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Load Lock to Chamber Water Transfer

Part 2: The Solution *Load Lock*

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As load locks continue to proliferate in modern process applications, and concerns about the presence of water vapor in process chambers become more prevalent; the next step in tracking water vapor is to evaluate its transfer from the load lock into the chamber.

Whether the work comes from the load lock directly into the process chamber or whether it first goes into a transfer chamber in a cluster tool, water vapor can be introduced on the surface of the work. This, in turn, can lead to a complex series of transfer of water vapor from surface to surface throughout the process chamber(s) and the process itself.

Often, the only feasible technique for minimizing the transfer of water vapor is to use UV energy transfer from a Phototron source to maximize desorption early in the process.

THE LOAD LOCK

Since the work being placed in the load lock is probably saturated with sorbed water vapor, and the internal surfaces of the load lock will probably also become saturated when the lock is let up-to-air for loading, energy transfer to the sorbed water vapor to induce a maximum of desorption while the load lock is being pumped down will reduce the amount of water carried into the process or transfer chamber when the lock is cycled.

In batch systems where the chamber itself is opened for reloading, the goal is usually to reach a specified process pressure as soon as possible during the pumpdown cycle. This goal is usually reached by using a Phototron to desorb just enough water vapor to adjust the gas load from desorption to an acceptable level.

A different approach is required in a load lock. The goal is to desorb as much water vapor as possible during an acceptable pumpdown time. This, then, is accomplished by applying as much energy as possible to the load lock and work as is possible.

A secondary decision is process dependent. You can either:

1. Cycle the load lock with the work at the lowest desorption rate possible within the pumpdown time restraints, or
2. Cycle the load lock with the work still desorbing at the highest rate possible.

Cycling at Low Desorption

This option means that the work is exposed to UV energy in the load lock for a pre-determined amount of time before the Phototron source is turned OFF and the energy that was pumped into the sorbed water bed allowed to decay while the lock is pumped on to produce a low pressure before cycling. The total time in the lock would be controlled by UV power level, surface area, and pumping speed.[1]

Advantages

1. The work is not adding too much to the chamber's walls since the desorption rate is lower than if it hadn't been pre-desorbed in the load lock.
2. The pressure in the load lock is low when the lock is cycled and this reduces the amount of water transferred into the chamber.[2,3]

Disadvantages

1. The surface of the work is still in a fairly high desorption rate condition because the full load lock time couldn't be used for desorption due to pumpdown time following Phototron OFF.

Cycling at High Desorption

If the entire time in the load lock is used to desorb the work, the Phototron source is ON during the entire load lock period.

Advantages

1. The surfaces of the work are as free of sorbed water as possible as allowed by the power level[1] applied in the load lock.
2. The work will continue to desorb at a high rate within the chamber since the original bed[1] is still in an energized state from the Phototron treatment in the load lock.

Disadvantages

1. The desorption from the introduced work will tend to load the walls of the chamber with water vapor which will re-desorb later and probably impact the work being introduced.

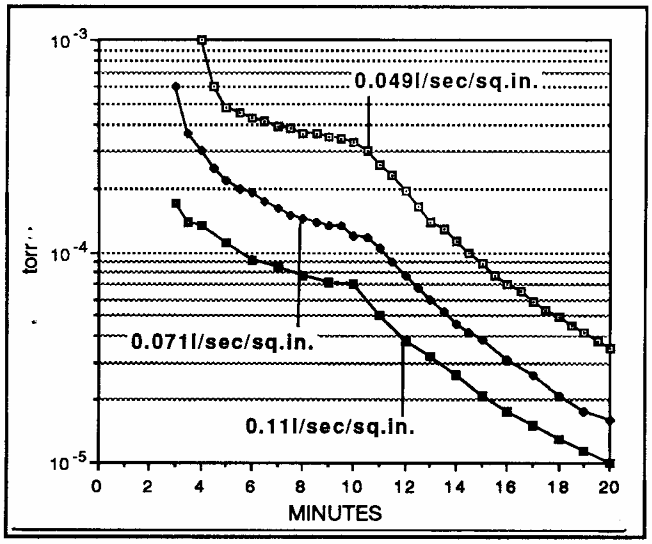

Figure 1. Effect of Pumping Speed on the Pumpdown Curves at 16.8 mw/in.^{2} *of Phototron Power for 10 minutes.*

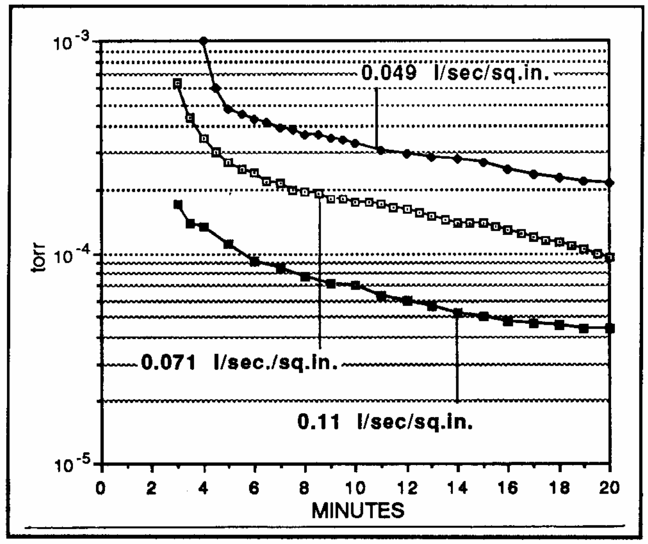

Figure 2. Effect of Pumping Speed on the Pumpdown Curves at 16.8 mw/in.^{2} *for 20 minutes.*

POWER LEVELS AND PUMPING SPEED IN THE LOAD LOCK

Since load lock times are usually limited, the maximum desorption should be accomplished during the time in the load lock. Maximum desorption rate means both maximum Phototron power and gas load, and that means that both have to be considered together.[1]

The critical pumping speed[4] for a production system is about 0.049 liters/sec./in.^{2} for a system undergoing "natural" desorption where no UV energy from a Phototron is applied. This means that increasing the pumping speed will not provide much improvement in pumpdown time due to the fact that the desorption rate is controlling the pumpdown time. When UV induced desorption is encountered, the gas load rises and a much higher critical pumping speed is required if the gas load is to be met.

Figure 1 shows the effect of pumping speed on a very high power system; 2.5 mw/in.^{2} is probably the most commonly used power level on batch systems since this is the power level for the "half rule" where the goal is to cut pumpdown time in half. In order to simulate the effects of a high power load lock requirement, the curves in Figure 1 show a power level of 16.8 mw/in.^{2}

Figure 1 clearly shows that increasing the pumping speed above the "natural" desorption critical pumping speed is now very important. For testing, it was assumed that a 20-minute total pumpdown with a 10-minute Phototron UV exposure time would be used to provide a working example to evaluate and exemplify any actual needs on a working system.

The need for pumpdown time following Phototron OFF is only under conditions of cycling the work into the chamber at a minimum desorption level and lowest load lock pressure as discussed above. Figure 2 shows the pumpdown curves that can be obtained at the same 16.8 mw/in.^{2} Phototron power level when the Phototron is operated during the entire 20-minute load lock cycle.

Comparison of Figure 1 and Figure 2 indicate clearly that the total amount of desorption from the work will be much higher when the Phototron is operated longer. In this case as well, higher pumping speed will provide a lower load lock pressure when the lock is cycled.

The choice of which type of Phototron exposure prior to cycling and its effects on the process chamber or transfer chamber is a choice that is not only process dependent, but will require a better understanding of the chamber's reaction, which will be discussed in Part 3.

REFERENCES

1 *"Phototron Power and Performance Relationships," The Vacuum Chronicles, Volume 4, No. 11,*

2 *"Understanding Load Locks, Part 1," The Vacuum Chronicles, Volume1, No. 11*

3 *"Understanding Load Locks, Part 2," The Vacuum Chronicles, Volume 1, No. 12*

4 *"Critical Pumping Speed and Water Vapor in Production Systems," The Vacuum Chronicles, Volume 4, No. 9*

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