Leaks in brazed joints

Leaks in brazed joints behave different from leaks in welded joints. Leaks in welded joints are much simpler because they are normally pores in the metal, normally created by trapped air or surface tension when the metal solidifies. Such leaks are normally not affected by mechanical stress, but do vary with temperature, contamination, condensation, and corrosion.

Leaks in brazed joints are not very stable.
Leaks in brazed joints are different and more complicated. The reason is that a brazed joint normally consists of one tube pushed into another tube, and the gap between them filled with brazing filler alloy. A gas leak in such a joint is therefore a long narrow channel along the tubes, rather than radially from inside to outside.

The length of the path reduces the leak flow even if the gap (and hence the cross section of the leak) is relatively large. If there is a tight fit between the two tubes there is very little leakage, sometimes not even detectable. If the joint is not completely filled it will still be mechanically strong, but may constitute a micro leak (not detectable in water, and sometimes not even with gas.) When such a joint is stressed mechanically (bent or pulled or pressurised) the variation in leak rate can be significant. Some changes are reversible, some are irreversible. It is therefore possible to detect a leakage at one pressure, and no leakage (i.e. flow less than a specified limit) at another pressure. When the joint is bent or pulled the leak rate may change several orders of magnitude. Sometimes a leak opens up and sometimes it closes.

The tighter the fit between the tubes is, the more likely are these variations. Also, the tighter the tubes are, the more likely will the joint not be entirely filled. Such leaks can be temporarily tightened by process materials such as zinc plating, flux and paint. These can block leaks and result in false acceptance in a leak test. It is therefore essential to consider what treatments a joint should go through between brazing and leak testing.

Tight even when not brazed.
It has been observed in automatic brazing that when a tube joint is put in a fixture and heated without filler being added, the joint can seem to be leak tight (<1 g/a) if tested in the fixture. When it is released from the fixture it falls apart. Consequently, a joint can also be partially filled, stick together mechanically, and be leak tight until mechanically stressed.

Corrosion
When leak testing directly after brazing or welding one should be aware that the inner surface of a leak is a fresh metal surface with no corrosion protection. It is therefore obvious that a layer of oxide, rust, or verdigris (depending on the metal composition) will grow on the surface during the first couple of days. The thickness of such surface layers are in the range of micrometers. Consequently, micro leaks are likely to clog up during the first couple of days after production (depending on humidity etc). Since a 1 μm hole leaks about 1 gram gas per year, this applies predominantly to leaks in refrigeration systems where leak testing is done at this level.

Capillary forces
Capillary forces play an important role in leak detection. The capillary force is the attraction between the surfaces of a tiny hole and a liquid. When a big tube (a water pipe for example) is filled with liquid the attractive force between the liquid and the inner surface is very small compared to the force applied by the water pressure. However, when a hole diameter is very small, as in a micro leak, the situation is reversed. The capillary force is far stronger than the force applied by the pressure in the tube. The capillary force in a 1 μm hole is about 1000 times stronger than the capillary force in a 1 mm capillary. The result is that liquid that has been sucked into a micro leak by capillary action can not be forced out with compressed air.