W-15 Cold Stretch Reduction for Small Tube Diameter Tube

In response to the increasing world wide demand for small diameter (i.e., 0.188" to .500" OD) steel tube for both refrigeration and automotive fuel line purposes, Yoder Manufacturing can provide equipment for production of these tubes.

A typical line begins with a double swivel uncoiler, a coil end joiner and a strip accumulator. This arrangement allows the tube mill to run continuously without stopping to the change coils of steel.

From the strip accumulator, the strip is cleaned before entering the forming and welding machine. Cleaning can be done using either fiber or wire brushes, high-pressure water, steam or ultrasonic cleaning methods. The addition of a mild solvent may be also be useful. The intent is to remove all mill oils and foreign particles from the strip to insure that the eventual ID of the tube will be clean as possible.

Once clean, the strip enters for the forming and welding machine. Here the strip passes through a series of con-toured horizontal and vertical rolls that form it into a tube. The driven mill stands may incorporate integral rolls and roll shafts along with precision bearings to minimize any out-of-roundness or "runout" in the shafts and tool-ing to produce the highest quality tube possible. Furthermore, the forming machine is run without the use of roll coolant to prevent the contamination of the ID of the tube being formed.

As the strip edges close to form an OD mother tube slightly larger than ½", a welder is used to join them. There are three common types of welder used on mills of this type (commonly referred to as "refrigeration tube mills"). They are: DC contact welding, AC Square Wave contact welding, and high-frequency induction welding. Yoder's recent expe-rience is with the last two methods.

High-frequency (HF) induction welding's main advantage is that it is a non-contact welding process. Unlike Square Wave or DC welding, the weld power is induced through an induction coil rather than mechanically deliv-ered through contacts to the tube. However, HF induc-tion welding does have some drawbacks.

The main disadvantage of the HF induction welder is that it requires the use of a cooled, ferrite impeder inside the tube at the welding point. On standard tube mills, this normally does not represent a problem because the impeder can be cooled simply by flushing through the impeder sleeve and into the inside of the tube. However, because of the critical inside cleanliness requirement of this mill's tubing, the impeder must be cooled without allowing water to come in contact with the ID of the tube using one of two methods. In the first method, the coolant must be returned back out of the impeder along the same line that it entered using what is called a "return flow" impeder. This is difficult to do because of the physical size of the tube being welded and the restricted cooling capacity of the water.

The other method reverts to a conventional "flow through" impeder with liquid nitrogen as the coolant rather than water. The method has an additional benefit though. As the nitrogen warms, it becomes a gas, which in turn provides the required protective gas atmosphere protects the tube from corrosion and is usu-ally supplied by an inert gas generator when not using liquid nitrogen.

The other type of welder used by Yoder is its own exclu-sive Solid State AC Square Wave welding system. This system consists of a power supply that feed high voltage, low current through a DC chopper and inverter that chops the DC into a special square wave AC. This high voltage, low current is then transmitted through conventional slip rings to a rotating toroidal transformer and a pair of electrodes. The elec-trodes then deliver the weld power to the weld joint on the tube.

The advantages of the Square Wave system are that it does not required the use of an impeder, the electrodes can be used to assist in controlling the weld seam pres-entation, and lower weld temperature used in this process reduces the risk of ID weld spatter. The disad-vantage is that it is a contact process; therefore, the electrodes are a wear item that require "dressing" or trimming - typically once a day.

FORMTEK

4899 Commerce Parkway, Cleveland, OH 44128 USA | formtekgroup.com/contact-us | +1.216.292.4460

W-15 COLD STRETCH REDUCTION

HF-Induction Weld Area and Tube Forming Machine

After the tube is welded, the OD weld upset bead is removed using a scarfing tool, the tube is cooled by water sprays, and it enters the reducing machine. (see photo below) The reducing machine uses special mill stands to progressively squeeze the tube down to its final diameter. All of the driven and idle stands are mounted on removable sub-plates or rafts. These rafts allow for quick changeover from one size to the next.

The use of individual AC drives on each of the driven passes allows the equipment to compensate for the increasing tube speed caused by the tube elongation during the reducing process. From the ½" OD mother tube, the reducing machine is capable of producing a 0.188" OD minimum tube. Output speeds can exceed 550 FPM when making the smallest tube.

Cold Stretched Tube Reducing Machine

After the last reducing pass, the tube is generally passed through a non-destructive, Eddy current tester. This unit is designed to look for smaller pin holes in the weld seam. If found, the unit can track the defect through the remaining processes to the end of the line where it can be marked and cut out as scrap.

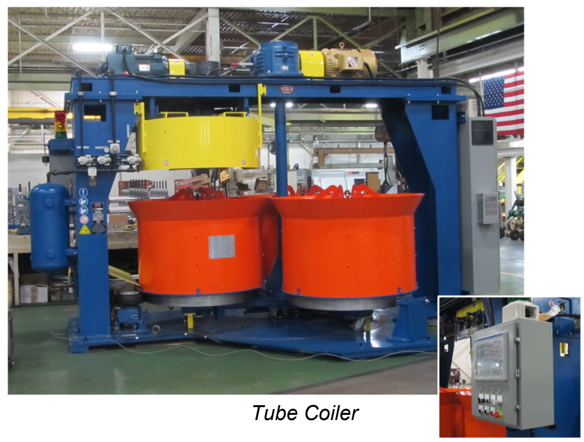
Because the reduction process occurs at room temperature, the tube is work hardened and, in most cases, needs to be annealed.

To anneal the tube in-line, an induction annealing sec-tion is typically used to heat the tube to a maximum temperature of 1450°F.

Once heated, the tube is then air cooled using a protective gas atmosphere in an after-cooling line. Because of the high mill speed, the cooling section can be several hundred feet in length. Once cooled to below 800°F, the tube is then quenched in a water bath.

Depending on the end product, the tube can now be coated. Coatings can range from a simple copper electroplate (i.e., refrigeration tube) to a complex zinc or Galfan (a licensed zinc-based material) coating followed by a paint coating (i.e., automotive fuel line tube). Regardless of the process, they may be able to be done in-line.

The final stage is to have the tube either cut for straight lengths or wound into coil form. For straight lengths, the tube is passed through a small straightener and into a cutoff press. Once cut, the tube is dumped to a storage bin by a tube runout table.



Tube Coiler

The tube coiler (see photo above) incorporates a bending roll to continuously vary the coil diameter as the tube is being run. The coiler's multiple-basket design allows the operator to unload a finished coil while a new coil is being wound.

It is important to note that refrigeration tube mills are unlike other types of tube mills. Although the basic tube making concepts are similar, refrigeration tube mills must be viewed more as a process then simply a line of equipment. Furthermore, the added complexity of the various processes (e.g., cleaning, annealing, coating, coiling, etc.) make them more difficult to understand and learn. However, with Yoder's vast experience with these types of lines, proper operation and success can be guaranteed.