THE VACUUM CHRONICLES

Volume 4, Number 11

Phototron Power and Performance Relationships

by Phil Danielson

UV radiation from a Phototron source is usually used to increase the desorption rate of water vapor from the vacuum system's internal surfaces during the pumpdown process to provide a lower desorption rate and subsequent lower water vapor component in the system's residual gases at the end of the specified pumpdown process. By carefully matching the UV power, exposure time, and pumping speed; specific pumpdown performance results can be achieved.

POWER REQUIREMENTS

In general, a given desorption rate of water vapor will be reached after a given amount of total desorption has occurred. The "natural" desorption rate vs pumping time curve shown on Figure 1 clearly demonstrates that the high desorption gas load must be pumped away before a condition of lower desorption is achieved. This means that until a certain amount of water vapor has desorbed and been pumped away, you can't reach the ultimate pressure you've targeted for your process.

In order to reach a desorption rate that is low enough you can either wait until you reach that point by "natural" desorption, or you can stimulate higher desorption rates by UV energy from a Phototron. Either way, you'll get there sooner or later. Maybe later. Note that the desorption rate shown on Figure 1 is still dropping after 10 hours, but very, very slowly.

Applying UV power from a Phototron will speed this effect; and obviously, the more power that is applied, the faster desorption will occur. The more power applied, the faster desorption will occur, but practical compromises are usually necessary due to such requirements as physical installation space or economic considerations. So, how do you pick a target power? Well, what do you want to accomplish? How about a target pumpdown performance time?

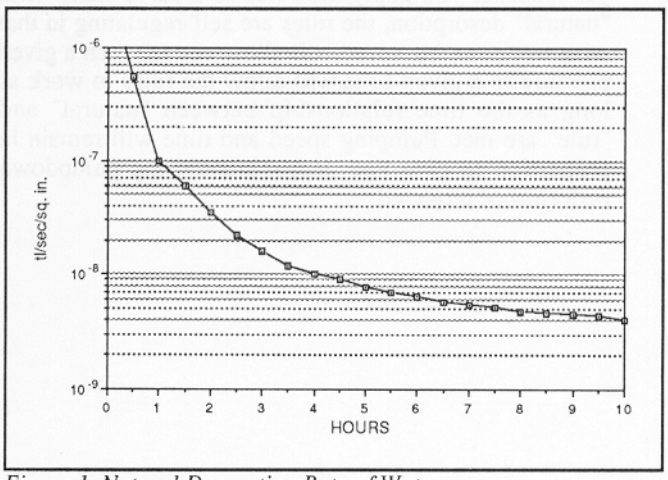

Figure 1. Natural Desorption Rate of Water.

CUTTING THE PUMPDOWN IN HALF, THE 1/2 RULE

You can cut your pumpdown time in half by irradiating the system with a power level of 2.5 mw/in^2. The trick is in knowing when to turn OFF the Phototron. In this case, you turn it off at one half the time you want to achieve to reach a given pressure. If you pump down to a given pressure in 1 hour with "natural" desorption and want to cut that time to 1/2 hour, you irradiate for 1/2 of 1/2 hour or 15 minutes. A typical example is shown in Figure 2. At this power level, you've dumped enough energy into the desorbing molecules and sorbed bed of water vapor that it takes about that long to settle down to the new desorption rate. These effects become even more apparent at higher power levels.

HIGHER POWER LEVELS

If we apply power levels that are approximately twice those used in the 1/2 rule, we can see what higher power levels will do. The pumpdown curves shown in Figure 3 demonstrate what happens when a system is exposed to

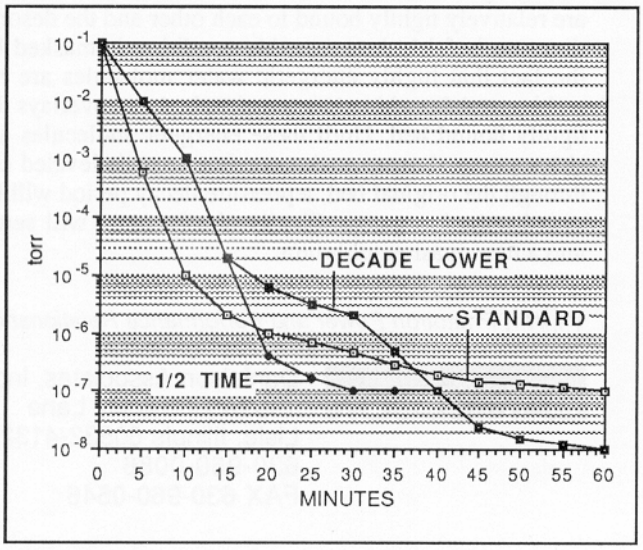

Figure 2. 1/2 Rule Pumpdown.

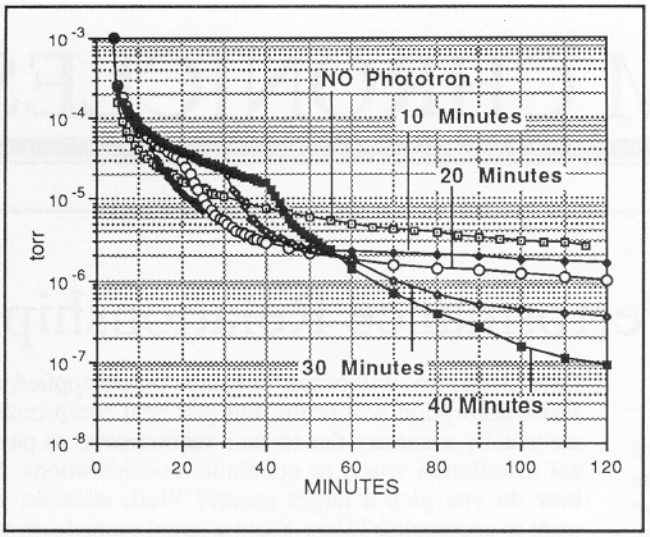

Figure 3. 5.5mw/sq. in. with Varying Time

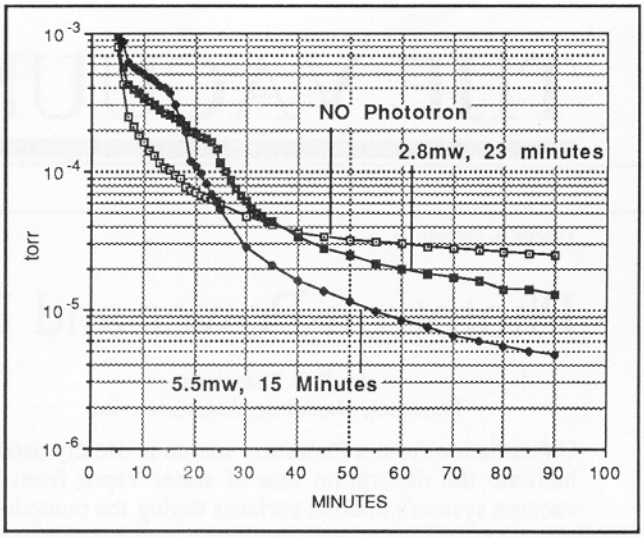

Figure 4. 1/3 and 1/2 Rule.

varying lengths of time at 5.5 mw/in^2 of UV power. A curve with 0 exposure time showing "natural" desorption is included in order to help understand the effects of UV exposure.

Figure 3 shows some expected results in that higher than "natural" desorption continues as long as the Phototron source is ON, and that the pressure falls off after the source is turned OFF. What is interesting is that you can adjust the final desorption rate by deciding when to turn it OFF. If you want a fast pumpdown to and intermediate pressure, in this case the same pressure of 2.8 x 10^{-5} torr as is reached by the "natural" desorption in 120 minutes, you can turn the source OFF at 10 minutes and it will drop quickly to that level. Longer ON periods will result in lower pressures being achieved in slightly longer ON periods.

Note that the pressure does not drop immediately to a new low level upon turning the source OFF as you might expect when closing a valve to a gas source. In general, the longer the source is ON, the steeper the slope after turning the source OFF.

Two conditions are present at the same time. The UV generated desorption has eroded the original bed of sorbed water vapor down to a level where the water molecules are relatively tightly bound to each other and the desorption rate is fairly low, but this condition is masked by the fact that highly energetic water molecules are resorbing and desorbing in a transient bed that overlays the tightly bound bed. Until these energetic molecules are either pumped away or the excess energy is leveled out through the original bed, a pressure decay period will be seen by the ion gauge. Finally, the pressure will settle into a new quasi-equilibrium.

The effects of higher UV power levels can be seen to allow specific application driven pumpdown performance criteria to be met by varying the ON time. In fact, at power levels twice the power used for the 1/2 rule, we are able to establish the 1/3 rule.

CUTTING THE PUMPDOWN TO ONE THIRD, THE 1/3 RULE

Using about 5 mw/in.^{2} power levels will allow you to cut the pumpdown time to 1/3 of what would be achieved without a Phototron. This rule of thumb says that you should keep the Phototron ON for 1/2 of the projected time. If you want to reach the same pressure that takes 1 hour under "natural" conditions, you can reach it in 20 minutes if you provide 5 mw/in.^{2} for 10 minutes.

USING THE RULES OF THUMB

Figure 4 shows pumpdown curves of the same system with Phototron power levels approximating the 1/2 and the 1/3 rules. Both of these rules can be considered as starting points for picking a power level to match your needs.

Note that we don't specify pumping speeds to meet these gas loads. If you apply the rules to a curve taken with "natural" desorption, the rules are self-regulating in that whatever pumping speed will allow you to reach a given pressure in a given time will allow the rules to work as long as the time relationship between "natural" and "rule" are met. Pumping speed and time will remain in proportion to give you approximately the pumpdown performance projected.

DANIELSON
Danielson Vacuum Products, Inc.
1989A University Lane
Lisle, IL 60532-4156

Toll Free (U.S.A. & Canada)
1-877-9DANVAC (1-877-932-6822)
TEL 630-960-0086
FAX 630-960-0546
Email: sales@danvac.com
www.danvac.com