



HVAC

Flexible Instruction Day

Assignment #5

Learning Standard	Standard CC.3.5.11-12.D Determine the meaning of symbols, key terms, and other domain specific words.
Task # 501	Identify piping materials

CONTACT INFORMATION/ASSISTANCE

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We will be available by email from 7:40-12, and 12:30-3:10 to answer your questions. Please reach out if you are having difficulty completing your assignments.

INSTRUCTIONS

✓ All work is due on the day we return to school. This is counted towards your attendance **and** as a classroom assignment.

Please use Unit 7 PowerPoint and note packet to complete the Quiz.

Name: _____

Session: _____

_____/____ points

Inclement Weather: Assignment 5

Basic Piping

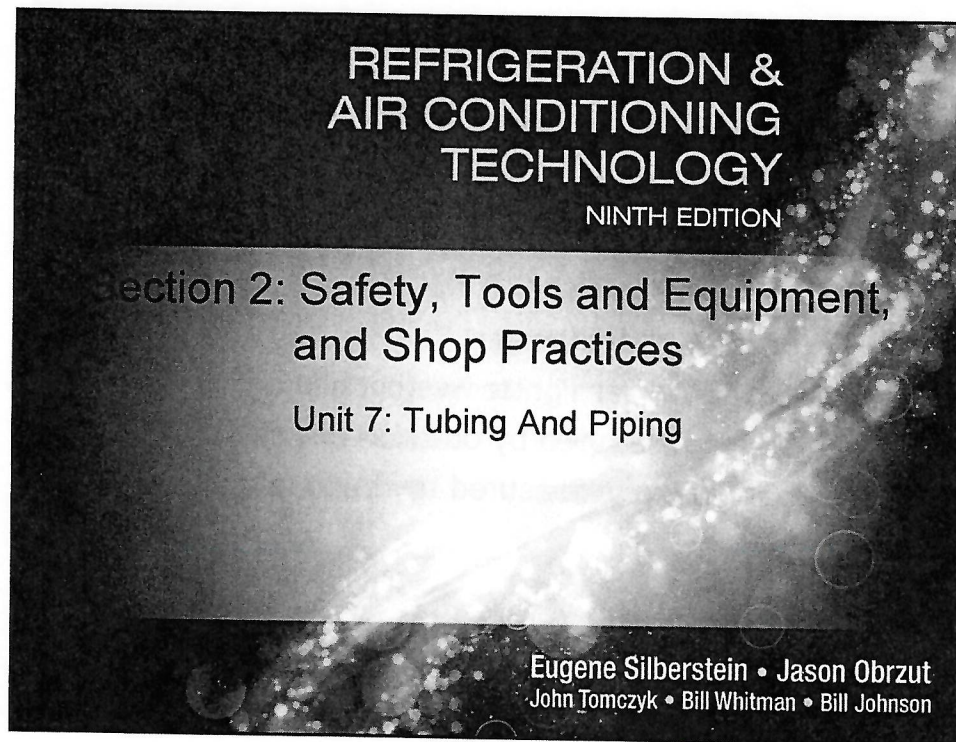
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Please use Unit 7 PowerPoint and note packet to complete the Quiz.

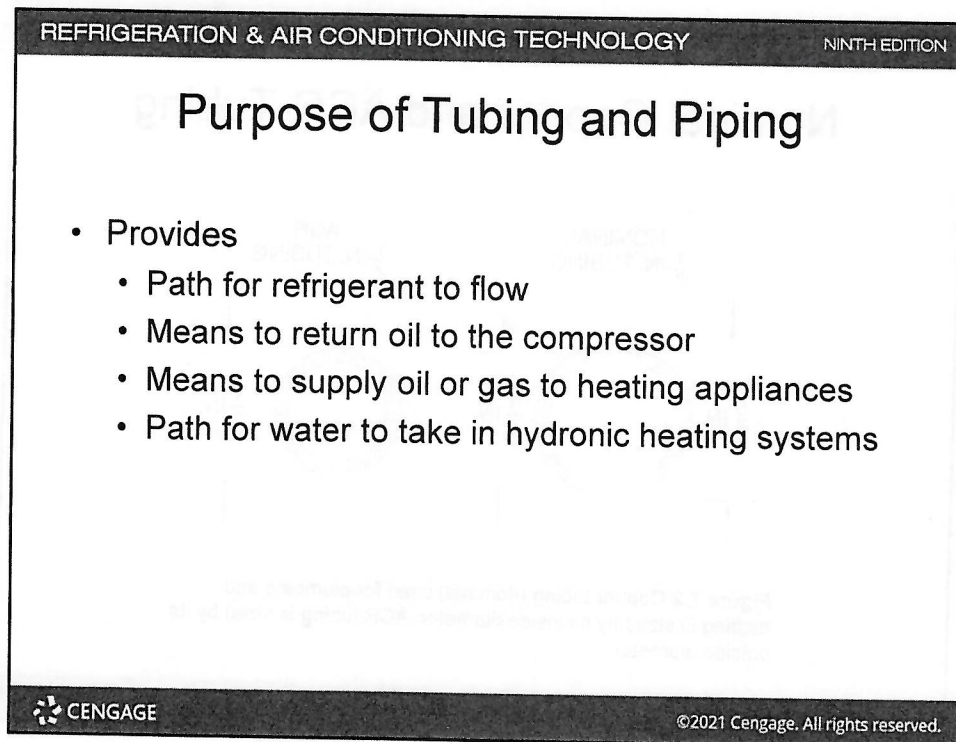
Please note that this assignment will be part of your participation grade for the day. This needs to be returned completed the day of return. If this is not returned you will NOT receive your participation grade for the day. You will also be marked absent for the day if not completed.

_____ COMPLETE

_____ INCOMPLETE



1



2

Types and Sizes of Copper Tubing

- Soft or hard drawn tubing
- "K" pipe is heavy duty
- "L" pipe is standard weight
- "M" and "DWV" are lighter weight piping
- ACR tubing measured by outside diameter
- Nominal tubing is measured by inside diameter

Nominal Copper and ACR Tubing

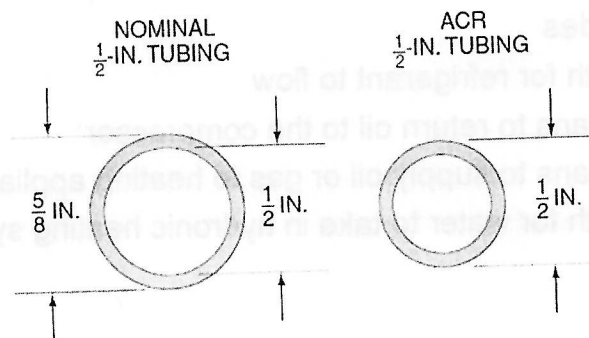


Figure 7.2 Copper tubing (nominal) used for plumbing and heating is sized by its inside diameter. ACR tubing is sized by its outside diameter.

Tubing Insulation

- Used on the low-pressure side of an air-conditioning or refrigeration system to keep the refrigerant from absorbing excess heat
- Prevents condensation from forming on the lines
- Closed-cell structure eliminates the need for a vapor barrier
- Inside surface usually powdered to allow easy slippage

Line Sets

- Tubing can be purchased in bundles called line sets
- One type comes precharged with refrigerant and each of the lines is sealed at both ends
- Another type comes with nitrogen-charged lines, just like standard ACR tubing

Cutting Tubing

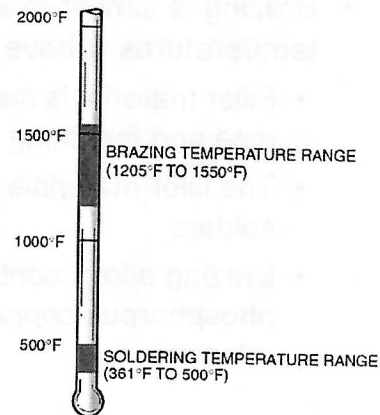
- Tubing can be cut with a hacksaw or tubing cutter
 - Tubing cutters for refrigeration lines and smaller tubing
 - Hacksaws for larger diameter hard-drawn tubing
- Remove burrs from tubing after cutting
- All cuts must be perfectly straight

Bending Tubing

- Only soft-drawn tubing should be bent
- Use as large a radius as possible
- Do not allow tubing to kink or flatten
- Tubing can be bent with a bending spring or lever-type bender
- Bending springs can be used on either the inside or outside of the tubing

Soldering and Brazing Temperatures

Figure 7.22 Temperature ranges for soldering and brazing.



Soldering Processes

- Process used to join piping material to fittings
 - Soldering is done in the 361°F to 500°F range
 - Filler material is melted into the gap between the pipe and the fitting
 - The filler material is called solder
 - 50/50 solder is 50% tin and 50% lead
 - 95/5 solder is 95% tin and 5% antimony

Brazing Processes

- Brazing is similar to soldering but requires higher temperatures (above 842°F)
 - Filler material is melted into the gap between the pipe and the fitting
 - The filler materials are called silver solders or hard solders
 - Brazing alloys contain 15% - 60% silver or phosphorous copper

A Soldered Joint

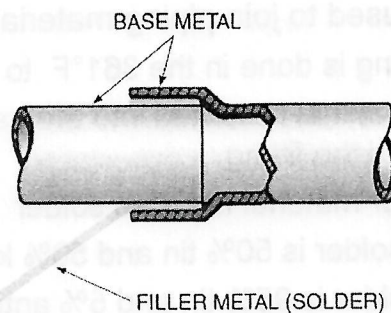


Figure 7.24 The molten solder in a soldered joint will be absorbed into the surface pores of the base metal.

Types of Torches

- Torches: propane, butane, MAPP™, air-acetylene and oxy-acetylene torches are commonly used
- The torch kit consists of a fuel tank, regulator, hose, and torch tips
- Torch tips are available in a wide range of sizes and styles

Setting Up the Air-acetylene Torch

- Setting up the air-acetylene torch
 - Quickly open and close tank to free any dirt
 - Connect regulator, hose, and torch to tank
 - Open tank one-half turn
 - Spray a soap bubble solution and look for bubbles that could indicate a leak
 - Open torch handle valve and ignite fuel with a spark lighter and adjust flame
 - Close all valves and bleed hose after use

Fluxing

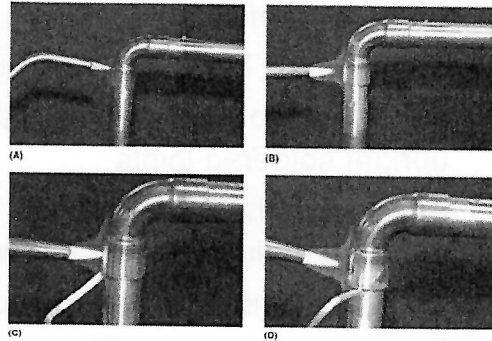
- The main function of flux is to prevent oxidation from forming on the surfaces of the pipes being joined and in the filler materials themselves
- Helps facilitate the flow of the filler material into the joint

Soldering Techniques

- Clean the end of the pipe as well as the inside of the fitting
- Apply flux immediately after cleaning
- Assemble the joint
- Heat and apply solder
- Wipe the joint after soldering to remove excess solder

Soldering Techniques Illustrated

Figure 7.43 The proper procedures for heating a joint and applying solder (A) Start by heating the tubing. (B) Keep the flame moving. Do not point the flame into the end of the fitting. (C) Touch the solder to the joint to check for proper heat. Do not melt the solder with the flame. (D) When the joint is hot enough, solder will flow. *Photos by Bill Johnson*



Brazing Techniques

- Clean the pipes and fittings
 - Introduce 1 to 2 psig of nitrogen to the piping circuit
- Light the torch and uniformly heat the joint
 - Correct temperature when cherry red
- Apply filler material to completely fill the joint

Soldering and Brazing Tips

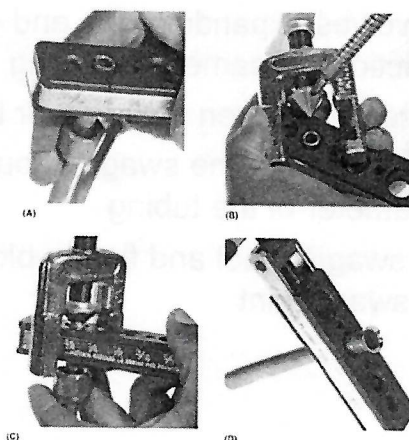
- Clean all surfaces
- Keep filings, burrs, and flux out of the pipe
- Apply heat to the top of the fitting when making upright soldered joints
- Apply more heat to the larger mass of metal when soldering fittings of different weights
- Do not overheat the connections
- Do not use too much filler material
- Clean the joints after soldering or brazing

Making Flare Joints

- Cut tube to the desired length and ream
- Slip flare nut over the end of the tubing
- Clamp the tube in the flaring block
- Place the yoke over the flaring block
- Turn the yoke screw down firmly to flare
- Remove the tubing from the block and inspect for defects
- Assemble the joint

Procedure for Making Flare Joints

Figure 7.51 (A) Secure the tubing in the flaring block. (B) Position the yoke on the block, centered over the tubing. (C) Tighten the yoke to form the flare. (D) Inspect the completed flare. *Photos by Bill Johnson*



Making A Double-Thickness Flare

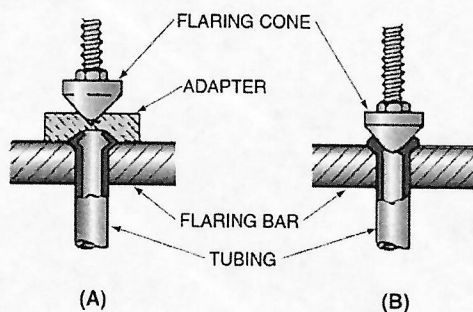


Figure 7.52 Procedure for making a double-thickness flare. (A) Place the adapter of the combination flaring tool over the tubing in the block. Screw down to bell out the tubing. (B) Remove the adapter, place a cone over the tubing, and screw down to form the double flare.

Swaging Techniques

- Involves expanding one end of tubing to join two sections of same size tubing
- The joint is then soldered or brazed
- The depth of the swage should be equal to the diameter of the tubing
- A swaging tool and flaring block are needed to make a swage joint

A Swage Connection

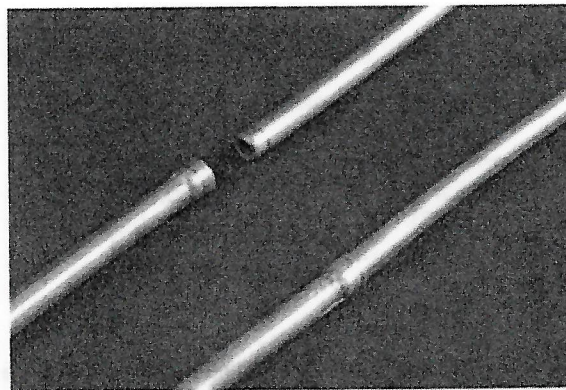
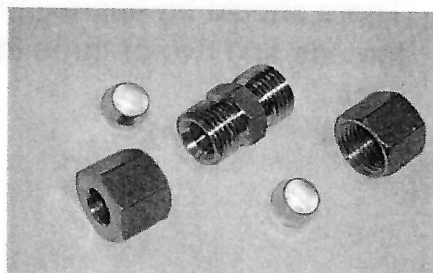


Figure 7.54 A swage connection.

Compression Fittings

- For joining sections of soft-drawn tubing
- Primarily used on piping that carries water, not refrigerant

Figure 7.57 Component parts of a compression fitting.
Photo by Eugene Silberstein



Steel and Wrought Iron Pipe

- Seam welded or produced without a seam
- Painted, left black, or galvanized (zinc coated)
- Plumbing, hydronic heating, and gas heating applications
- Pipe size is referred to as the nominal pipe size, which is approximately equal to the inside diameter of the pipe

Joining Steel Pipe

- Joined by welding or by using threaded fittings
- Tapered threads are used on pipe and fittings
- Tapered threads reduce the chance of leaks
- There should be approximately seven perfect threads and two or three imperfect threads for each joint

Cutting Steel Pipe

- Cutting:
 - Can be cut with a hacksaw or a pipe cutter
 - All cuts must be perfectly square
 - Overtightening the cutter can result in a large burr in the pipe and the shortened life of the cutting wheel
 - Ream the pipe after cutting is complete

Threading Steel Pipe

- Secure the pipe in a pipe vise and place cutting die on the end of the pipe; apply oil
- Turn the die onto the pipe, using the stock as a ratchet
- Turn the die one or two turns and then back the die off the pipe $\frac{1}{4}$ turn
- Repeat oiling and threading until the pipe is flush with the far side of the die

Example of How to Cut Steel Pipe

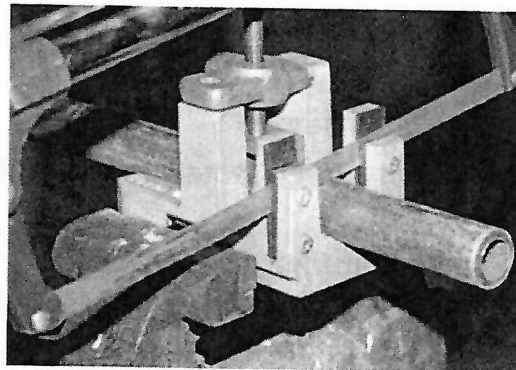


Figure 7.72 Cutting steel pipe with a hacksaw and a holding fixture. *Photo by Bill Johnson*

Installing Steel Pipe

- Tips:
 - Pipe wrenches are used to hold and/or turn pipes and fittings
 - Apply pipe dope to the male threads
 - Avoid getting dope on the two threads at the end of the pipe
 - Use two wrenches to tighten a connection
 - The wrenches should be positioned in opposite directions

Plastic Piping Materials

- ABS: for drains, waste, and venting
- PE: for water, gas, and irrigation
- PVC (polyvinyl chloride)
 - Can be used for high pressure applications at low temperatures
- CPVC (chlorinated polyvinyl chloride)
 - For temperatures up to 180°F at 100 psig

Joining Plastic Piping Materials

- Cut the pipe square
- Remove any burrs from the end of the pipe
- Clean the end of the pipe and apply primer if required
- Apply cement to the inside of the fitting and the outside of the end of the pipe
- Insert the pipe all the way into the fitting
- Turn pipe about $\frac{1}{4}$ turn and hold for 1 minute

Alternative Mechanical Piping Connections

- Each method is unique and intended for specific purposes and applications
- Piping is joined by coupling/connection device, crimping, or press-on fitting
- Eliminates the need for soldering

Joining Plastic Piping Materials

- Turn pipe about 1/2 turn and hold for 1 minute
- Insert the pipe all the way into the fitting
- outside of the end of the pipe
- Apply cement to the inside of the fitting and the
- required
- Clean the end of the pipe and apply primer if
- Remove any burrs from the end of the pipe
- Cut the pipe square

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Alternative Mechanical Piping Connections

- Eliminates the need for soldering
- crimping, or press-on fitting
- Piping is joined by coupling/connection device,
- purposes and applications
- Each method is unique and intended for specific

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Copper Tubing

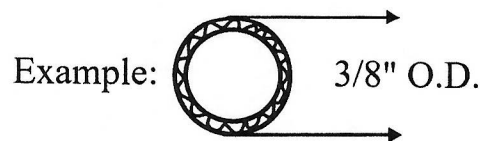
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Types of Copper Tubing

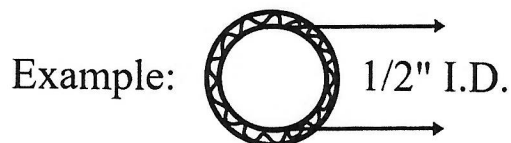
1.) ACR Tubing

- Stands for Air Conditioning and Refrigeration
- Soft Copper (Rolls of 50') Annealed Tubing
- Hard Drawn (20' Lengths) Hardened Tubing
- Comes Dehydrated and Capped
- Pressured with nitrogen (Dry inert gas)
- Measured by outside diameter



2.) Nominal Tubing

- Plumbing Trade Tubing
- Nominal (Approximate) Size
- Soft Copper
- Hard Drawn (Rigid)
- Used on water lines, boilers, or anything from the plumbing trade



Wall Thickness:

- Type:
 - K = Heavy Wall (Green) Industrial
 - L = Standard Wall (Blue) A/C and water lines
 - M = Thin Wall (Red) low pressure systems – EX. Boilers
 - DMV = Drain, Waste, and Vent (Yellow)
 - Thin wall
 - Non - Pressurized Systems

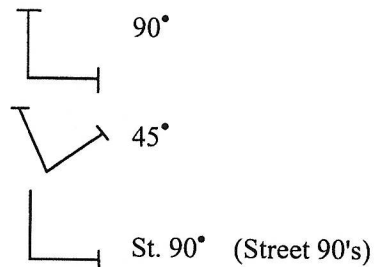
Copper Tubing

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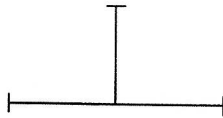
Ways to Join Copper Tubing

1.) Fittings (Store Bought)

- Elbows



- Tees



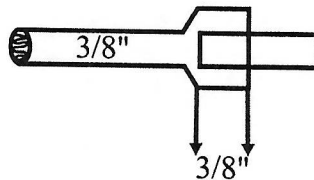
- Collars (Couplers)



- Many More.....

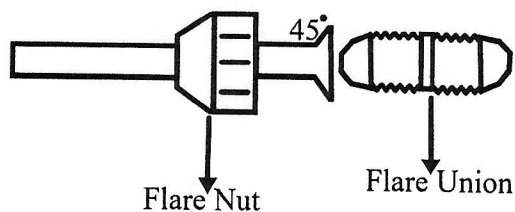
2.) Swage (Field Produced)

- Can join two pieces of alike size tubing
- Swage Depth should be equal to diameter of tubing



3.) Flare Fittings

- Mechanical Fitting
- Good for water, fuel, or refrigeration



4.) Press Fitting

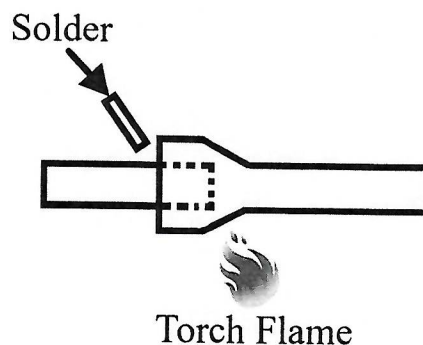
- Special Copper Fittings (Expensive)
- Saves time and labor
- Cordless tool usually 18 volt
- Used on water, air, fuel, refrigerant

5.) Soldering

- Completed air temperatures below 800°F

Solder	Melting Point	Flow Point	Plastic Range
50/50 50% Tin 50% Lead	360°F	420°F	60°F
95/5 95% Tin 5% Antimony	452°F	464°F	12°F
Silver Bearing 96% Tin 4% Silver	430°F	430°F	0°F

- Antimony strengthens the solder
- Flux: Oil based paste that slows down the oxidation process and provides flow for the solder
- Material needed to solder and their order
 - 1.) Copper tubing cut to length
 - 2.) Reamer – Removed the burr
 - 3.) Fitting brush – removes oxides
 - 4.) Emery cloth – oxides
 - 5.) Flux slows the down the oxides
 - 6.) Solder (Filler Material)
 - 7.) Fuel (Flame) Melt + flow the solder
 - 8.) Damp Rag – Clean the joint
- Capillary Action: The point where allow automatically fills the gap between two base metals



Copper Tubing

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6.) Brazing

- Hard Soldering
 - Completed at temperatures above 800°F
 - Fuels:
 1. Air Acetylene
 2. Turbo Torch
 3. Oxy – Acetylene (Can reach temperatures above 6000°F)

- Alloys: Silphos Rods

AWS Number	Copper	Phosphorus	Silver	Melts	Flows
BCUP - 3	88.75%	6.25%	5%	1190%	1485%
BCUP - 5	80%	5%	15%	1190%	1500%

- Water based brazing flux can be used but it is not required. The phosphorus will act as its own fluxing agent.
- Range Of Temperatures
 - 212°F Water Boils
 - 1200°F to 1500°F Plastic range for various brazing alloys
 - 1700°F to 1800°F tubing turns red
 - 1981°F Copper melts
- Heat needs to be applied to the male end of the tubing to allow heat to conduct into the joint
- The braze joint using silphos will be stronger than the copper itself

AWS = American Welding Society

❖ Definition of Soldering:

- Anything soldered at 800°F and down = soft soldering
 - Ex:
 - 50/50 Lead/Tin (illegal)
 - 95/5 Tin/Antimony (Plumbing)
 - 96/4 Tin/Silver (ACR)
- Anything soldered at 800°F and up = hard soldering
 - Ex:
 - Brazing (Flux coated brass rod) metal repair
 - Silphos (Silver 15% Copper 80% Phosphorus 5%)
 - Silver Solder 60% Silver (Very Expensive)

Fuel Gas

❖ Propane 3623°F

- Lower temperature
- Portable
- Liquefied gas
- Soft soldering
- Can be used with oxygen for flame cutting

❖ Mapp Gas 5300°F

- Higher temperature than propane
- Portable
- Mixture of propane and acetylene
- Solder and brazing small diameter tubing

❖ Acetylene (Air) 6633°F

- Hotter than mapp gas and propane
- Multiple tank sizes
 - MC (Smallest) - B (Medium Size) - WS (Lrg.)
 - 10 Cu. Ft. - 40 Cu. Ft. - 150 Cu. Ft.
- Soldering and brazing
- Air acetylene/ Turbo Torch

Copper Tubing

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- ❖ Oxygen Acetylene (Oxy Acetylene) over 6000°F
 - Hottest of all fuel gas
 - Brazing and flame cutting
 - Multiple tank sizes

Tanks	Acetylene	Oxygen
Small Set	MC	R
Medium Set	WB	B – 40 Cu. Ft.
Large Set	WS	OS

Torch Parts

- 1.) Tanks oxygen and acetylene
- 2.) Tank regulators
- 3.) Check valves
- 4.) Manifold
- 5.) Torch tips
- 6.) Tip cleaners
- 7.) Hoses red (acetylene) reverse threads green (oxygen)
- 8.) Gauges (Tank pressure gauge) (regulated pressure gauge)

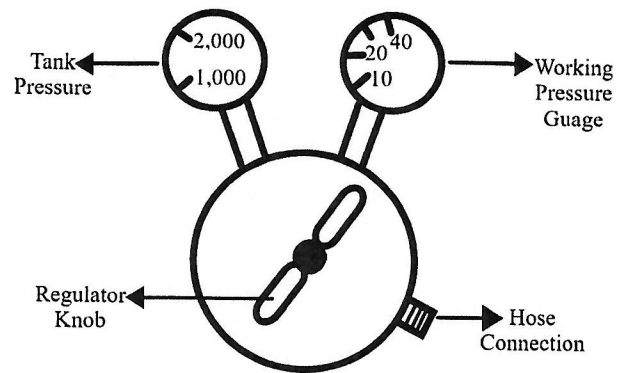
Brazing with Silphos

- ❖ Ferrous (Contains Iron) Non Ferrous (No Iron)
- ❖ Desired Flame: Neutral Flame
 - 5 psig oxygen
 - 5 psig acetylene

Copper Tubing

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Tank Regulators



Ways to Bend Copper Tubing

- ❖ Hand Bend
- ❖ Spring Bend
- ❖ Lever Bend
- ❖ Ratchet Bend

Unit 07: Tubing and Piping

Refrigeration and Air Conditioning Technology

- _____ 1. If a technician needed 5/8" ACR for an installation and was located near only a plumbing supply house, what size and type of pipe should he ask for?
- a. 1/2" ACR. b. 1/2" PVC.
 - c. 1/2" ID Copper. d. 5/8" PVC.
- _____ 2. The size indicated for the diameter of copper tubing used for **plumbing** is the ____.
- a. inside diameter b. outside diameter
 - c. wall thickness d. None of the above.
- _____ 3. The size indicated for the diameter of ACR copper tubing is the ____.
- a. inside diameter b. outside diameter
 - c. wall thickness d. None of the above.
- _____ 4. The maximum temperature at which soft soldering is done is ____.
- a. 212°F b. 400°F
 - c. 600°F d. 800°F
- _____ 5. Brazing is done at ____ soldering.
- a. the same temperature as
 - b. lower temperatures than
 - c. higher temperatures than
 - d. temperatures that can be higher or lower than
- _____ 6. When soldering or brazing, the solder is ____.
- a. heated directly by the flame of the heat source
 - b. heated by the surrounding air
 - c. used to oxidize the metal
 - d. melted by heat from the tubing and fitting
- _____ 7. Filler materials used in the brazing of copper joints are composed of ____.
- a. 50/50 tin-lead b. 95/5 tin-antimony
 - c. 5%-15% silver d. bronze
- _____ 8. Molten solder flows between the two base metals being soldered because ____.
- a. the atmospheric pressure pushes it in
 - b. of capillary attraction
 - c. there are no surface pores in the base metal
 - d. the tubing surface melts and the pressure differential forces it in

Unit 07: Tubing and Piping

Refrigeration and Air Conditioning Technology

- _____ 9. The proper type of flame from an oxyacetylene torch for silver brazing is _____.
a. long tail flame b. neutral flame
c. oxidizing flame d. carbonizing flame
- _____ 10. When soldering, why should flux be used?
a. It helps prevent oxidation. b. It helps keep pipes clean.
c. It helps solder flow easier. d. All of the above are correct.
- _____ 11. When soldering, flux should be applied to _____.
a. the male part of the joint only
b. the female part of the joint only
c. both the male and female parts of the joint
d. around the mated parts
- _____ 12. For cleaning ACR copper tubing before soldering, a material that can be used is _____.
a. steel wool b. carborundum cloth
c. emery cloth d. nylon wool
- _____ 13. Pipe threads are standardized by the A.N.S.I., A.N.S.I stands for _____.
a. All Nominal Standard Industry b. American National Standard Institute
c. All New Steel Inspection d. Apparent Nominal Standard Inside
- _____ 14. Pipe threads, when used on pipe that will contain liquid or vapor under pressure, _____.
a. are tapered
b. should have at least seven perfect threads
c. generally have a "V" shape
d. All of the above.
- _____ 15. When joining steel pipe, a _____ should be applied to the threads before connecting.
a. pipe dope b. flux
c. solder d. gasket

TRUE/FALSE

- _____ 16. K-type copper is heavy duty with a thick tubing wall.
- _____ 17. L-type copper is considered medium weight and is used most frequently.

Unit 07: Tubing and Piping

Refrigeration and Air Conditioning Technology

- _____ 18. M is a lightweight copper and is not commonly used in our industry.
- _____ 19. DWV copper stands for drain, waste and vent and is also a lightweight copper not typically used in the HVACR industry as far as refrigerant-carrying applications are concerned.
- _____ 20. When tubing is cut with a tubing cutter, a burr is produced in the process. This slight decrease in the inside diameter of the tube can adversely affect the operation of the system.
- _____ 21. When installing a refrigeration system, the piping should be connected with as few joints as possible.
- _____ 22. When soldering, the technician should heat the solder with the torch to allow it to melt.
- _____ 23. 95/5 tin-antimony solder can be used in any part of a refrigeration system.
- _____ 24. An air-acetylene unit usually consists of a B tank of acetylene gas, a regulator, a hose, and a torch.
- _____ 25. The use of flux is always required when soldering or brazing.
- _____ 26. The end of a piece of a steel pipe is reamed after it is cut with a pipe cutter to make it easier to start the thread die.
- _____ 27. ABS and PVC pipe can be used to carry the new blended refrigerants in low temperature applications.

COMPLETION

PLEASE USE THE WORD BANK FOR COMPLETION AND SHORT ANSWER

WORD BANK:

- PE
- CUTTING OIL
- ABS
- CPVC
- THREAD DIAMETER
- ACR
- NATIONAL PIPE TAPER
- PVC
- THE DIAMETER
- THREADS PER INCH
- CAPILLARY ATTRACTION
- BLACK IRON

Name: _____ Class: _____ Date: _____

Unit 07: Tubing and Piping

Refrigeration and Air Conditioning Technology

28. The copper tubing used in the field piping of refrigeration systems is type _____.
29. The tubing or pipe for natural gas supply to a gas heating unit is _____.
30. In order to thread steel pipe, _____ is applied so friction and heat do not damage the pipe and/or cutting dies.
31. In the thread specification 1/2-14 NPT, the 1/2 is the _____.
32. In the thread specification 1/2-14 NPT, the 14 stands for _____.
33. In the thread specification 1/2-14 NPT, the NPT stands for _____.
34. The abbreviation for the black plastic pipe used in systems for water drains, waste drains, and low-temperature vents is _____.
35. The abbreviation for the plastic pipe used in systems for water and gas supply lines and irrigation systems is _____.
36. The abbreviation for the plastic pipe used in high pressure systems at low temperature is _____.
37. The abbreviation for the plastic pipe used in hot and cold water supply systems is _____.

SHORT ANSWER

38. When soldering, by what force, the molten filler material flows between the two base metals?
39. When making a swage joint, what should the depth of the enlarged portion of the tube be?

Name: _____ Class: _____ Date: _____

Unit 07: Tubing and Piping
Refrigeration and Air Conditioning Technology

MATCHING

Match the term with its definition

- a. brazing
- b. work hardening
- c. flaring
- d. swaging
- e. annealing
- f. reaming
- g. soldering

- _____ 40. Operation that causes one end of a copper tube to expand at an angle for flare nut connection to system.
- _____ 41. Operation of heating and cooling tubing to make it softer.
- _____ 42. Accomplished at temperatures under 842°F.
- _____ 43. Removal of burrs and rough edges from tubing.
- _____ 44. Accomplished at temperatures above 842°F.
- _____ 45. Caused by excessive bending and straightening of tubing.
- _____ 46. Operation that allows two tubes of equal diameter to be joined together.

