

General:

This procedure can be used for expanding ferrous or nonferrous tubes used in YORK vessels. Included is a list of equipment required, set-up and sequence of operations.

Equipment:

Various materials and hand tools are required for tube expansion.

1. Tube Hole Cleaning Equipment - Rotary wire brushes, solvent, etc.
2. Sealant and Lubricant - Loctite AV 087 (YORK P/N 013-01046-000) and mineral oil.
3. Tube Rolling Gun - Torque controlled motor can be either air or electric driven with adjustable torque control.
4. Expanders - Three roll expanders are used for plain end wall thickness greater than .028 inch. (Special tubes having plain end wall thickness less than .028 inch must be expanded with five roll expanders.) Typical tube expanders are shown in Figure 1.



FIGURE 1 - TYPICAL TUBE EXPANDERS

5. Micrometers - I.D. micrometer capable of measuring 5/8-inch nominal tube I.D.'s and 3/4 inch nominal tube holes. Tube micrometer capable of measuring the tube wall thickness of approximately .025 to .065 inch.

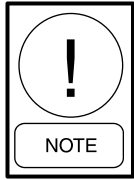
Preparation

Proper tube hole preparation is the most important and most overlooked step in the tube rolling process. To insure a good bond between the tube and tube hole, the tube O.D. and tube hole must be clean and free of oil, rust and damage. Inspect the tubes and holes closely prior to tube insertion.

1. Brush Tube Holes - Using steel bristle rotary brushes, remove all loose rust and debris from the I.D. of the tube holes.
2. Wash Tube Holes - Using solvent, wash the tube holes to remove any oil residue.
3. Wash Tubes - If tubes are not clean, wash tubes with solvent prior to insertion.

Set-up

1. Tube Wall Reduction - To insure adequate sealing, the tube wall thickness requires a 5 to 6 percent reduction in thickness. The procedure for determining the finish rolled tube thickness is as follows:
 - a. Measure the unrolled tube wall thickness with a tube micrometer.



You can increase the accuracy of this measurement by taking several readings around the diameter on the end of the tube and use the average of these measurements for the tube wall thickness.

- b. To determine the rolled tube wall thickness @ 6% wall reduction, multiply the average measurement found in step 1-a. by .94 (6% wall reduction = 100% unrolled thickness minus the 6% desired reduction = 94% of the unrolled wall thickness. To calculate 94% of unrolled wall thickness—wall thickness after rolling = 94% / 100% X unrolled wall thickness). This will be the desired wall thickness after rolling.
2. Rolled I.D. - Use the following procedure to determine the finished rolled tube I.D.
 - a. Measure the I.D. of several tube holes (at least three) and log their dimensions and locations.
 - b. To determine the desired tube I.D. after rolling, subtract two times the rolled tube thickness found in step 1-b. from the tube hole I.D. measured in step 2-a.
 - c. Record these test hole locations and dimensions. They will be required for setting torque on tube rolling gun.

Example: 'Setup tube #1'

- Unrolled tube wall thickness = .050 inch
- Tube wall thickness after rolling to 6% wall reduction = .050 x .94 = .047 inch
- Tube hole I.D. = .762 inch
- Rolled tube I.D. = .762 inch - (.047 inch x 2) = .668 inch

Repeat calculation for additional setup tubes for future use in setting torque on tube rolling gun.

Operation

After cleaning the tube holes and tubes and determining the desired finished rolled tube I.D., the tube insertion and rolling process can proceed.

1. Tube insertion
 - a. Visually inspect the inside of the shell for loose dirt. Use a vacuum and/or air hose to remove as necessary.
 - b. Insert the tubes into the appropriate tube holes.
 - c. The tubes must be as long as the vessel and will typically be slightly longer extending past the tube sheets. With the tubes flush with the tube sheet on one end of the vessel, check the tube extension past the opposite end's tube sheet. If there is more than 3/8 inch of tube extension past the opposite tube sheet, use a recessed rolling thrust collar on your expander to more evenly distribute the tube extension on both ends of the shell. See Figure 2.
2. Setting tube rolling gun torque: Starting with the tube holes that were measured in the set-up procedure, use this procedure for setting the rolling gun torque:
 - a. Adjust the expander to a roll depth of approximately 1/2 of the tube sheet thickness.
 - b. Apply a drop of Loctite (Grade AV 087 sealing compound—York P/N 013-01046-000) to the top of the set-up test tube.
 - c. Set torque setting on tube rolling gun to a minimum position and roll this tube. Measure the rolled I.D. and increase torque and roll using incremental steps until calculated rolled I.D. is achieved.
 - d. Re-adjust the expander roll depth to a depth that would roll the tube end to within 1/8 inch from the inside of the tube sheet.

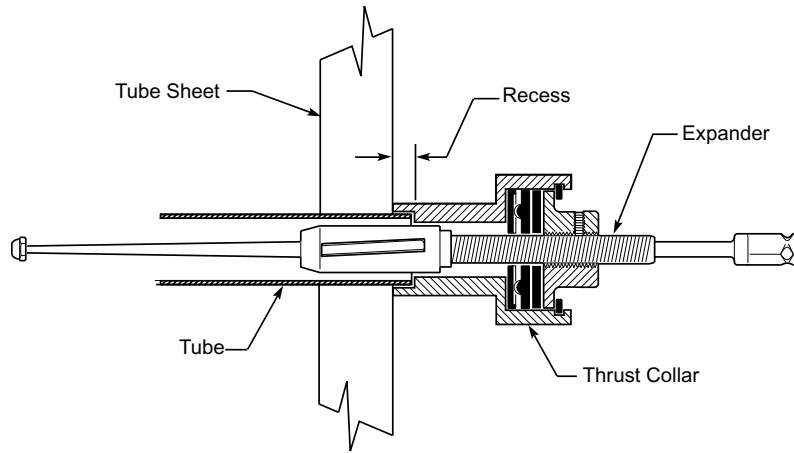


FIGURE 2 - USING TUBE EXPANDER



Do not roll tubes deeper than the thickness of the tube sheet.

- e. Finish rolling the test tube to the full roll depth.
- f. Apply Loctite to the second test tube and roll to full roll depth using the torque setting found in the first tube.
- g. You will most likely have to increase rolling torque slightly to achieve calculated finish rolled I.D.
- h. Repeat this process on a third tube to insure that torque setting is now correct.

3. Tube rolling process:

- a. Starting with the bottom row of tubes, apply just enough Loctite (Grade AV 087 sealing compound—York P/N 013-01046-000) to the top of each tube to completely encircle the tube. Apply Loctite AV 087 as shown in Figure 3, allowing capillary action to pull the sealing compound into the tube hole to insure proper bonding.

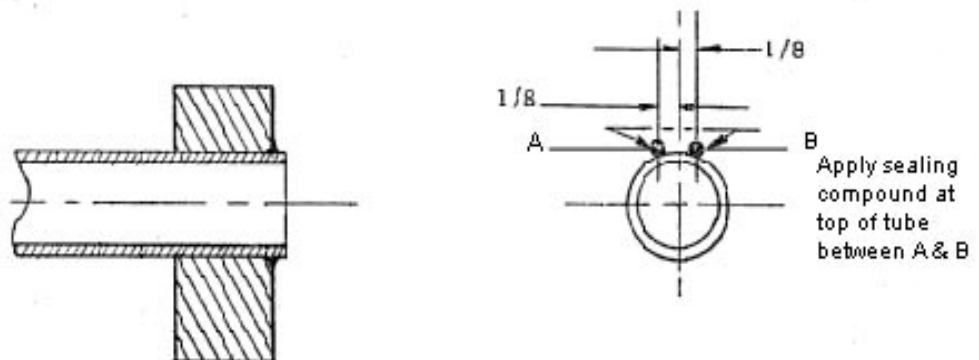


FIGURE 3 - APPLICATION POINT ON TUBE FOR SEALING COMPOUND

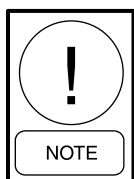


Loctite products have shelf life dates printed on their container. Do not use any Loctite product that is out of date. Do not apply sealing compound to more tubes than will be rolled within 15 minutes. Apply sealing compound in this manner to each succeeding row of tubes, always working in the same horizontal direction, either right-to-left or left-to-right.

- b. Lubricate the inside of every third or fourth tube ends with a couple drops of (SAE 30) motor oil. This will lubricate the tube rollers, reducing friction, heat and particle transfer from the I.D. of the tube to the rolling device.
 - c. Inspect and clean tube expander frequently during the rolling process. The expander rollers can pick up particles of copper from the tubes and if not removed will cause excessive wear to the rollers. If these particles are allowed to build up on the rollers, it may alter the torque required to properly roll the tubes.
 - d. Check the finished rolled I.D. frequently to insure that the rolling operation is correct. Keep in mind that tube wall thickness and tube hole diameters can and will vary so you're not always looking for the same exact I.D. and it's acceptable to see rolled tube I.D.'s vary several thousandths of an inch.
 - e. After rolling is completed on the lead end of the tubes, clean and remove any residual oil and Loctite from the tubes and tube sheet.
 - f. Repeat steps 5 thru 9 on the opposite end of the vessel. Replace the recessed thrust collar used on the lead end with a full depth thrust collar.
4. Testing: After completion of tube expansion, allow 30 minutes for the Loctite to cure prior to pressurizing vessel to test for leaks.

Trouble Shooting:

1. If you are not able to achieve calculated roll I.D. :
 - a. Double-check your dimensions and calculations.
 - b. Check the tube roll gun operation to insure proper operation and torque for the application. There are many manufacturers and types of rolling guns on the market and it may be advisable to consult your vendor if the equipment isn't providing enough torque for the application.
 - c. Replace the tube-rolling gun with one that provides adequate torque for the application.
 - d. Step rolling is acceptable, but requires more time and shouldn't be necessary for copper tube installations if the right equipment is used.



Step rolling is a process where tube ends are expanded in stages where the roll depth is increased incrementally with each pass with the expander.

2. If tube roll leaks are found during leak test:
 - a. Locate and mark any leaking tubes.
 - b. Leaking tubes should be re-rolled tighter by hand. Use a hand tool on the end of the expander. Rotate the expander clockwise in a step pattern similar to the process you would use to hand tap threads. Back off the expander in a counter clockwise direction at least once for every clockwise revolution. This method will minimize the stress applied to the tube hole ligaments, reducing the risk of disturbing adjoining tube rolls and causing them to leak as well.
 - c. The total maximum allowable wall reduction is 16%. A tube which has been re-rolled to the maximum and is still leaking must be replaced.