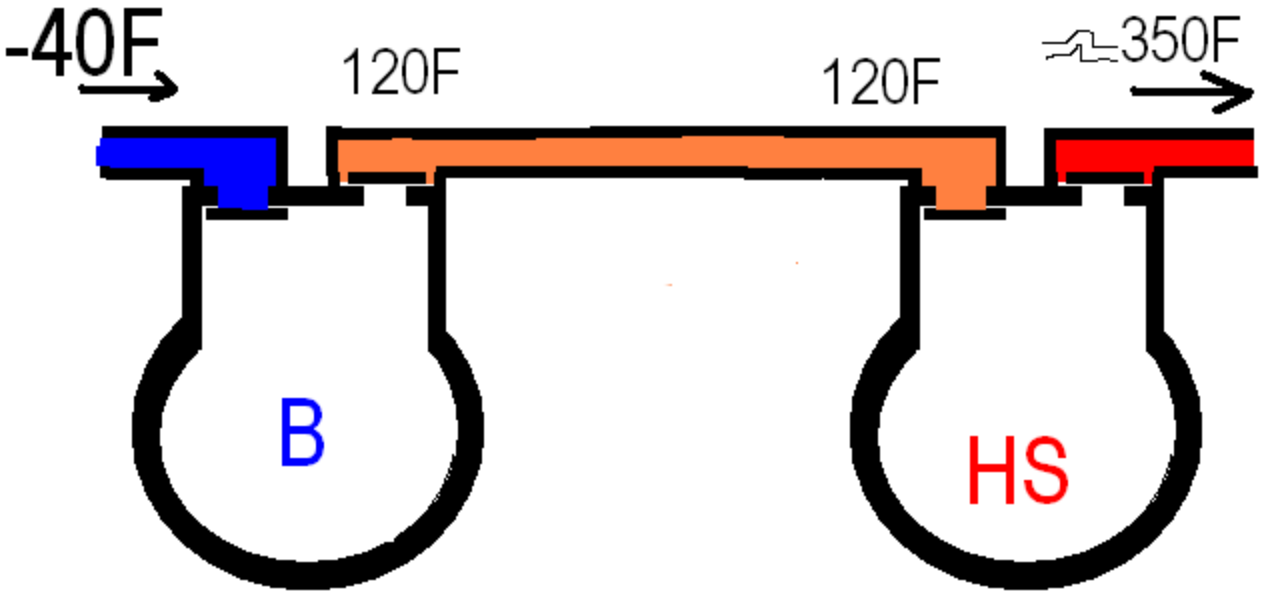
- When the oil temperature gets near or above 300F, then the oil breaks down forming Sludge and carbon in the system.

  Operating your compressor under these conditions for too long will lead to a compressor meltdown…This means the compressor becomes a boat anchor!

Two Stage, no Desuperheater



Two Stage, no Desuperheater

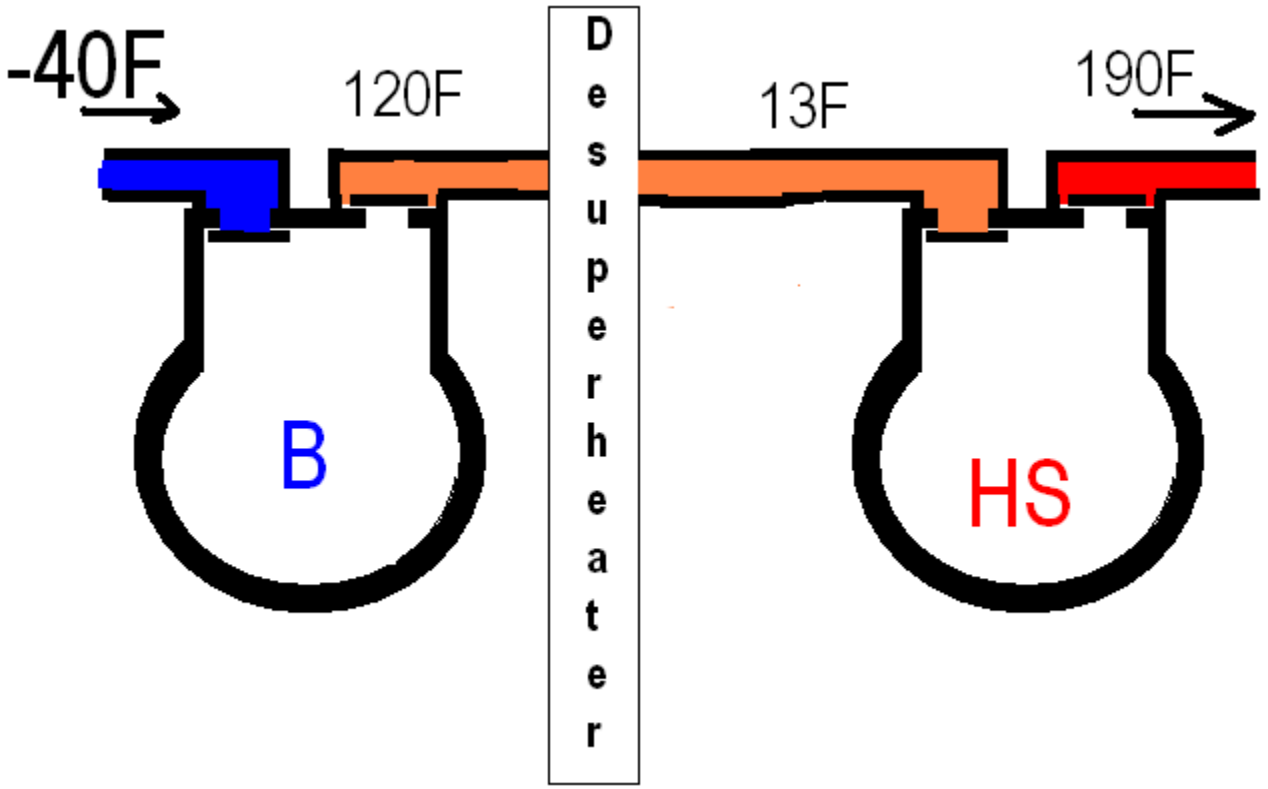


So What is the Answer?

- A device to cool down the Booster discharge gas to as close to saturation as possible before it enters the suction of the High Stage Compressor.

- It is called a desuperheater.

A Device called a Desuperheater



Compression Ratio for Two Stage System

- Think of it as dividing the workload of the compressors in half. We do it by calculating the compression ratio.

- In other words the compression ratios of the Booster and of the High stage compressors will be the same.

Compression Ratios

- System compression ratio is

  $\frac{166 \text{ psia}}{10.38 \text{ psia}} = \frac{15.99 : 1}{}$

Cannot be done with piston compressors because their mechanical limitation is about 8:1.

Note: Always us absolute pressures for calculating Compression ratios.

Compression Ratios

With a booster suction of -40F at 8.7”hg and a High Stage Discharge of 85F Condensing Temp at 151 psig, the system requires an intermediate (or middle) pressure of 26.4 psig.

Compression Ratios

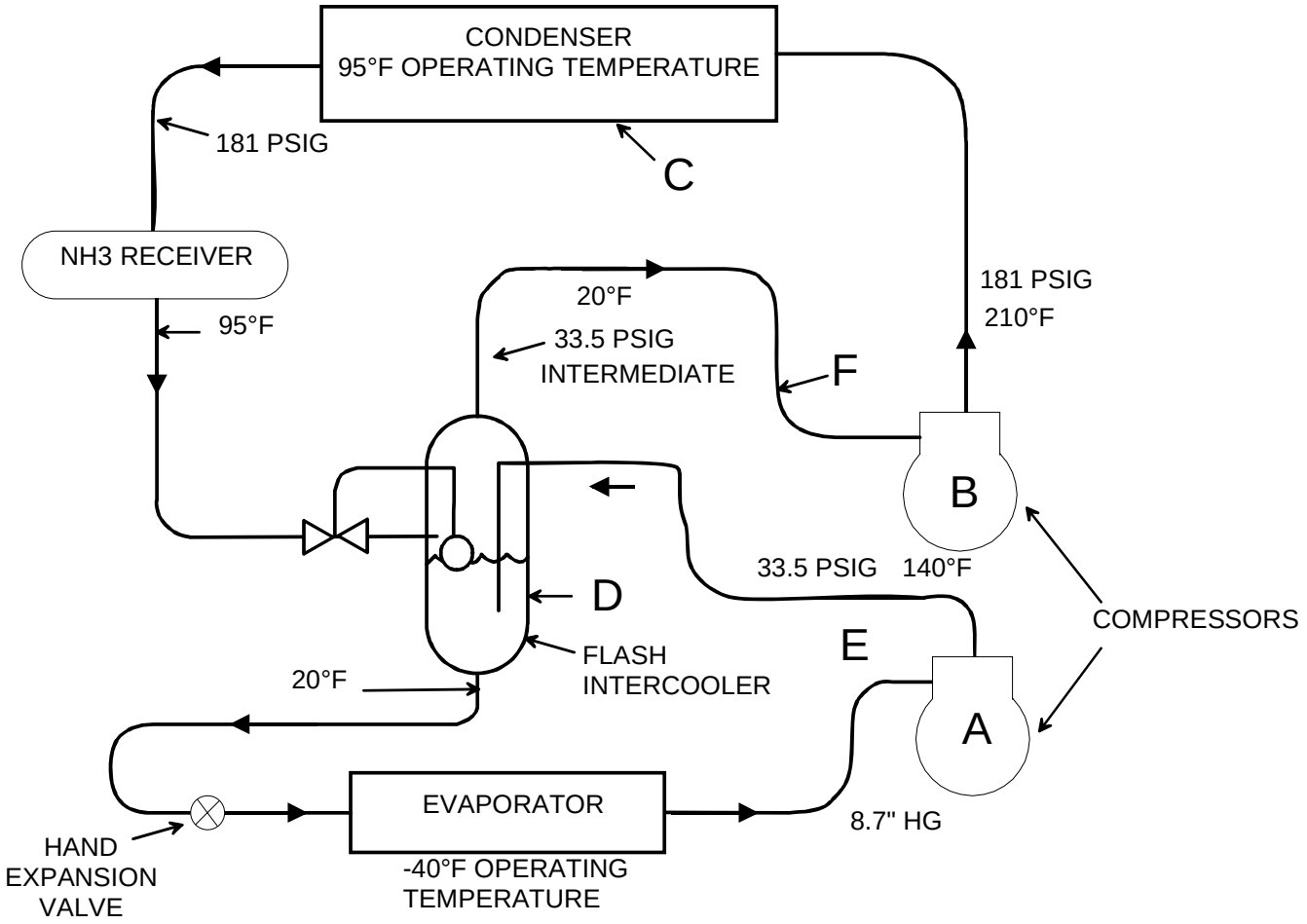
- HS 166 psia = 4.03 : 1 CR

  41.11 psia

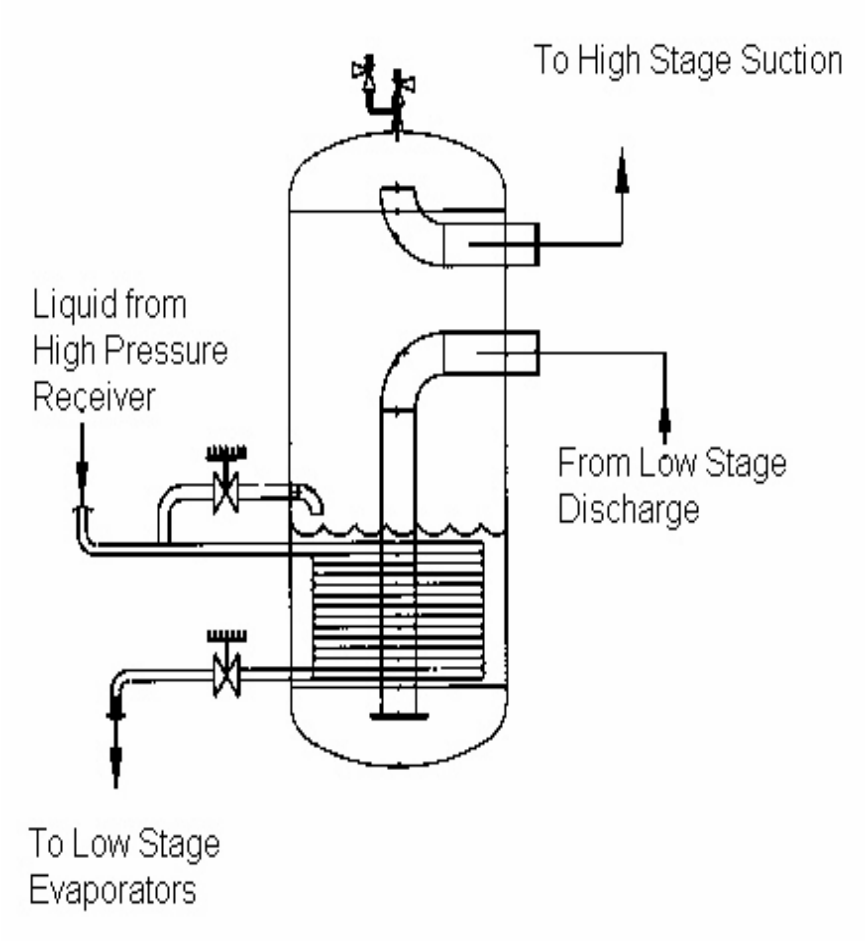
Booster 41.11 psia = 3.96 : 1 CR

10.38 psia

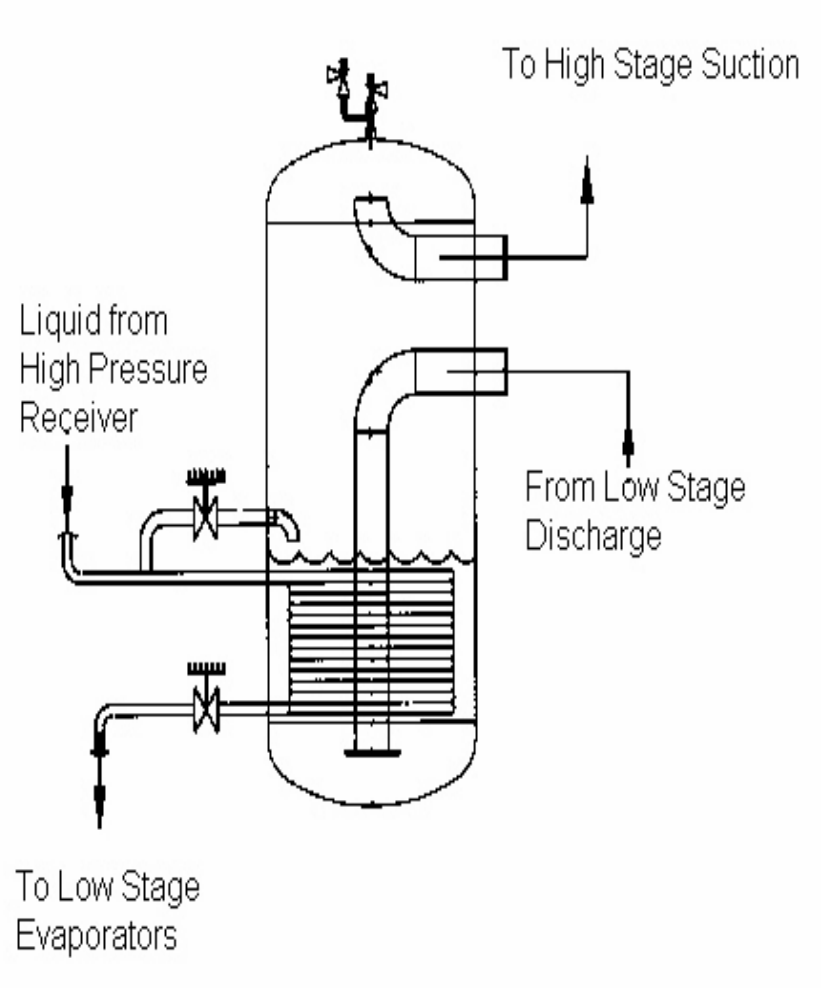
Two Stage System



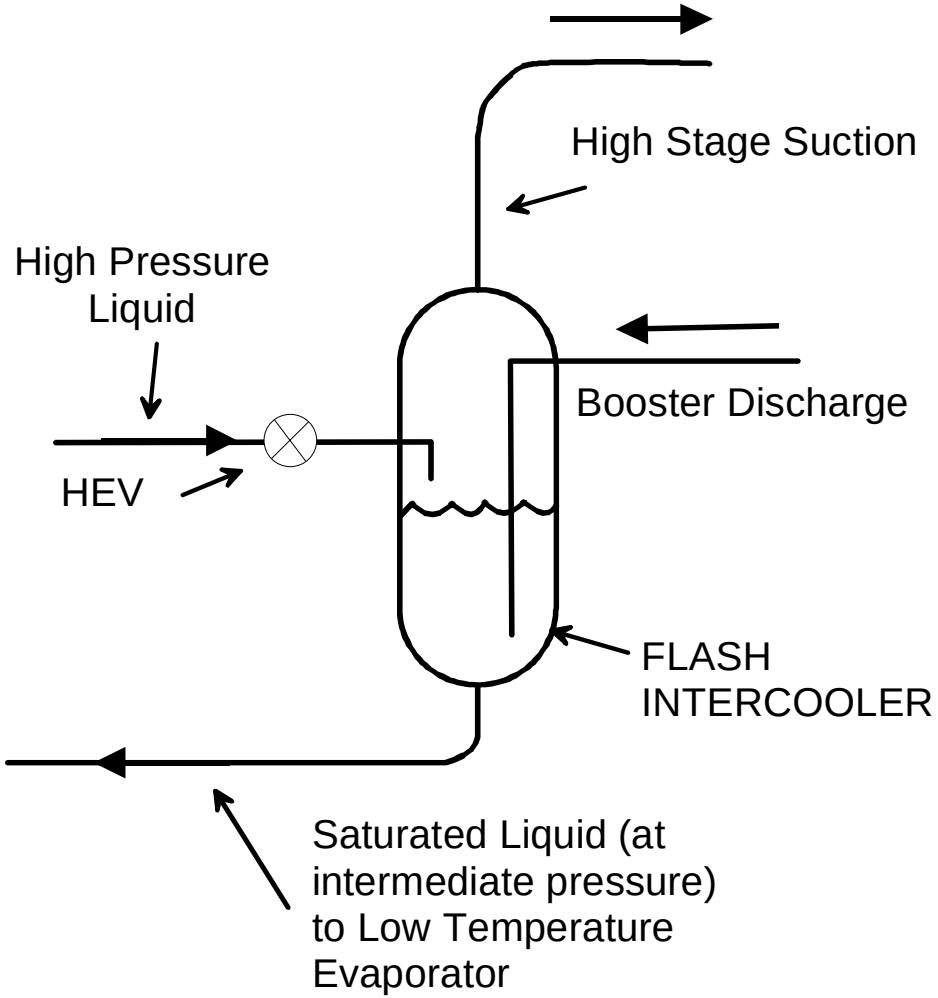
A Shell and Coil Intercooler



Also referred to as an Intercooler with a Subcooling Coil.



A Flash Intercooler



Two Stage Vs Single Stage

- Why do it?
- Which method saves the most $$$$$?
- The two stage system wins this battle everytime.

Two Stage Vs Single Stage

- Example: 100 ton load
- **Single Stage** -40F SST and 85F CT
- Model 400GL, thermosyphon Oil cooled
- Rated at 98.6 TR at **294 BHP**
- 2.99 BHP per Ton

Two Stage Vs Single Stage

- Example: 100 ton load
- **Booster** -40F SST 13F Intermediate
- Model 340GL, thermosyphon Oil cooled
- Rated at 99.2 TR at **117.2 BHP**
- 1.18 BHP per Ton

Two Stage Vs Single Stage

- Example: 100 ton load
- **High Stage** 13F SST and 85F CT
- Model 110GM, thermosyphon Oil cooled
- Rated at 102.7 TR at **116.9 BHP**
- 1.14BHP per Ton

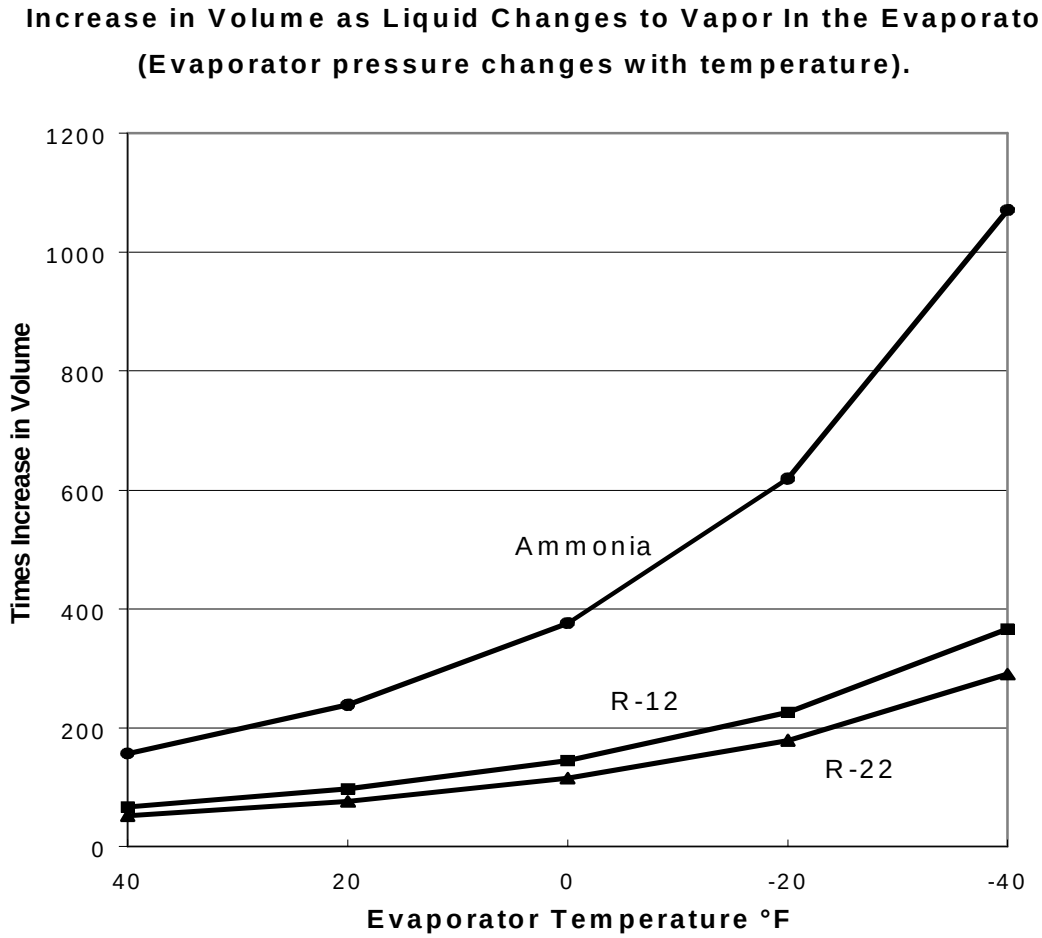
Two Stage Vs Single Stage

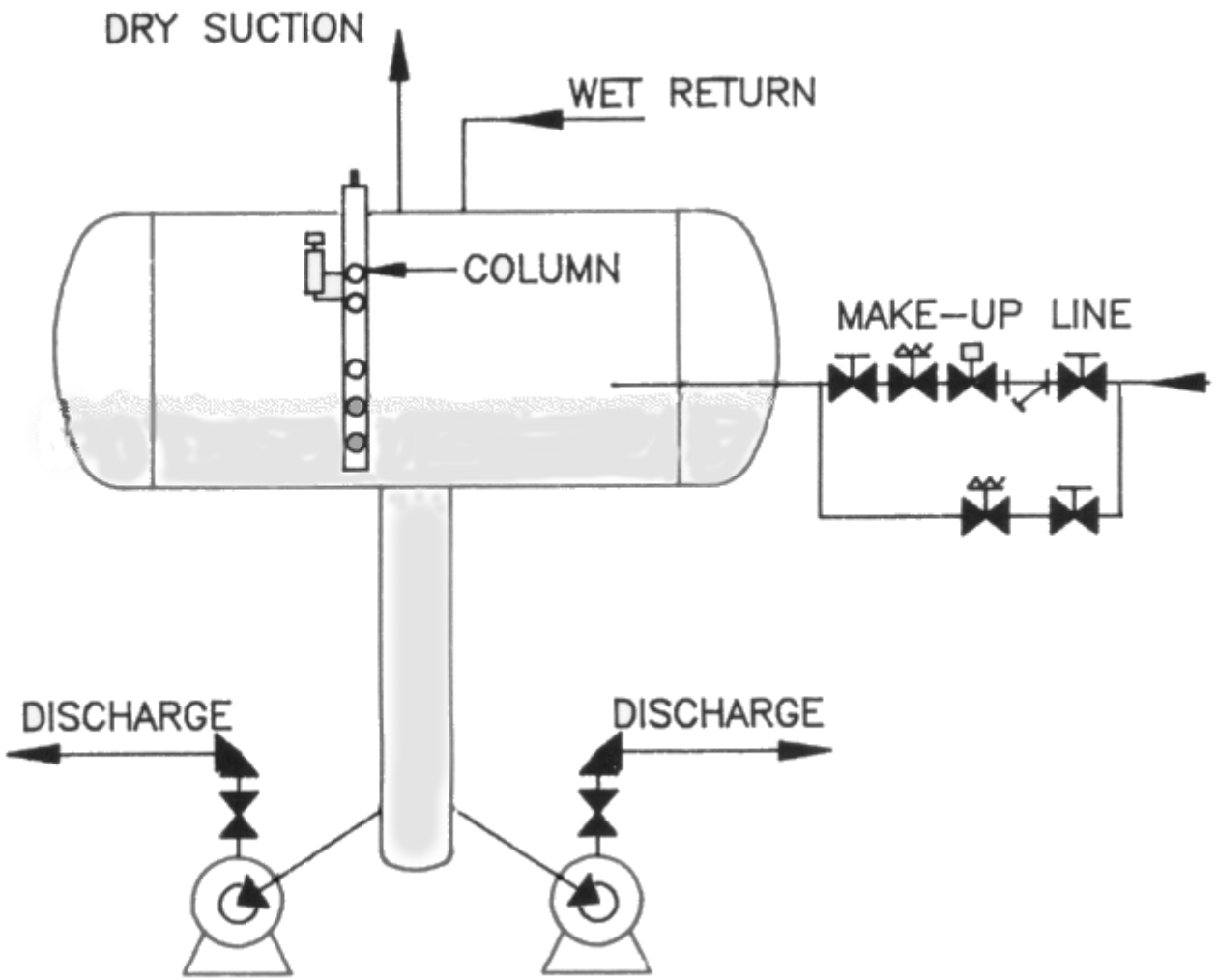
- Comparison:
- Booster ……. 117.2 BHP
- High Stage ……. 116.9 BHP
- **Total Two Stage …… 234.1 BHP**

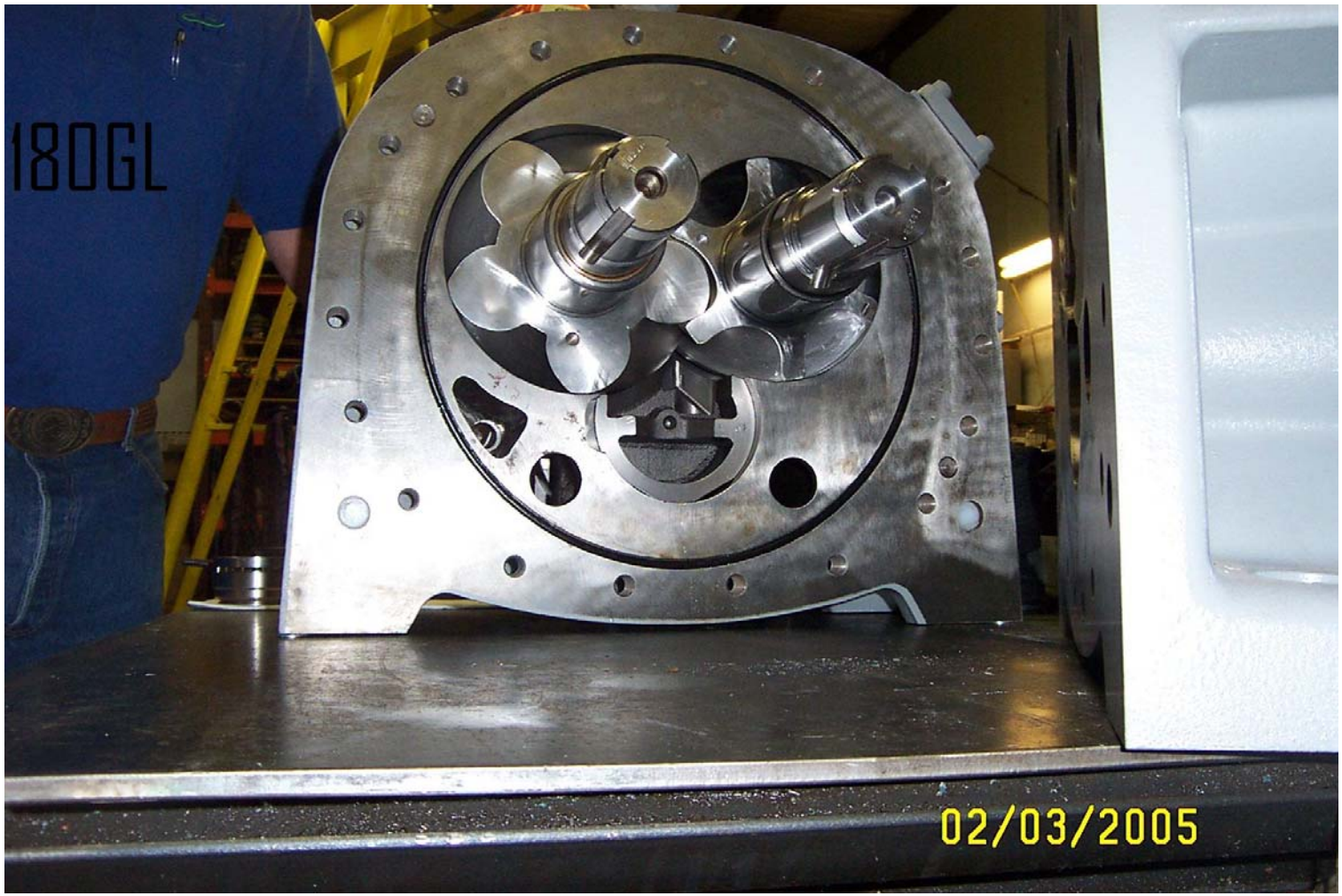
- **Total Single Stage……294.0**

- **Difference of 60 BHP**

Suction Vapor Volume




DRY SUCTION
WET RETURN
COLUMN
MAKE–UP LINE
DISCHARGE
DISCHARGE


180GL
02/03/2005


180GL
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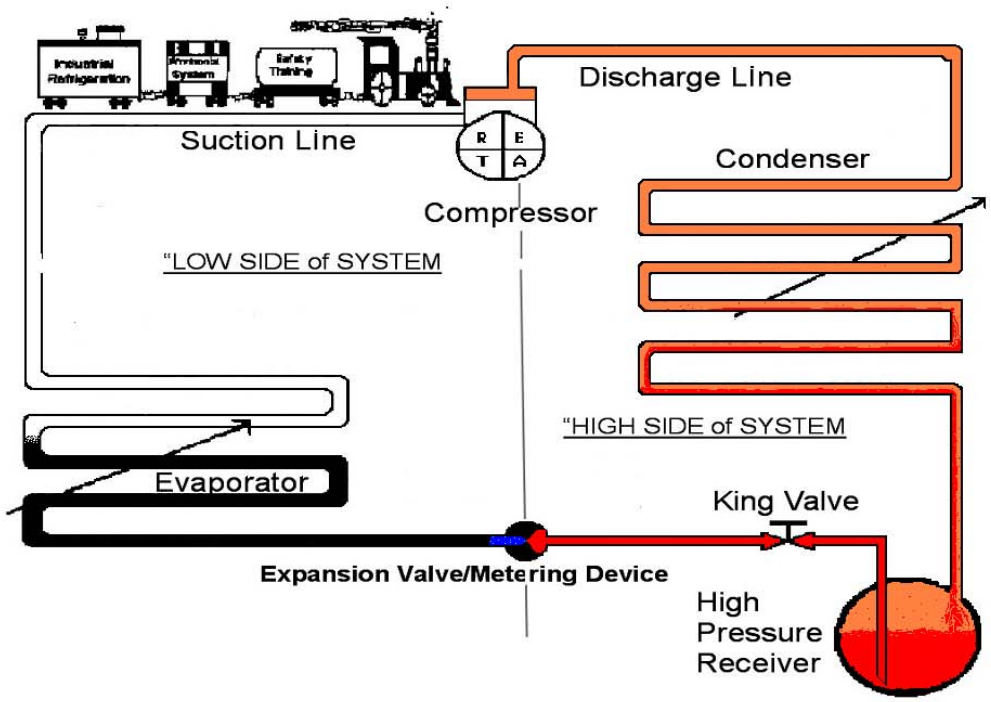
Industrial Refrigeration
Ammonia System
Safety Training
Discharge Line
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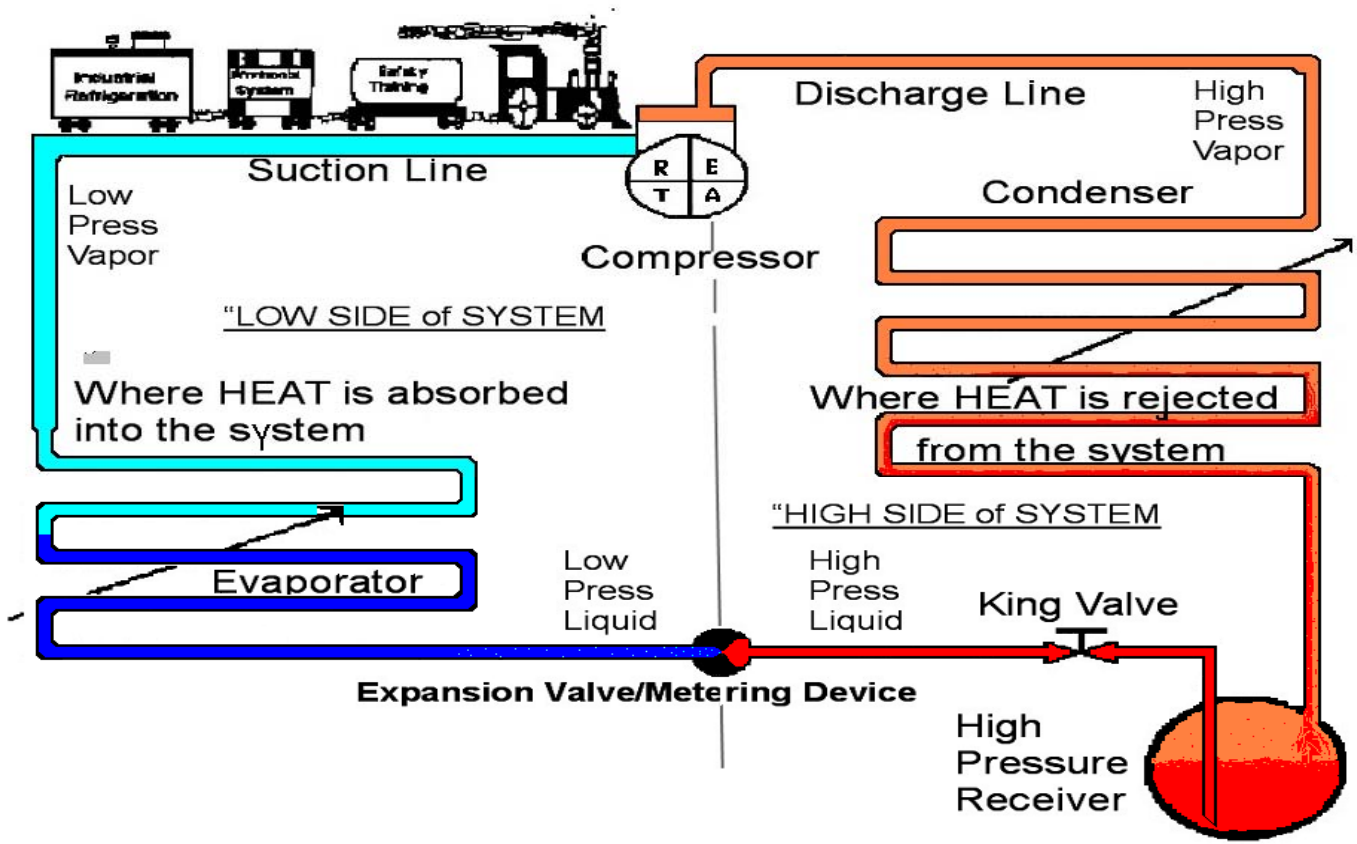
Discharge Line
High
Press
Vapor
Suction Line
Low
Press
Vapor
Condenser
Compressor
"LOW SIDE of SYSTEM
Where HEAT is absorbed
into the system
Where HEAT is rejected
from the system
"HIGH SIDE of SYSTEM
Evaporator
Low
Press
Liquid
High
Press
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Challenge to all Operators- Old and New

March 24, 2011

- (Specific list of things every operator should know and be able to do.)

Challenge to all Operators- Old and New

- #1:You need to have the attitude that **Learning Is Fun.**

Challenge to all Operators- Old and New

- #2:**You should be able to draw a sketch of your HPR** and accurately locate and describe all the piping connections, especially the HPL line and the King Valve.

Challenge to all Operators- Old and New

- #3: **You should be able to draw your entire system** (in a block flow diagram format) and represent every compressor, condenser, metering device, and evaporator, along with all vessels and pressure regulators if present. You should be able to draw and explain this system to all of the top management and engineers in your organization, with few notes if any, while explaining all the pressures, temperatures, the relative speed of flow and the condition of the refrigerant in every component.

Challenge to all Operators- Old and New

- #4: You should know "**how close to perfect**" you can operate your system in regards to head pressure and non-condensables. In other words how close can you get your actual system head pressure to the pressure that corresponds to your actual system condensing temperature. Within 6 psig, 5? 3? 2?

Challenge to all Operators- Old and New

- #5. You must be able to explain to me why I consider **the evaporative condenser** to be the most important component in the system. (My list, my opinion). Hint: How maintaining it properly can pay for your salary; or how not maintaining it can cost your company big bucks.

Challenge to all Operators- Old and New

- #6. **You must be an expert on the construction of Hand Valves**. (Why? Because through investigations the Chemical Safety Board says that most NH3 releases are related to valves). You must be able to explain everything about the valves you have in your system while using the correct terminology. (**Body Style**: globe, angle, ball, other; **Connection Type**: threaded, socket weld or butt weld; **Bonnets**: bolted or threaded; **Stems**: stainless or carbon steel; **Packings**: graphite, teflon or "O" rings. If "O" rings, single or double; **Seats**: moveable (lead, teflon or other) and stationary; **Hand wheels or Seal Caps**; **Directional Arrow**; etc.

Challenge to all Operators- Old and New

- #7. **You must be able to explain the function(s) of every system "safety" that you have in your plant.** You will be reading this off of a "chart or table" that you made (or that your plant already had). You will explain where these safeties are physically located, what their purpose is, how they work, how you know when they have "alarmed" or "tripped", and how to reset them to put the system back into normal operation. Some examples of system safeties (alarms and shut downs) would be: Ammonia Detection, High Liquid Level(s), Low Liquid Level(s), High Pressure(s), High Temperature(s), Ventilation System Controls, Transfer System(s), etc.

Challenge to all Operators- Old and New

- #8:**You must be able to explain all these items above in great detail**.

  My philosophy is this…if you can't explain it, then you don't know it well enough yet. Keep practicing until you can.

Challenge to all Operators- Old and New

- When you accomplish these tasks, then you will be in a very elite group of operators.

Courtesy of Russell Ramos, Joseph H. Schauf Co.,
Cell: 559-351-4288)