

TechNote TN-4

Steel Tube for Ozone Gas Sampling

Rev 12/2005

For continuous measurement of the ozone content in an ozone process gas it is necessary to lead a stream of sample gas into the ozone analyser. The desirable sample gas flow rate mainly depends on the acceptable time delay between sampling and measurement. But the ozone analyser is limiting the maximum flow rate.

We recommend a flow rate between 0.3 and 1 NI/min for our high concentration OZONE ANALYZER BMT 964, typically 0.5 NI/min. At a flow rate of more than one NI/min the pressure compensation of the analyser would be influenced too much by the rising pressure drop inside the cuvette.

When the sample gas line is made of 1/8" SS tube (for 1/8" Swagelok fittings) the ID of this tube is 2.06 mm. At a typical flow rate of 0.5 NI/min and a typical ozone gas pressure of 1.7 bars absolute (0.7 bars gauge) the pressure drop in the 1/8" tube is about 2 mbars per meter tube. The velocity of the ozone gas is about 150 cm/s. When the sample gas is at atmospheric pressure (e.g. ozone off-gas) the pressure drop is 3.5 mbars per meter tube. The velocity is 250 cm/s.

When the sample gas line is made of 1/4" SS tube (for 1/4" Swagelok fittings) the ID is 4.37 mm. The pressure drop is lower. But the velocity of the ozone gas is also significantly lower: by the factor of 4.5 (!). At 1.7 bars absolute the velocity is only 33 cm/s.

If the ozone content measured by the ozone analyser is used for automatic control of the ozone generator, time delay of the measurement should be kept as short as possible. The 1/8" tube is the best choice in this case. But it is the best choice anyway: The low pressure drop in the 1/8" tube never presents any problem, and the 1/8" tube can simply be bent by hand, whereas the 1/4" tube can be bent only with a special tool.

No physical and no technical reason exists which demands 1/4" tube instead of 1/8" tube.

Pre-swaging of Swagelok or equivalent fittings:

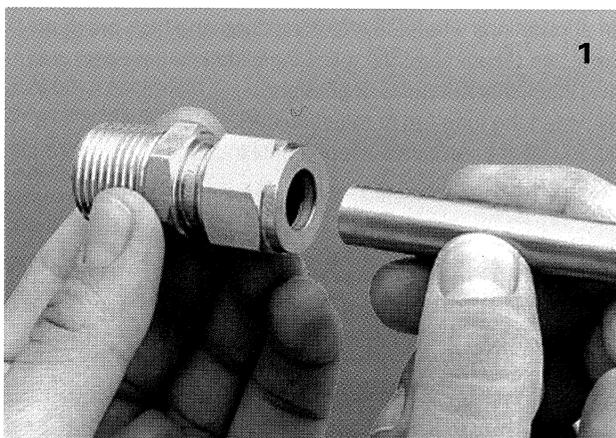
The body of the fitting is tightened into a part of the ozone sampling system (e.g. an ozone filter, or an ozone analyser). The body usually is sealed with a special epoxy resin to prevent any ozone leakage. The epoxy seal may not be cracked, of course. If the body is manually held with a wrench during tightening of the nut, it is quite likely that some torque is acting on the body. This torque could crack the epoxy seal.

We strongly recommend that the steel tube be pre-swaged using a dummy fitting mounted in a vise (see installation instructions for LET-LOK fittings). Now the very high torque necessary for swaging the ferrules and the tube is not applied to the original body and its epoxy seal. After pre-swaging the tube (with the ferrules and the nut) now is reassembled in the original fitting body of the ozone instrument by only slightly tightening the nut. This method significantly reduces the risk of cracking the epoxy seal.

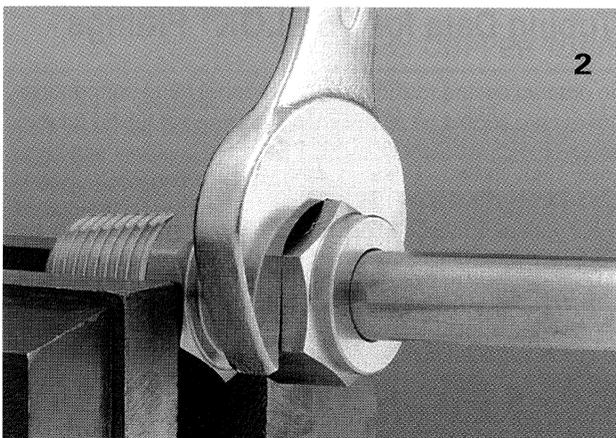
It should be noted that the torque necessary for swaging and for reassembly is about three times higher for 1/4" fittings than for 1/8" fittings.

PTFE tubing, in contrary to steel tube, does not present any problem concerning tightening of the fitting. But PTFE tubing is much more vulnerable than steel tube. As a compromise we offer flexible SS steel tubing (FLEXA tubing SPR-VA, 1010.801.008, ID 7.5 mm, www.flexa.de) which easily fits on our PTFE tubing 3x5 mm (high concentration ozone analysers) and 4x6 mm or 1/4" (ambient ozone monitors). If this flexible steel tubing covers the PTFE tubing from fitting to fitting, it will protect the PTFE tubing nearly perfectly from any mechanical lesion.

LET-LOK® INSTALLATION INSTRUCTIONS



1



2

LET-LOK® fittings are supplied assembled, finger tight. Disassembly before use can allow the entry of dirt or other particles.

1. Insert the tubing into the Let-Lok® fitting. Check that the tube rests firmly on the fitting shoulder and that the nut is finger tight. At this point it is recommended that a scribe mark be drawn on the hex of the nut extending onto the fitting body. This mark will serve as an indicator for the starting point and proper pull-up.
2. Tighten the nut. (see Fig. A & B)
 1 1/4 turns of the nut is required for 1/4" (6 mm) and higher.
 3/4 turns of the nut is required for 3/16" (4 mm) and lower.

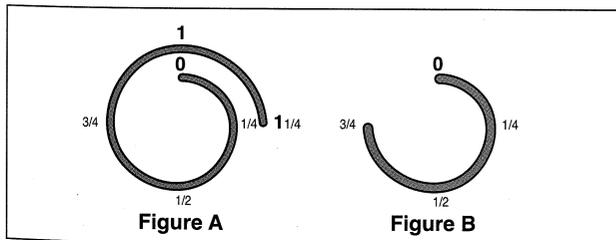


Figure A

Figure B

Reassembly Instructions

Let-Lok connections may be disconnected and remade repeatedly, without loss of leaktight seal.

1. Before disconnecting, mark the position of the nut in relation to the fitting body.
2. To reassemble, use a wrench to tighten nut to original position.
3. Tighten slightly with wrench until a slight rise in torque is felt.

Tube Cutting

Two different methods can be used to cut tubes:

1. Tube cutter
2. Hacksaw

Tube Cutter

To attain a leak free connection, the tubing must be cut squarely. A good quality tube cutter with the appropriate blade for the tubing material is recommended.

Do not try to reduce the time of cutting by taking deep cuts with each turn of the cutter. This will work harden the tube.

The end of the tube must be deburred to avoid damage to the fitting and to ensure that the tube reaches the bottom of the fitting.

Hacksaw Cutting

In order to cut the tube with a hacksaw and get square ends, the tube must be cut with guide blocks.

This method of cutting necessitates deburring of the tube ends.

Warning

Do not hold the tube in a vise in the place where it will be inserted into the fitting (the vise will leave a mark on the tube that may cause leaks, and might cause ovality).

Tube Handling

Scratches on the tube might cause leaks. It is, therefore, important to handle the tube carefully to reduce the risk of leaks.

Some precautions to be taken:

1. Tubes must not be dragged on the floor.
2. Tubes must not be dragged out of a tubing rack, especially in case of large OD tubes.

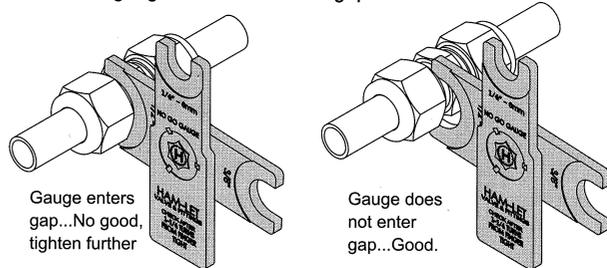
Copper Tubing

If using copper tubing from a roll, hold the end of the tube and roll the roll outwards allowing the tubing to lie on a flat surface.

Inspection Gauge

Use: This is a "No-Go" gauge and should be used as follows:

1. Make up the fitting according to the following instructions:
 1/4 inch (6mm), 3/8 inch, 1/2 inch (12mm) - make up 1.1/4 turns from finger tight.
2. Check gap between nut and body, using the appropriate sized gauge. If the gauge slides easily into the gap, tighten the nut further until gauge can not enter the gap.



Gauge enters gap...No good, tighten further

Gauge does not enter gap...Good.

To order, use part No. 3900098

Available only in:

1/4 inch (6mm), 3/8 inch,
 1/2 inch (12mm) - make up 1.1/4

