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Various copper and steel tubing operations involved in HVAC field

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Abstract: In the HVAC (Heating, Ventilation, and Air Conditioning) industry, copper and steel tubing are essential materials used for various operations that are critical to system performance, durability, and efficiency. Copper, known for its excellent thermal conductivity and corrosion resistance, is widely used for refrigerant lines, while steel tubing provides structural integrity and strength in applications involving higher pressure systems. This abstract explores the key operations involved in the fabrication and installation of copper and steel tubing within HVAC systems. The processes examined include cutting, bending, flaring, swaging, pinching, brazing, and welding of both copper and steel tubes. Special emphasis is placed on the importance of correct material selection, tool usage, and safety procedures to ensure that tubing systems meet performance standards and regulatory requirements. The integration of these operations contributes significantly to system efficiency, reducing energy consumption and preventing operational failures in HVAC systems.

Keywords: HVAC, flaring, swaging, pinching, brazing, filler rod.

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I. INTRODUCTION

Copper and steel tubing play pivotal roles in HVAC systems, each offering unique properties that cater to specific applications within the field. Copper is renowned for its excellent thermal conductivity, making it a preferred choice for heat exchange processes in HVAC systems. Copper tubing is extensively used in refrigerant lines, condensers, evaporators, and heat exchangers due to its durability and resistance to corrosion. The development of internally grooved copper tubes has enhanced heat transfer efficiency, allowing for more compact and efficient HVAC units. Steel tubing, including stainless steel variants, is integral to HVAC systems, especially where strength and durability are paramount. Steel tubing is commonly used for transporting steam, chilled water, and other fluids in HVAC systems, particularly in commercial and industrial applications.

Understanding the specific operations and applications of copper and steel tubing is essential for designing efficient and reliable HVAC systems..

II. TOOLS AND EQUIPMENTS REQUIRED

1. Copper tubes (hard & soft) (3mm, 6mm, 12.5mm diameter)
2. Tube cutter
3. Bending tool
4. Flaring tool (block & yoke)
5. Pinching tool
6. Steel rule
7. Swaging tool
8. Brazing rod (60% copper+ 40% lead)
9. Blow lamp
10. Flux material
11. File

III. PURPOSE OF VARIOUS OPERATIONS ON COPPER AND STEEL TUBING

1. Tube Cutting

Tube cutting is the operation of cutting copper or steel tubes to the required length using tube cutter. If a tube cutter is used, the feed screw should not be unduly forced. It is better to take more turns of the cutting wheel since this prevents formation of a large burr.

2. Tube Bending

Tube bending is the operation of bending the tube to the required angle as per the need using various tube benders. The bending radius for tubes upto 0.5 inch diameter is 5 times the diameter of the tube and for tubes more than 0.5 inch diameter is 10 times the diameter. Bends in annealed copper tube can be made on the job by using lever-type benders or either internal or external bending springs.

3. Flaring

Flaring is the operation normally performed on the copper and steel tubing to enlarge the diameter of the tubes at the ends to prevent the flare-coupling nuts coming out of the tubes. Flaring should be properly done to avoid leaks when the nuts are fastened. Flares should be uniform and smooth. A carefully deburred tube permits formation of a smooth flare.

4. Swaging

Swaging is an operation done on two sections of identical size tubing that can be joined permanently. It is the expansion of one section of the tube at its end by a swaging punch so that one tube can be snugly fit into one another. The swaging joints must be always soldered.

5. Brazing

Brazing is the operation of joining the copper tubes by a filler rod with the application of heat.

6. Pinching

Pinching is the operation done on copper or steel tubes to shield the tube passage so that the leak of the refrigerant is avoided. It is also done on the system to remove any worn-out fittings in the line without pumping down the system.

IV. WORKING STEPS FOR CUTTING OPERATION

1. Measure the copper tube to the required length to be cut.
2. Place the copper tube in the 'V' guide of the tube cutter.

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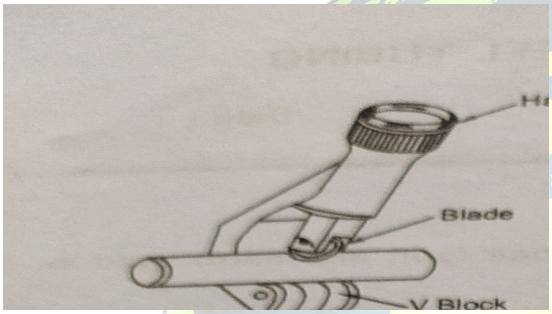
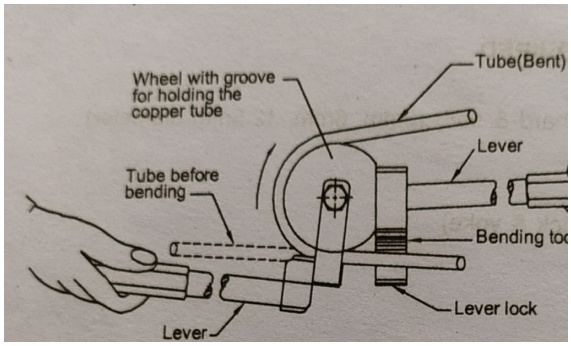
3. Place the cutting edge of the cutter at the point measured for cutting.
4. Tighten the thimble nut so that the cutting edge has a considerable pressure against the copper tube.
5. Slowly rotate the cutter around the copper tube in such a way that the cutting edge is gradually fed into the copper tube (visible cutting ring around the tube).
6. Apply pressure slowly with the thumb screw by turning the screw into the tube and give a turn to the cutting tool.
7. Repeat this till the tube is cut.
8. File the edge of the copper tube that is cut.
9. The ends of the copper tube must be sealed to protect it against dust, moisture etc., if it is cut in a refrigeration unit.



V. WORKING STEPS FOR BENDING OPERATION

1. After cutting the copper tube to the required length, the tube is required to be bent on a lever type tool bender at 90°, 180° bends (as required in the job).
2. Unscrew the nut, remove the bolt, fit the tube in the grooves both at the top and bottom and tighten the nut and bolt to lock the tube in the lever.
3. Hold the tube with the clamp holder
4. Hold the copper tube in the bending tool with the hands and bend it by turning the lever rod.
5. Repeat this process for further bending or as required in the job.



VI. WORKING STEPS FOR FLARING

1. The copper tube to be flared is cut according to the required size and is placed in the flaring block. The copper tube must be projected to a height above the block to about 1.5mm.
2. Tighten the clamp to lock the tube in position.
3. Select the yoke according to the diameter of the tube to be flared.
4. Attach the yoke to the flare block in such a way that the taper of the cone must be 45°.
5. Apply a small amount of oil on the cone and place the cone on the opening of the tube.
6. Slowly tighten the cone by screwing the handle of the yoke into the opening of the tube.
7. Flaring is made in the tube by the gentle tightening of the screw by rotating the handle.
8. Unscrew the screw handle and unlock the tube after the flaring is made.
9. Check for any defects.

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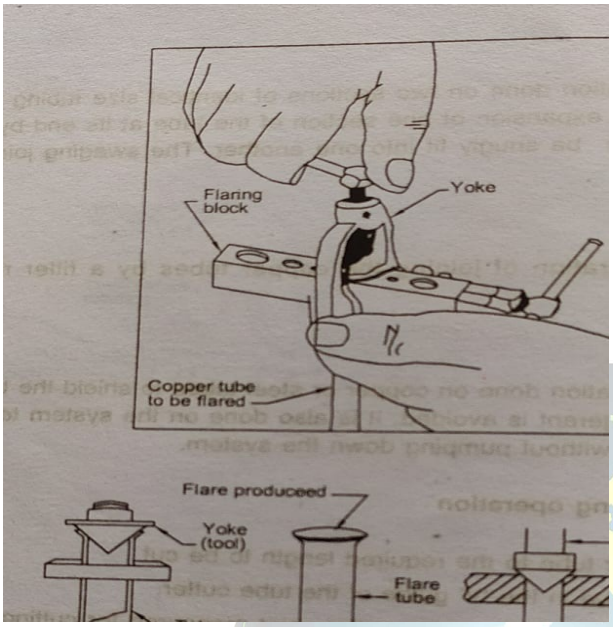
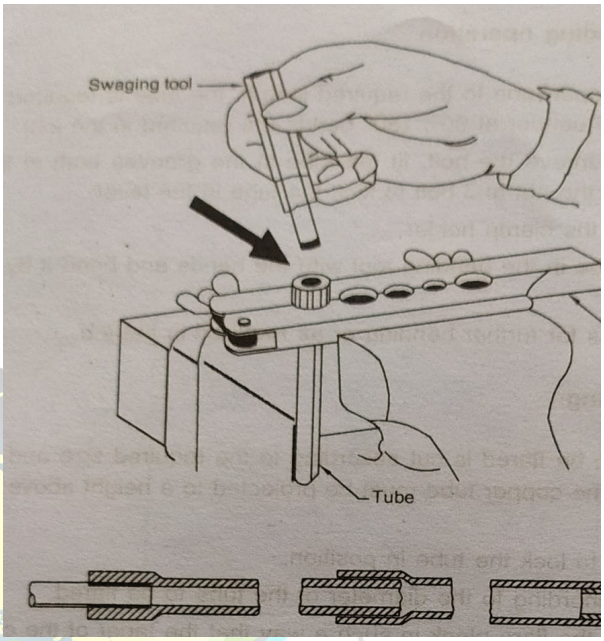
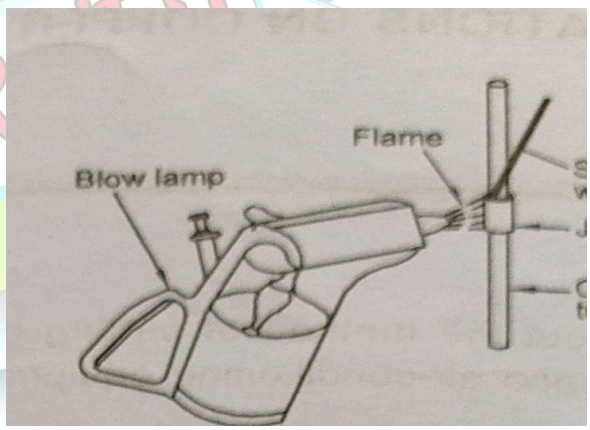




VII. WORKING STEPS FOR SWAGING OPERATION

1. Place the flared tube properly in the flaring block and hold the block in the vice.
2. The copper tube must be projected above the block for a distance equal to the diameter of the tube + 4mm.
3. Select a punch equal to the diameter of the copper tube and oil the tip of the punch.
4. The punch is fed slowly with a hammer to a depth approximately equal to the diameter of the tube + 2mm.
5. Now, gradually punch a little more and remove the punch slowly.
6. The swaging operation has been completed.

VIII. WORKING STEPS FOR BRAZING



1. Clean the surface of the tubes to be brazed with an abrasive paper
2. Apply any flux material to clean the surface chemically to dissolve the oxides formed on the surface.
3. Force till the parts to be brazed.

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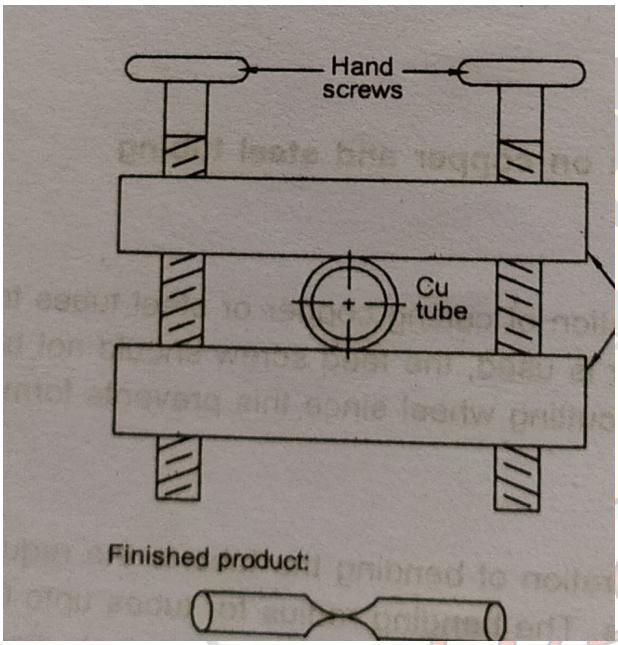
4. Hold the brazing rod in one hand and blow lamp in the other.
5. Heat both the tubes with the blow lamp uniformly.
6. Apply the brazing material around the joint where brazing is to be made.
7. Feed the brazing material by melting it over till the required joint is achieved.

IX. WORKING STEPS FOR PINCHING



1. Place the pinching tool in the portion of the tube where pinching is to be done.
2. Tighten both the screws equally so that the pressure is evenly applied on the copper tube.
3. Tighten as much as possible by hand or by a lever so that the gap between the block becomes minimum.
4. Check the end of the tube exposed to air for any leak.
5. If any leak is found at the end, tighten further to avoid leakage of the refrigerant.
6. Remove the pinching tool from the tube by unscrewing the block.

X. CONCLUSION

The operations involving copper and steel tubing play a vital role in the efficient and reliable functioning of HVAC systems. From cutting, bending, flaring, swaging, pinching and brazing, each process must be executed with precision and adherence to safety standards to ensure system integrity and performance. Proper selection of materials, skilled workmanship, and the use of appropriate tools and techniques directly impact the longevity, energy efficiency, and safety of HVAC installations. In conclusion, mastering these tubing processes is essential for HVAC professionals, as they are foundational to the construction, maintenance, and optimization of modern HVAC systems.

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