AirCon Academy

EPA Certification

Preparatory Course

1

Section I R-410A and the HCFC Phase Out

2

Background

- Chlorine based refrigerants contribute to the depletion of the earth's stratospheric ozone.
- In recent years, the HVACR industry has supported global efforts to transition to safer non-chlorine based refrigerants.
- HCFCs, (including R-22) that have been widely used in air conditioning and refrigeration applications since the 1940's, are being phased out.
- 1987 the U.S. and 22 other countries sign the original Montreal Protocol establishing timetables and phase-out schedules for CFCs and HCFCs.

3

Additional Background

- 1990 The Clean Air Act (CAA) signed in the U.S. calling for refrigerant, production reductions, recycling and emission reduction and the eventual phase-out of CFCs and HCFCs.
- 1992 unlawful to vent CFCs and HCFCs into the atmosphere.
- 1994 technician certification required for purchasing and handling of CFCs and HCFCs.

4

Additional Background

- 1995 unlawful to vent alternate (substitute) refrigerants such as HFCs, into the atmosphere.
- 1996 phase-out of CFC refrigerant production in the U.S.
- 1996 cap HCFC production levels.

5

Phase- Out

PHASE-OUT CHART			
Montreal Protocol		United States	
Year	Consumption % Reduction	Year	HCFC Phase-out
2004	35.0%	2003	No production and no importing of HCFC-141b

- HCFCs are being phased-out.
- In response, many manufacturers are building air conditioning equipment using HFC based R-410A.
- 1996 is the Base Line year on which the % of reduction is based.

6

Phase- Out

PHASE-OUT CHART			
Montreal Protocol		United States	
Year	Consumption % Reduction	Year	HCFC Phase-out
2010	65%	2010	No production or importing of HCFC-142b and HCFC-22, except for use in equipment manufactured before 1/1/2010 (no production or importing for NEW equipment that uses these refrigerants)

- 2010 phase-out HCFC-22 (R-22) for new equipment.

7

Phase- Out

PHASE-OUT CHART			
Montreal Protocol		United States	
Year	Consumption % Reduction	Year	HCFC Phase-out
2015	90%	2015	No production and no importing of any HCFCs, except for use as refrigerants in equipment manufactured before 1/1/2010

8

Phase- Out

PHASE-OUT CHART			
Montreal Protocol		United States	
Year	Consumption % Reduction	Year	HCFC Phase-out
2020	99.5%	2020	No production and no importing of HCFC-142b and HCFC-22

- 2020 Phase-out HCFC-22 production.

9

Phase- Out

PHASE-OUT CHART			
Montreal Protocol		United States	
Year	Consumption % Reduction	Year	HCFC Phase-out
2030	100%	2030	No production and no importing of any HCFCs

10

The Future

- HFCs such as R-410A, R-407C and R-134a are the refrigerants of choice for this generation.
- As we continue to transition to R-410A, R-407C and R-134a, we could see technological changes and pressures that may bring newer refrigerants and more transition.

11

The Future

- With increased attention to global warming and climate change, we may see a new family of refrigerants and changes in refrigeration and air conditioning systems.
- Energy shortages, along with higher utility bills may bring increased demand for maintenance and service procedures that guarantee HVACR systems operate at their peak performance.

12

R-410A

- R-410A is a binary (two part) near-azeotropic mixture .

Presently marketed under the brand names of:

- AZ-20
- “Puron”
- “Suva”

13

Section II Refrigeration & Air Conditioning System Fundamentals

14

Some R-410A Basics

- R-410A operates at 40 – 70% higher pressures than R-22.
- Special cylinders, gauges and recovery equipment rated for higher pressures are necessary.
- R-410A utilizes Polyol Ester (POE) based oils.
- R-410A is more efficient than R-22, & has a lower TEWI. (Total Equivalent Warming Impact)
- R-410A is a near azeotropic, has a very small temperature glide (0.3) and fractionation potential.

15

Compression Issues

The compression ratio can determine how efficiently a system is operating. Compression ratio is calculated as follows:

$$\text{Compression ratio} = \frac{\text{Absolute discharge pressure}}{\text{Absolute suction pressure}}$$

R-410A Considerations:

- Compressors have been redesigned with increased wall thickness due to the higher pressures associated with R-410A.
- Compressor IPR, high / low pressure switch settings are different for R-22 and R-410A.

16

Compression Issues

R-410A Considerations:

- The IPR will open at a pressure 550 - 625 psig for R-410A systems.
- The high pressure switch opens at 610 psig ± 10 psig and closes at 500 psig ± 15 psig.
- The low pressure control will open at 50 psig.
- The discharge temperature of R-410A is lower than R-22 due to its higher vapor heat capacity.

17

Condenser Issues

R-410A Considerations:

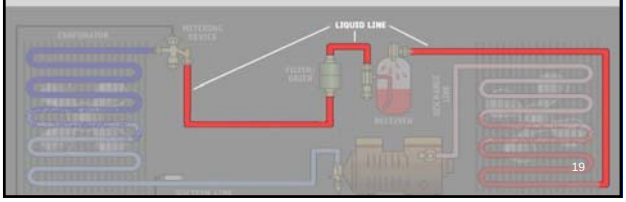
- Equipment designed for R-22 cannot withstand the higher pressure of R-410A.
- The condensing unit must be replaced with a specific model designed for R-410A.

18

Liquid Line Issues

R-410A Considerations:

- Liquid lines used with R-22 may be used with R-410A if sized correctly and cleaned properly.
- Liquid may either lose or gain subcooling depending on the surrounding temperature.



19

Filter / Drier Issues

R-410A Considerations:

- Liquid line filter driers must have rated working pressures of no less than 600 psig and must be approved for use with R-410A.
- The technician must always check with the system manufacturer for specific drier recommendations if unsure of what filter drier to use.

20

Metering Device Issues

R-410A Considerations:

- R-410A metering devices are designed to be about 15% smaller than in R-22 systems to achieve the same capacity.
- Metering device for R-410A and R-22 systems are not interchangeable.

21

Evaporator Issues

R-410A Considerations:

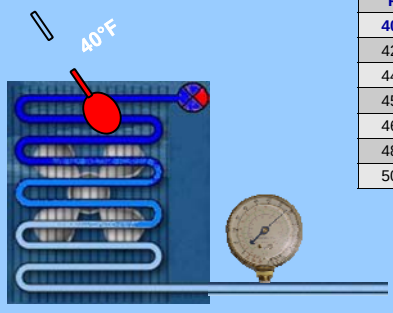
- The evaporator or indoor coil should be removed when changing out existing equipment and be replaced with a R-410A specific model.
- Some R-22 indoor coils meet the UL design & service pressure rating of 235 psig, (confirm with the manufacturer before using R-22 indoor coils with R-410A).

22

Temperature & Pressure

Evaporator

R-22



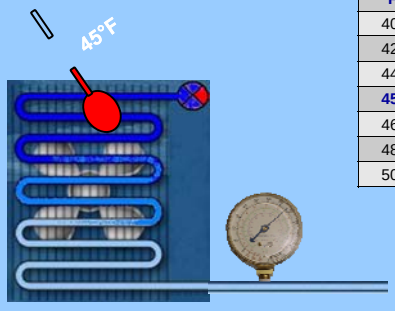
PT Chart	
°F	Psig
40	**68.5**
42	71.5
44	74.5
45	76.0
46	77.6
48	80.7
50	84

23

Temperature & Pressure

Evaporator

R-22



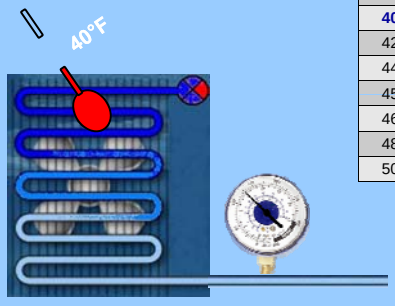
PT Chart	
°F	Psig
40	68.5
42	71.5
44	74.5
45	**76.0**
46	77.6
48	80.7
50	84

24

Temperature & Pressure

Evaporator

R-410a



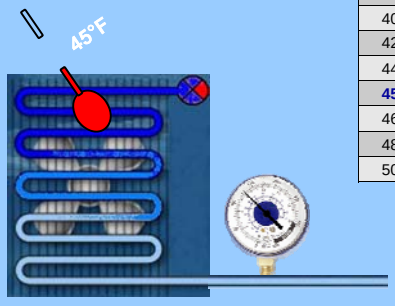
PT Chart	
°F	Psig
40	**118.0**
42	123.6
44	128.3
45	129.0
46	133.2
48	138.2
50	142.2

25

Temperature & Pressure

Evaporator

R-410a



PT Chart	
°F	Psig
40	118.0
42	123.6
44	128.3
45	**129.0**
46	133.2
48	138.2
50	142.2

26

Suction Line Issues

R-410A Considerations:

- Suction lines used with R-22 can also be used with R-410A providing they are correctly sized and properly cleaned.
- Always make sure all components such as reversing valves, expansion valves and filter driers are specifically designed for R-410A.

27

Section III Refrigeration Chemistry & Applications


28

Refrigerant Blends

Near azeotropic mixtures (NARMs) can be:

- HCFC based
- HFC based
- A combination of the two

Most blends are either:

- Binary – 2 refrigerants mixed together
- Ternary – 3 refrigerants mixed together

29

Blend Fractionation

Fractionation can occur in zeotropic and near azeotropic blends (NARMs).

- One or more refrigerants in the blend leaks at a faster rate than the other refrigerant.
- Causes a change in composition of the blend. Liquid and vapor must exist simultaneously.
- Different partial pressures of refrigerants causes different rates of leakage.

30

Blend Fractionation

When recharging a refrigeration system using near azeotropic blends:

- Use liquid refrigerant to avoid fractionation.
- Only remove liquid from recharging cylinder to ensure proper blend is recharged into system.
- When adding liquid refrigerant, liquid must be throttled to the low side of the system to avoid compressor damage.

31

Temperature Glide

Temperature glide is a range of temperatures in which NARMs evaporate and condense.

- Temperature glide depends on the system design and blend makeup.
- Temperature glide can range from 0.2° to 16° F.
- Temperature glide for R-410A is less than 0.3° F over air conditioning and refrigerating operating ranges.

32

A Word About R-407C

The rundown on R-407C:

- R-407C has a high temperature glide.
- R-407C may fractionate into its component refrigerants.
- When calculating the subcooling with R-407C, use the bubble point value only.

33

A Word About R-407C

The rundown on R-407C:

- When calculating the superheating with R-407C, use the dew point value only.
- R-407C pressures and temperatures are similar to those of R-22.
- R-407C has a slightly lower efficiency than R-22.

34

Bubble & Dew Point

R-407C

TEMP (°F)	BUBBLE (Psig)	DEW (Psig)
0	29.5	19.4
10	39.6	27.8
20	51.3	37.8
30	64.8	49.4
40	80.4	63.0
50	98.1	78.7
60	118.2	96.7
70	140.9	117.1
80	166.2	140.4
90	194.6	166.5
95	209.9	180.8
100	226.0	195.9
105	243.0	211.9
110	260.8	228.7
120	299.0	265.3
130	341.0	305.8
135	363.4	327.6
140	386.9	350.5
145	411.3	374.6
150	436.8	399.8

Saturated Evaporator Temperature

Condensing Temperature

35

Calculate Superheat for R-407C

Pressure vs. Temperature R-407C		
TEMP (°F)	BUBBLE (Psig)	DEW (Psig)
0	29.5	19.4
10	39.6	27.8
20	51.3	37.8
30	64.8	49.4
40	80.4	63.0
50	98.1	78.7
60	118.2	96.7
70	140.9	117.1
80	166.2	140.4
90	194.6	166.5
95	209.9	180.8
100	226.0	195.9
105	243.0	211.9
110	260.8	228.7
120	299.0	265.3
130	341.0	305.8
135	363.4	327.6
140	386.9	350.5
145	411.3	374.6
150	436.8	399.8

1. Operate the system and note the low side gauge pressure reading.
2. Using an accurate thermometer, determine the evaporator outlet temperature.
3. Using the Dew Point temperature column of the chart, convert the obtained pressure reading to temperature.
4. Deduct the Dew Point temperature from the evaporator outlet.

36

Calculate Subcooling for R407C

Pressure vs. Temperature R-407C		
TEMP (°F)	BUBBLE (Psig)	DEW (Psig)
0	29.5	19.4
10	39.6	27.8
20	51.3	37.8
30	64.8	49.4
40	80.4	63.0
50	98.1	78.7
60	118.2	96.7
70	140.9	117.1
80	166.2	140.4
90	194.6	166.5
95	209.9	180.8
100	226.0	195.9
105	243.0	211.9
110	260.8	228.7
120	299.0	265.3
130	341.0	305.8
135	363.4	327.6
140	386.9	350.5
145	411.3	374.6
150	436.8	399.8

1. Operate the system and note the high side gauge reading.
2. Using an accurate thermometer determine the condenser outlet temperature.
3. Using the Bubble Point temperature column of the chart, convert the obtained pressure reading to temperature.
4. Deduct the condenser outlet temperature from the Bubble Point temperature.

37

R-410A Basic Service Tools

Gauge Manifold Considerations:

- High side gauge must range to 800 psig.
- Low side gauge must range to 250 psig with 550 psig retard.
- All service hoses must have a service rating of 800 psig.

R-410A Gauge Manifold

Recovery Equipment

38

Micron Gauge and Vacuum Pumps

- The system must be evacuated to 500 microns and the filter/drier must be changed each time the system is opened.






39

Recovery Cylinders

- R-410A recovery cylinders must have a DOT rating of 4BA 400 or 4BW 400

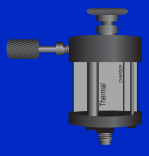
40

R-410A System Charging

R-410A System Charging Basics:

- Use liquid R-410A
- Cylinders with dip tubes can be used in the upright position.
- Cylinders without dip tubes must be turned upside down.
- Can be charged as vapor as long as all contents are charged into system.
- Throttle liquid into low side of the system.

Cylinder w/Dip Tube



Throttling Valve

41

System Charging

Do NOT clear sight glass when charging:

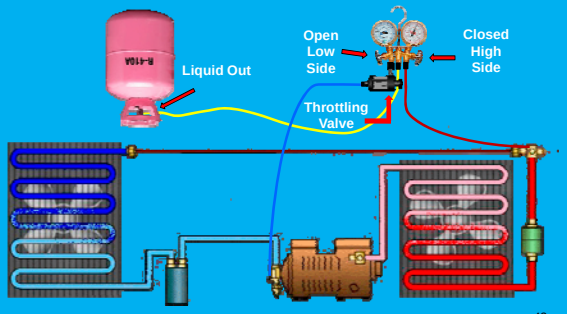
- Liquid may flash to vapor in sight glass
- Flash gas will reform to 100% liquid
- Attempts to clear sight glass may overcharge system

- Charge for Proper Subcooling and / or Superheating.
- In systems using a thermostatic expansion valve, follow the manufacturers recommended practice to check for proper charge conditions.

42

System Charging

Adding Refrigerant to an Operating System

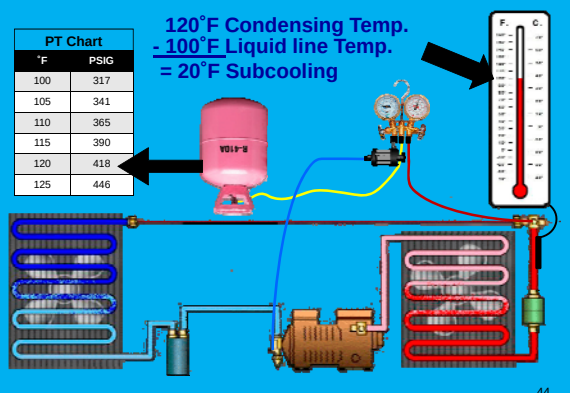


43

System Charging

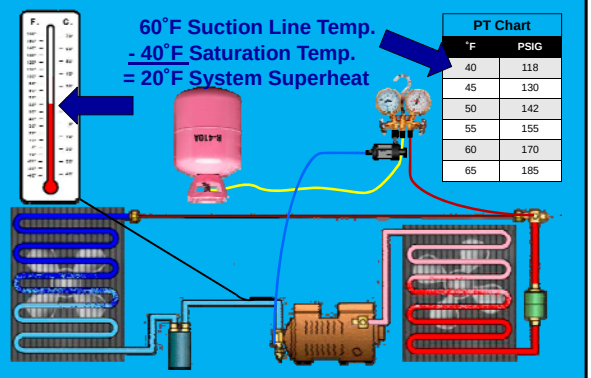
120˚F Condensing Temp.
- 100˚F Liquid line Temp.
= 20˚F Subcooling

PT Chart	
˚F	PSIG
100	317
105	341
110	365
115	390
120	418
125	446



44

System Charging



PT Chart	
˚F	PSIG
40	118
45	130
50	142
55	155
60	170
65	185

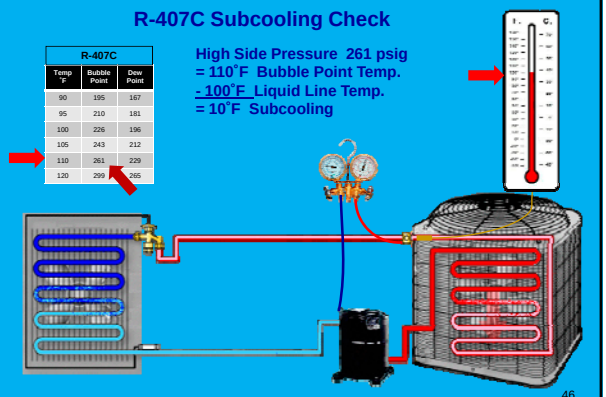
45

System Charging

R-407C Subcooling Check

R-407C		
Temp ˚F	Bubble Point	Dew Point
90	195	167
95	210	181
100	226	196
105	243	212
110	261	229
120	299	265

High Side Pressure 261 psig
= 110˚F Bubble Point Temp.
- 100˚F Liquid Line Temp.
= 10˚F Subcooling



46

Leak Detectors

- A leak detector capable of detecting HFC refrigerant must be used with R-410A
- If a R-410A system develops a leak, the remaining refrigerant may be used because R-410A has a low fractionation rate

47

Section IV
Oils

48

Refrigerant Oils

Oil functions

- Minimizes mechanical wear
- Acts as the seal between the discharge and suction sides of the compressor.
- Prevents excessive blow by around a piston in a reciprocating compressor.
- Acts as a noise dampener.
- Performs heat transfer tasks.

49

Refrigerant Oils

Alkylbenzene

- HCFC- based refrigerant blends perform best with alkylbenzenes lubricants.
- Alkylbenzenes and scenes can be mixed with up to 20% mineral oil.
- Mineral oil systems won't require extensive Flushing.

50

Refrigerant Oils

Polyalkylene glycols, or PAGs

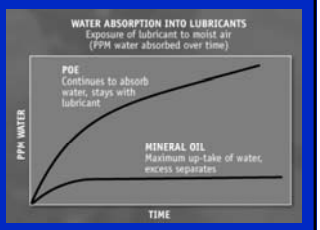
Drawbacks

- They are very hydroscopic.
- Some are not fully soluble and will separate.
- They have poor aluminum on steel lubricating abilities.
- They have very high molecular weight.
- They can be harmful if inhaled insert concentrations.
- They have been known to have reversed solubility in some refrigeration systems.

51

Refrigerant Oils

Polyol Ester



Advantage

- Used in many HFC-based systems.
- Wax free oil
- Lower pour point

Disadvantage

- Very hydroscopic

52

Section V Safety

53

Safety

Safety Basics:

- When handling refrigerants:
  - wear eye protection
  - wear gloves.

Electrical Safety:

- Before working on any circuit power should be shut off, locked and tagged at the distribution panel.

54

Safety

Compressed Gas Safety:

- Full Nitrogen cylinders have a pressure of approximately 2500 psig.
- Only move nitrogen cylinders with the protective cap on.
- R-410A cylinders should not be allowed to exceed 125º F.

55

Safety

Refrigerant Leak Precautions:

- If a large refrigerant leak should occur in an enclosed area, you should immediately ventilate and vacate the area.

56

Safety

POE Lubricant Safety:

- POE's can be irritating to the skin
- POE's are extremely "Hygroscopic"
- POE's have improved heat transfer characteristics over mineral oil.

57

Safety

Policies

- OSHA – Occupational Safety & Health Administration
- Federal & State regulations
- Company or job site regulations
- ASHRAE Standard 34

58

Safety

Concerns

59

This concludes the 410a training module.

Please download the handouts and read over the material.

Good luck and see you on the next module.

60