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Application Note Number 40: Use of Extorr XT Systems with Vacuum Furnaces

Abstract: Vacuum furnaces are becoming more and more common for all sorts of brazing operations. The use of vacuum measuring probes such as the Extorr, gives operators an inside track in explaining the chemistry occurring in their systems.

Some vacuum furnaces are quite complex, offering programmed heating and cooling options, multi-gas backfill options and even high pressure quenching. However, the overall effectiveness of the equipment, still lies with the people who run the furnaces and their knowledge of the processes involved.

The Extorr probe has the capability to measure pressures from atmosphere down to partial pressures in the millionth of billionths of an atmosphere range. Since we are dealing with vacuum furnaces, and very small fractions of air pressure, we will need terms to describe these minute pressures. A convenient starting point is a pressure which can sustain a mercury column of only 1 mm of mercury. This pressure is called the torr and is one 760ths of one standard atmosphere.

However, even 1 torr is too high for meaningful vacuum brazing operations (unless you are backfilling the furnace with a partial pressure of argon or nitrogen). Thus the millitorr is used to indicate levels of vacuum equal to 1/1000th of a Torr, or 1×10^{-3} Torr (equal to about one millionth of an atmosphere).

Other terms used to describe levels of vacuum are "rough," "soft" or "hard" vacuums. These descriptive terms give qualitative meaning to vacuum levels; however, they lack specific quantitative values because each term covers a broad spectrum of the vacuum chart. Some vacuum brazing operations are run with a backfill in the 1-0.1 millitorr range and some furnaces may be evacuated to 1/100 of a millitorr or below (the "hard vacuum" range).

Although the Extorr can measure total pressures up to an atmosphere, reliable partial pressure measurements can only be taken at pressures below 1/100 of a millitorr. If a higher pressure is required during the brazing process, a pressure reduction system, with a small turbo pump, such as described in Application Note #5, is required. A 1 mm diameter sampling aperture would be ideal. At a millitorr of pressure, the Extorr probe will be at a comfortable 10^{-6} torr range. If the furnace is up to atmosphere, the pressure in the sampling chamber would increase to above 2 torr. This is too high for the quadrupole or ion gauge, but the Pirani reads this pressure. A complete partial pressure time history of your brazing process will prove invaluable to your quality control.

For instance, it is critical to ensure that as little oxygen as possible is allowed to come in contact with the parts being brazed. Small leaks in your furnace allow air (and water vapor) to enter the furnace and oxidize parts during heating, irrespective of the "vacuum level." The Extorr is able to monitor for the required vacuum integrity and process reproducibility.