

WATER VAPOR AND VACUUM METALLIZING

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by MIDWEST TUNGSTEN SERVICE

Water vapor is a factor in all metallizing systems. The presence of water vapor in a chamber can have adverse effects on product throughput, quality of the finished product, and the life of vacuum system components. Considering this, it is well worth the time to understand more about water vapor and how it interacts with the metallizing system.

Water vapor is the gaseous state of water. We are most familiar with it as clouds, steam, or humid weather, but it is present even when we cannot notice it. Warm air holds more water vapor, therefore, its effects are usually more severe in the summer months. Our toll-free service line is busiest during the month of May, and the majority of the calls we receive are ultimately related to the increased humidity.

The most obvious question is: "How does water vapor get into my chamber in the first place?" The simplest way is for water vapor to be carried along with the air entering your chamber. As a chamber is vented to the atmosphere, humidity in the surrounding room is brought into the chamber. This moisture can remain airborne, or it can deposit onto the inner surfaces of the chamber. To reduce the effects of weather-related humidity, many metallizers choose to air condition or dehumidify the spaces in which their chambers are located.

Other ways for water vapor to enter the system are less obvious and require the use of what may be some unfamiliar terminology. Water vapor can be trapped on the surface of the chamber walls and fixtures, forming a thin film composed of loosely bound layers of water. This phenomenon is called adsorption. It is different from absorption in that it is a surface phenomenon only. No water penetrates to the interior of the coated object. Adsorbed water is released from a surface under vacuum conditions, or under increased heat.

Water vapor can also come from the parts which are to be metallized. This water can be adsorbed onto the parts as discussed above, or it can be absorbed into the parts. Certain plastic materials will absorb large amounts of water, especially if they are stored in humid areas prior to metallizing. Nylon is an example of such a material. Under vacuum, this water is drawn into the atmosphere of the chamber.

What problems can be caused by water vapor in the chamber? A noticeable problem is an increase in pumpdown times. At 10^{-4} torr, there is more water vapor than any other gas. So, the job of the pumping system at this point is mainly to pump water vapor, which is more difficult than pumping other gases. The reason is that the weak bonds that hold water vapor to a surface are easily broken and water vapor is released into the chamber space without much energy. Other gases have much higher energies and tend to bounce off chamber walls and each other before eventually bouncing into the pumping area and being removed. Water's low energy level does not

promote this bouncing behavior. Rather, water molecules tend to stick to surfaces they collide with. They must gather energy to break free of the surface all over again. This sticking and breaking away continues until the molecule finally makes it into the pump area and is removed. Often times, the energy to break away from a surface is provided by heat generated during evaporation. This is a particularly bad situation, for now the water can react chemically with the material being evaporated and cause discoloration, poor adhesion, or other undesirable results.

Water vapor also takes its toll on your pumping system. Water vapor can accumulate in your mechanical pump where it promotes the formation of acids which will eat away at the interior surfaces of the pump. It can also emulsify with pump oil, degrading its lubricating ability and causing increased friction, wear, and heat. Water will also raise the backstreaming rate of your oil increasing the chances of burned shots.

How can you eliminate water vapor from your system? Unfortunately, you can't. You can, however, reduce the amount of water vapor and minimize the effects of it. Here are some ways of reducing water vapor and its harmful effects in the metallizing system:

1. Metallize parts as quickly as possible after basecoating. The longer parts are exposed to atmosphere, the more water they will bring into the chamber with them.
2. Keep chamber clean. Aluminum deposits are porous and will adsorb lots of water.
3. Keep chamber closed and under vacuum unless loading or unloading parts.
4. Air-condition or dehumidify metallizing area.
5. Learn proper use of your mechanical pump's gas ballast.
6. Consider installing a cryogenic pump to trap water vapor. This is expensive, but highly effective. It usually pays for itself with shorter cycle times and fewer bad parts.

If you have any questions on how the presence of water vapor is affecting your vacuum metallizing operation, please contact us. We will be happy to discuss your situation.

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