TECHNICAL BULLETIN

EHF

TB-1015

Impeders for ID painted or coated tubing

There are several welded tubular products that require painting or powder coating of the tube ID as an inline process. The most common of these is electrical conduit, where the coating provides lubricity which aids in drawing wires through the conduit. Paint or other ID coating is also applied to certain types of tubing for corrosion resistance. Fire sprinkler tubing & fence post tubing is often ID coated for this reason. In some cases, the outside of the tube is also hot dip galvanized in line.

The Process

When tubing is welded using high frequency induction welding, an impeder is required to reduce weld power requirements & avoid heating the entire circumference of the tube. The impeder acts to focus the magnetic field created by the work coil so that most of the heat occurs on the extreme edges of the metal strip. Impeders are normally water cooled, and this coolant is frequently dumped inside the tube after passing through the impeder. If an ID coating is applied, return flow or gas cooled impeders must be used so that the tube has a clean, dry ID, since any impeder or mill coolant will interfere with the coating process.

In cases where inline galvanizing is used on the outside of the tube, oxygen must be purged from the tube ID to prevent oxidation of the ID paint coating. This is normally accomplished by introducing nitrogen into the tube to displace the air.

Because any impeder must be a return flow type, and provide an axial tube so that paint & frequently nitrogen can pass through the length of the impeder, the space available for ferrite is limited. This can reduce the efficiency of the welding process, and often limits the smallest practical tube size to approximately 1" (25mm) OD. For smaller sizes of tubing, low frequency Electrical Resistance welding (ERW) is more frequently used, since impeders are not required with this process.

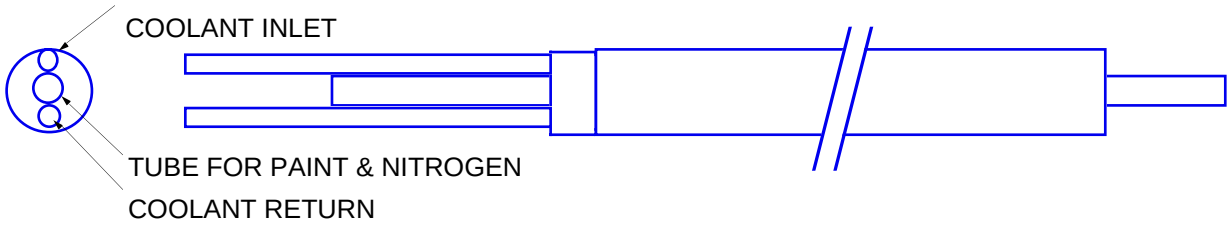
It is possible to HF induction weld, and ID paint conduit as small as 1/2" EMT (0.706" OD x 0.035" WT), however the impeders have very little clearance to the tube ID, and require frequent replacement.

In some cases, chilled nitrogen gas is used to cool impeders on small diameter ID painting/HF induction welding mills. Because of its low density & cooling capacity, very large quantities of nitrogen must be used - typically 1000 times as much as water. The volume requirement can be reduced by chilling the gas prior to entering the impeder, however there are limits to how effective this is, as the losses in ferrite are inversely related to temperature. The cost of providing nitrogen from cryogenic storage in the volumes required for impeder cooling are usually to high to be economical.

Impeder design

Return flow impeders for ID painting systems generally use a single hollow, fluted ferrite rod (TDK type ZRSH or similar). The paint and nitrogen (if needed) passes through the

center of the ferrite, through a thin-walled brass tube. Coolant enters & leaves through two brass tubes at the “upsteam” end of the impeder. The ferrite is a fairly close fit within the impeder casing, and coolant flow is entirely along the slots in the ferrite, flowing down the slots on one side & back along the slots on the opposite side, crossing over at the end of the ferrite closest to the weld point. Because this type of impeder offers more resistance to coolant flow than conventional types, the use of a booster pump & impeder coolant filter system is strongly recommended. Both these items are available from EHE, Inc.



The diagram above shows the outline of a typical hollow return flow impeder, used for ID painting applications. The coolant tubes are normally 6” (150mm) long, and are extended by the customer to the length required for the mill. This is done by soldering longer tubes to those on the impeder, or by using flexible tubing or hose that fits over the tubes on the impeder. The paint lance passes through the center tube, but is not normally attached to it. When an inert purge gas is used, the impeder center tube is usually larger than the paint lance, allowing gas to flow in the space between them.

Welder setup

Hollow return flow impeders contain less ferrite than conventional impeders of the same diameter. In order to operate the mill as efficiently as possible, the welder must be correctly installed & set up. The key to efficient induction welding is to keep the vee length and the coil length as short as possible. This means using the smallest possible weld rolls, and keeping the coil as close as possible to the weld point. The coil should also be closely coupled to the tube. Minimizing the gap between coil ID & tube concentrates the magnetic field & reduces uneccessary heating of the weld rolls & bearings. For best results, weld rolls should be non magnetic. Ceramic rolls are ideal, however hard bronze (AMPCO 25) or carbide are also good material choices.

With small diameter tubing, very little space exists for ferrite, and the ferrite will become magnetically saturated at lower power levels than with conventional impeders. When this occurs, welding efficiency is greatly reduced. The flux density at which saturation occurs decreases with rising temperature, so it is important to provide sufficient cooling for the impeder. A minimum coolant pressure of 100 PSI (750 kPa) is recommended for impeders below 1” (25mm) in diameter. This generally requires a multi stage coolant boost pump. Using a refrigerative chiller to reduce coolant temperature to 40°F (5°C) will greatly increase the effectiveness of small impeders. EHE, Inc. can supply or recommend complete integrated cooling systems for return flow impeders.

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