APPLICATION NOTE

CONSIDERATIONS FOR A TURBOMOLECULAR PUMP WHEN PERFORMING A SYSTEM 'BAKE-OUT'

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After several hours of evacuating a typical vacuum system from atmospheric pressure an 'equilibrium pressure' is achieved. This pressure (~ 10^{-6} to 10^{-7} mbar) depends on the size of the chamber, its materials, seal's, pre-treatments, venting procedure, leak-tightness and type of vacuum pump used.

Each system is different but generally the equilibrium pressure is achieved when the gas load from outgassing is matched to the pumping speed.
Water vapour, which is preferentially bound to the vacuum materials, is the dominant contribution to the load in high vacuum: it can constitute an almost infinite source.

To achieve lower (UHV and XHV) pressures the systems are deliberately heated (typically at temperature) 150 °C to 250 °C for 24 to 48 hours. During the baking process the system pressure will rise into the 10^{-5} mbar range. Baking continues until the system pressure reduces significantly. The maximum bake-out temperature should not be greater than that allowed by each component of the system.

Specific consideration needs to be made for baking turbomolecular pumped systems. Generally the maximum operational temperature of a turbomolecular pump is typically limited to ~100-120 °C at its flange. Hence special bake-out 'bands' are used for the flange and also around the envelope of the pump. If the blades are not heated water vapour will be adsorbed onto their surfaces. These bands need to be temperature controlled so as to not exceed the maximum allowable temperatures. Additional care needs to be made to ensure that no radiant heat source is in line-of-sight of the turbomolecular pump inlet.

Considering a 'typical' system of ~ 200 litres with a total surface area of ~ 2 m^2 pumped with a 300 l/s turbomolecular pump then the gas load at a bake-out pressure of $3x10^{-5}$ mbar is ~0.01 mbar l/s. This is equivalent to ~ 0.6 sccm or 0.03 g/hour.

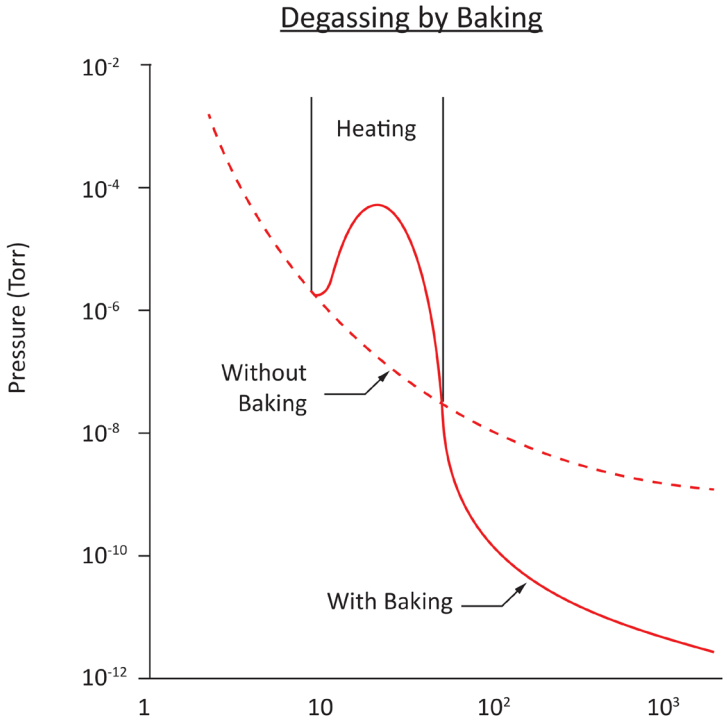
This load is not significant when matching a compatible capacity backing pump, for example a scroll or oil sealed rotary vane pump. However, consideration needs to be made for the nature of the load i.e. water vapour.

Edwards nEXT turbomolecular pump with 'bake-out' band

To help to limit water adsorption, an inert gas purge can be used in the lower blade stacks of the turbomolecular pump at ~10-20 sccm. Additionally the backing pump should be operated on gas to prevent condensation.

Even at these low operational flows the volume of the backing pump will become composed of ~100 percent water relatively quickly and the backing pressure will become limited if there is no ballast. Some UHV practitioners operate the ballast periodically during the baking sequence.

Although water has been the main focus, consideration should also be made to determine any other specific gas loads which can be generated during bake-out. During bake-out the percentage of hydrogen increases and after the bake-out hydrogen is usually the dominant residual gas. As with any flammable gas care and best practice should be made to ensure safe operation with hydrogen even with low flows.



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