Care and Cleanliness of a Vacuum System

The speed at which the chamber can be pumped down, the ultimate vacuum level that can be achieved, and the leak-up rates typically characterize the performance of a vacuum system. For the best performance, it is essential that the pumps and the vacuum systems be kept clean and in good condition at all times.

The leak-up rate of a system is determined by actual leaks, virtual leaks, and outgassing of the vacuum chamber and its contents. A virtual leak is where a volume of air or other gas is trapped within the chamber and can only be pumped out through a small passage. This trapped gas will simulate a true leak until all of the trapped gas has been pumped from the system. Outgassing is where a material, usually a liquid, is slowly becoming a vapor under vacuum. Even small amounts of liquid such as moisture from the air can become trapped in porous material such graphite felt, and will outgas until all of the material has been pumped away. Like a virtual leak, outgassing will simulate a true leak. If you suspect a virtual leak or outgassing let the vacuum system pump for several more hours and re-check the vacuum leak-up rate. If the leak-up rate has improved, then it is likely that you either have a virtual leak or outgassing.

Vacuum is measured in microns or Torr. One atmosphere is 760 Torr, and zero Torr would be a perfect vacuum. Vacuum leak rates are measured in millitorr (mTorr) per hour (the number of mTorr that the chamber pressure would rise if left isolated for one hour). However, leak tests are usually performed over a shorter period of time than one hour, and the results are extrapolated to obtain hourly leak rates.

Thus, the observed vacuum loss over the test period is multiplied by 60 / (t_1 - t_0), where:

60 = minutes/hour t_0 = start time in minutes

Leak Test Example:

Vacuum level at test start (valves closed at time t_0):	10 mTorr
Vacuum level at test end (time t_1):	12 mTorr
Change in vacuum from t_0 to t_1:	2 mTorr

If the 2 mTorr loss was measured over a 15-minute period so that t_1 - t_0 = 15 minutes,

Then: Leak Rate = 2 mTorr x 60 / (t_1 - t_0)

= 2 mTorr × (60 min/hr) / (15 min) = 8 mTorr per hour

Leak rates below 5 mTorr per hour are typical for most systems when the chamber is empty, clean, dry, and outgassed.

When the furnace is not clean, dry, empty or outgassed much higher leak rate would be acceptable. It is common to fill a furnace with parts and pump it down for at least 30 minutes. If after 30 minutes, the leak-up rate is below 100 mTorr per hour the chamber is considered tight enough to run.

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Leak Detection Procedures

The preferred method of leak detection is to use a **Mass Spectrometer Leak Detector**. These devices are hooked into the vacuum system and Helium gas is then sprayed on any area where a leak is suspected. The Leak Detector will sense the presence of any Helium passing through the leak. Mass Spectrometer Leak Detectors are available from most manufactures of vacuum instrumentation. Mass Spectrometer Leak Detectors work best when the system's ultimate vacuum is below 200 mTorr.

Another method of detecting leaks when the system vacuum is above 200 mTorr consists of spraying suspect areas with a fine stream of volatile solvent such as Methanol, Ethel Alcohol or Acetone and watching the vacuum gage for a sudden change in pressure. This method requires two people, one to watch the gauge and one to spray the volatile liquid in the suspect areas. The reason for this is that the pressure change will be so sudden that one person could easily miss any changes on the vacuum instrument unless he or she was paying full attention. This method works best with a thermal conductance gauge such as a TC Gauge, Pirani Gauge, Convectron Gauge or Convectorr Gauge. Since Thermal Conductance Gauges are not suited for many applications your furnace may not be equipped with such a device. An inexpensive TC gauge can be purchased from several sources to aid in leak detecting.

WARNING!

Volatile solvents are potentially hazardous. Please refer to the appropriate material safety data sheets for proper safety and use instructions.

Vacuum Pump Oil Level and Condition

The vacuum pump oil levels should be checked frequently. The oil should be clean, and should be replaced as necessary. The levels can be observed through the sight glasses or sight tubes on the pumps. Under most circumstances the oil level should be checked when the pump is running and warmed up. On pumps with level marks on the sight glass, the oil level should be between the minimum and maximum marks. On sight glasses without level marks, the oil level should be about halfway up the sight glass. The oil should appear clean and clear in the sight glass. If the oil appears milky brown, water may be present in the oil. Opening the rough pump's gas ballast valve will help remove moisture from the pump's oil. Refer to the rough pump's operator manual for further details in using the gas ballast valve. If the pump oil appears dark or particles are suspended in the oil it should be replaced.