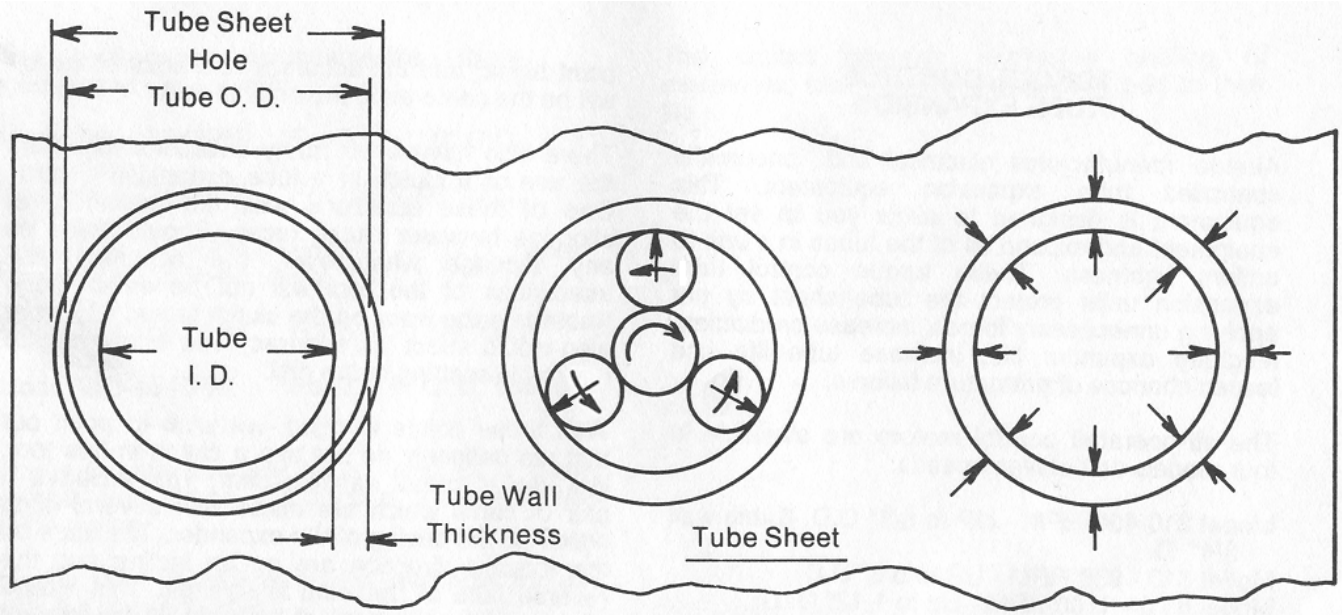
Tube Expanders
Basic Principles of Tube Expanding

Tube Expanding is the art of reducing a tube wall by compressing the O.D. of the tube against a fixed container . . . such as rolling tubes into tube sheets, drums, ferrules or flanges. To assure a proper tube joint, the tube wall must be reduced by a predetermined percentage. The following chart can be used for determining the correct tube wall reduction.

Tube Wall Reduction Set-up Guide



Step A – Measure Tube Sheet Hole
Step B – Measure Tube OD
Step C – Calculate Clearance (A-B)
Step D – Measure Tube ID
Step E – Calculate Total Tube Wall Thickness (B-D)
Step F - Calculate 7% Wall Reduction (.07 X E)
Step G – Calculate Finished Rolled Tube ID (C+D+F)

Step	Tube #	Example	1	2	3	4	5
A	Tube Sheet Hole	.760”					
B	- Tube OD	.750”					
C	= Clearance	.010”					
D	+ Tube ID	.620”					
E	Tube Wall Thickness (X2)	.130”					
F	+ Calculated % Wall Reduction (7%)	.009”					
G	= Finished Rolled Tube ID	.639”					

Elliott Tool Technologies - 1760 Tuttle Ave. - P.O. Box 1165-45401 - Dayton, OH 45403-3428 - 937-253-6133 Phone - 937-253-9189 Fax

Here is a summary of important factors in rolling certain alloys: When rolling 3003 or 4004 Aluminum you should not reduce the walls over 5%. When rolling 6061-T Aluminum, which is one of the most popular materials used in aircraft fittings, you can reduce the wall 10% to 12% for a mechanical joint.

There is a tube process called Alonizing. It is stated that Alonized steel combines the heat and corrosion resistant properties of the iron aluminum alloy with the strength and rigidity of steel. When rolling this tubing, it is extremely important to lubricate each tube end and make certain that the tube expanders are kept clean. Remove all particles of the tubing materials from the expanders to decrease tool fatigue. When rolling Alonized tubing, abrasive particles are removed from the inside diameter of the tubing and gathered in the expander. It is recommended that two expanders be used. One should be cleaned and lubricated while the other is being used.

Admiralty Brass is widely used in condensers. This material should be well lubricated. The tube wall is reduced approximately 7% to 8% for optimum tube joints. In general, only a 4% to 10% reduction in wall thickness is necessary to produce a tight tube in a serrated hole. On the other hand, reduction in excess of 15% may cause leaking, splits or flaked tubes.

Carbon Steel is used in almost every type of pressure vessel built today. Tube wall reduction should be approximately 7% to 8%. Heavy lubrication is a must. If the tube is cracking or tooling shows excessive wear, tube hardness should be checked. Carbon Steel tubes should be 90 to 120 Brinnel hardness for rolling. It is possible to roll tubes up to 150 Brinnel however, flaking and cracking are more likely to occur as the tube hardness increases.

When rolling Copper and Cupro Nickel, consider approximately 8% - 10% wall reduction to be a proper tube joint. Copper, since it is one of the softer tubes used in pressure vessels, can be easily rolled. Use plenty of lubrication because copper has an abrasive action on tube expanders.

When rolling Stainless Steel and Titanium, approximately 4% to 5% wall reduction is sufficient to produce a tight tube in a serrated hole. When rolling these alloys the entire wall reduction should be done quickly. These materials have a greater tendency to work harden therefore, minimal or no rerolling should done.

When rolling Titanium, it is recommended to use an expander with four rolls or more. This decreases the spring back effect that is common with Titanium and Stainless Steel tubing.

This discussion of alloys has been related to those used in pressure vessels such as boilers, heat exchangers, and condensers. These factors would be approximately the same in a mechanical joint for industrial use. However, a greater percent of wall reduction is usually considered when making a mechanical joint. Higher quality tubes are used in industrial applications.

Major Causes of Tube Leaks

Tube joint leakage is usually caused by one of the following: dirty, scratched or cracked tube sheet holes, under-rolling, over-rolling, improper preparation of tube sheets and differential thermal expansion. Improper expansion can lead to serious difficulties for both the manufacturer and the repair servicemen.

Under-Rolling

Under-Rolling, as the word would imply, is when the tube is not expanded to fill the tube sheet hole and the proper amount of wall reduction is not obtained. **It is better to under-roll than to over-roll.**

Over-Rolling

Over-rolling, is when the expansion of the inside diameter of the tube surpasses the ultimate limit of the tube material required for the proper percentage of wall reduction for the ultimate tube joint. **Over-rolling can do considerable damage to a vessel.** Over-rolling will decrease the dimensions of the ligament between tubes and weaken this bridge. Once a ligament is weakened, it will cause a reaction in all ligaments surrounding that weak ligament. If the strength of the ligament is decreased the adjacent tubes may leak.

Over-rolling also causes distortion in tube sheets or drums, such as egg-shaped holes. Over-rolling has been known to cause a tube sheet to bow or warp to the point where the standard length tube could not be used in the vessel until the bowing or warpage is returned to normal.

Tube Expanders
Basic Principles of Tube Expanding

Improper Preparation of Tube Holes
Improper preparation of tube holes is another major cause of tube leakage. If the tube sheet or drum is gouged, it is extremely hard to expand the tube to fill these gouges or tears without over-rolling. The smoother the tube seat or tube hole the easier it is to roll an optimum tube joint. The ligaments and light tube walls make it more important that the finish of the tube hole be in the low microfinish range. We find many manufacturers today are drilling, reaming and sizing or burnishing to get the microfinish desired for tube holes.

Differential Thermal Expansion
Differential thermal expansion can result with thicker tube sheets. When the expansion due to heat varies noticeably between the thinner tube and tube sheet, a shift of the tube results. One of the most important steps for insuring a safe and permanent tube joint is to thoroughly clean the surfaces of the tube end and the tube hole wall. These two surfaces must be clean and free of all dust, mill scale and pits or scratches. It is extremely important to eliminate any longitudinal scratches in the tube hole wall. These longitudinal lines will cause leaky tubes.

Preparation of Tube Holes
Preparation of tube holes in heat exchangers and condensers is as follows:
1. Drill and ream tube sheet holes to .007" to .010" over the outside diameter of the tube to be used.
2. Be certain the ligaments are sufficient to guarantee a safe and permanent tube joint.
3. When conditions permit, utilize a sizing or burnishing tool to further assure a high quality finish in the tube hole. This will also increase the tensile strength of the ligament.
4. The serrations or grooves to be used will determine the holding power of the tube.
5. It is extremely important when retubing that the grooves be cleared of all metals or any foreign material.

Preparation of Tube Seats
Preparation of tube seats in drums, tube sheets, and headers are as follows:
1. Tube holes are normally drilled and reamed to approximately 1/32" larger than the nominal outside diameter of the tubes.
2. It is extremely important during this operation that there are no longitudinal scratches left in the tube seat.
3. In cases where out-of-roundness is extreme, prerolling of the tube holes is advised.
4. Be certain that the tube sheet holes and the grooves in the tube sheet holes are cleaned down to bare metal before tubes are inserted. Be certain all foreign material such as oil, grease, rust, or dirt are removed. Special attention during this cleaning of the tube sheet holes will prevent serious trouble later.

After tube sheet holes have been prepared they are usually coated with a rust preventative compound. Before inserting any tube it is important to remove all traces of this coating. It is extremely important that great care be taken in handling the tubes for insertion in all of the vessels discussed above. Be certain that the tube ends are clear of any foreign material. Be especially certain that there are no chips on the tubing which may gouge the tube sheet or tube seat when the tube is placed in the vessel.

Quality, Care, Maintenance and Storage of Tube Expanders

Quality
Elliott tube expanders are made of special alloy tool steels carefully heat treated to withstand severe operating forces. These tools are produced by a highly skilled workforce using the latest machinery and state-of-the-art manufacturing technology.

Care
Tube expanders are precision made tools. After rolling several tubes, submerge tools in solvent to clean and cool, then dip in light weight oil to lubricate. For best results in rolling tubes, it is suggested to use two or more tube expanders alternately.

Maintenance of Tube Expanders
Replace chipped or worn mandrels and rolls immediately. Worn mandrels and rolls can damage other parts of tool.

Storage
Clean tools thoroughly in solvent, replace worn parts, then coat with rust preventive or keep submerged in light weight oil.