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Getting the Most Out of Your Ion Pump

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Ion pumps are often used when a clean ultrahigh vacuum is required. Since they are totally oil-free and require no additional services other than 115vac power, they are considered to be easy to operate without the constant attendance of an operator. They have been used successfully in many uhv applications for years, and they have gained a high degree of acceptance.

Ion pumps, however, tend to become a problem in getting them into operation in the first place. This problem is traced to the fact that they have a very low pumping speed at pressures above 10^{-4} torr, as shown in Figure 1. If, for exam-ple, an ion pumped system is roughed to a few millitorr which is the ultimate pressure attainable with most traditional roughing pumps, it is often difficult to "start" the ion pump. Ion pumps operate from "high reactance" power supplies. This means that the power supply will provide low voltage and high current when the circuit has a low resistance and will provide a low current and high voltage when the circuit has a high resistance as shown in Figure 2. The higher the pressure within the ion pump, the higher the current. It is helpful to think of an ion pump as a very large cold cathode gauge since it reacts electrically to pressure.

At typical roughing pressures, the ion pump power supply has to provide a high current and low voltage and this results in a low pumping speed relative to the pump's speed at lower pressures. This current is high enough, say 2 amps, to allow heating of the titanium electrodes within the pump. Any gas that is within the bulk of the titanium will tend to be released when heating occurs, and the pressure within the pump and system will rise and result in even more heating. In a new pump, the titanium is fairly gas free and starting is not much of a problem, but it will become more and more of a problem as the pump ages.

During pumping, titanium is sputtered around inside the pump to provide clean titanium surfaces for gettering of active gases. As more and more titanium sputters and reacts with the residual gases, spongy deposits of titanium compounds build up on the electrodes and inner pump surfaces. The spongy layers will absorb large quantities of water vapor when the pump is let up to air with the system. As heating occurs during starting, the water will desorb from the spongy layers; and the pressure can easily rise to the point where it is impossible to start the pump. The common reaction to this problem is to allow the roughing pump to remove some of the released water until the temperature and desorption rate stabilize and the roughing pump can be valved off. At this point, the pressure should begin to fall and the voltage begin to rise to allow more and more pumping speed. Once the voltage has reached its highest point, the pump has "started," and the pump will continue to operate without further concern.

ROUGHING PRESSURES

Most ion pumped systems have been roughed with sorption pumps due to their inherent cleanliness since they contain no oil at all. Most uhv practitioners have been willing to go through the hassle of chilling the pumps with liquid nitrogen and baking them out from time to time in order to obtain an oil-free and basically clean roughing pressure. This is especially true since uhv systems are usually pumped down from atmosphere occasionally because they stay at uhv for protracted periods. The most unacceptable feature about sorption pumps is their ultimate pressure capability. They will usually stop pumping somewhere between 2 and 10 millitorr. This limit is due to the partial pressures of inert gases such as helium in the atmosphere since helium will not pump at all at liquid nitrogen

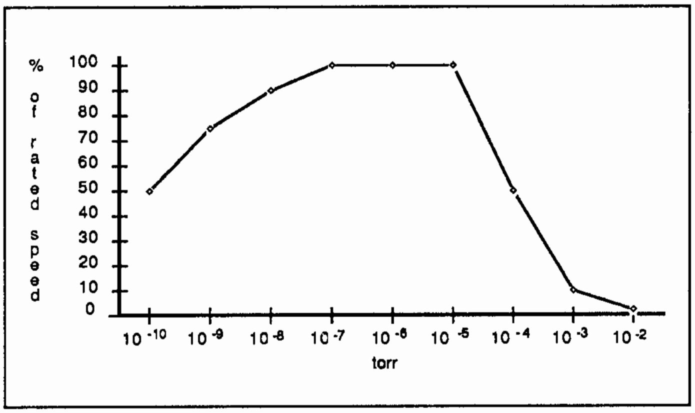

Figure 1. Ion Pump Speed vs. Pressure

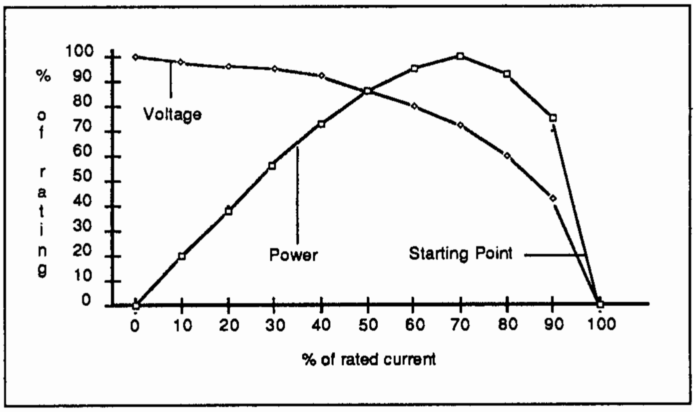

Figure 2. Ion Pump Voltage Current Relationship

temperatures. If the ion pump is started at these pressures, heating will easily result. Additionally, it will take a long time for the pressure to drop since the inert helium will pump very slowly in the ion pump.

Slightly lower pressures can be achieved by a well trapped oil-sealed mechanical pump which will result in faster and easier starting, but the risk of oil contamination is always present.

TRIBODYN ROUGHING FOR ION PUMPS

Tribodyn pumps are well suited for roughing ion pumped systems. They can provide a totally oil-free ultimate below 10^{-4} torr without need for traps or liquid nitrogen. At these pressures, the ion pump power supply will be able to reach full operating voltage almost immediately, so the heating problems associated with higher pressure starting are totally avoided. Even very old pumps that already have heavy buildups of spongy titanium will start very quickly if roughed to pressures below 10^{-4} torr.

RESIDUAL GAS CLEANLINESS

Since ion pumps are often used rather than some other type of high vacuum pump because of their inherent cleanliness, it is vital that no contamination be introduced by the roughing pump. The low roughing pressure capability and ease of use of the Tribodyn pump does not require a compromise in cleanliness over sorption pumping. Long term residual gas analysis of at the Tribodyn's ultimate pressure shows no hydrocarbon contamination. Since there is always a suspicion that hydrocarbon contamination levels may lurk below quadrupole RGA detectability limits, a manufacturer of surface science instrumentation conducted a long term exposure test of a production Tribodyn. Auger analysis showed no hydrocarbon contamination on surfaces even after long exposure.

PHOTOTRON WITH ION PUMPS

Using a Phototron for water vapor desorption in place of bakeout is commonly accomplished on ion pumped systems. There are several considerations that must be taken into account, however. The low pumping speed and throughput of the ion pump at higher pressures can be a problem if the Phototron is turned on at pressures above 10^{-5} torr.

The sudden gas load from the desorbing water vapor can easily become too high too quickly for the ion pump to handle it. The pressure will then rise until the ion pump is "choked." This potential problem can be easily overcome by using the Phototron during the roughing cycle to desorb the initial heavy gas load such that the roughing pump can handle it. Alternatively, the Phototron can be turned ON and OFF in short cycles above 10^{-5} torr to limit the initial gas load. Each Phototron power supply has both a timer and an external ON/OFF control input. The Phototron source is a fixed power level device, so the UV power output cannot be regulated to lower levels for initial desorption. Once total pressures below 10^{-5} torr are achieved, there should be no further problem with high gas loads generated by Phototron induced water vapor desorption.

Although some Phototron UV energy will enter the ion pump's body and reflect around to induce desorption within the ion pump, it will not fully desorb water from the internal surfaces since the UV cannot reach all of them. It is usually necessary to provide at least some bakeout of the ion pump itself to ensure that all the water is desorbed from the surfaces and pumped chemically by the ion pump.

CONCLUSION

The inherent cleanliness of the ion pump and its ability to reach ultrahigh vacuum can be made easier by the application of Tribodyn roughing and Phototron water vapor desorption. It is merely the application of new technology to an accepted and successful older technology.

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