

Dealing with Moisture Inside Electric Heaters

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Those who work with electronics usually equate water and electricity as a bad combination – and for good reason. Labels can be found on many kitchen appliances and bathroom electronics, such as electric knives and hair dryers, warning users a shock can occur if the device comes into contact with water.

It stands to reason any electronic device should be handled with care when water is present. But how does one deal with electronic devices when water or moisture is inside the device and yet needs to be energized? Examples include industrial heaters used in plastics processing, foodservice equipment, packaging, telecommunications and semiconductor processing industries, to name just a few.

Heater manufacturers hear a variety of issues in the field such as:

- ∞ When the power is turned on, the heater smokes.
- ∞ The heater does not pass high potential (hi-pot) testing.
- ∞ The heaters are tripping the Ground Fault Interrupter (GFI).

These complaints typically can be attributed to moisture inside the heater. While this can seem daunting and even irritating to the new user, inconveniences can be minimized with proper precautions.

Many industrial heaters are manufactured with a compacted insulation called magnesium oxide (MgO). MgO is hygroscopic, meaning it can readily take and retain moisture out of the environment. The heaters must go through a bake-out process prior to final assembly. At times when the heaters are exposed to high humidity environments after shipment from the factory, the heaters can absorb moisture. Additionally, when the heater sits idle on a machine at room temperature, occasionally they can take up moisture.

For example, take into consideration heaters installed in high humidity environments on equipment that travel overseas. Moisture in these heaters could cause a nuisance tripping the GFI. When the heater is powered it smokes or outgases. This out-gassing is a result of the moisture exiting the heater as it reaches its operating temperature and is actually quite common in most heaters. Additionally, there are various levels of binders along with the moisture that can

burn out from the heater when it is energized. The user should not be concerned when the moisture in the heater outgases. For more information regarding the binders and other ingredients the make-up part of the out-gassing, see the product's related Material Safety Data Sheet (MSDS).

An important requirement for industrial heaters is they must pass an electrical specification called a dielectric strength test or hi-pot test. The hi-pot test measures the heater's ability to restrain leakage current at a given voltage. A breakdown in insulation or a faulty assembly can cause a hi-pot failure. Additionally, a high level of moisture can also indicate excessive leakage and/or a hi-pot failure. When moisture is in the heater, it serves as a direct path to ground, which will cause the heater to fail hi-pot.

Remedies

There are several steps that can be taken to avoid issues related to moisture:

Field Bake Out

It is often inconvenient for the user to send heaters back to the factory to be dried. However, one approach to ridding the heater of moisture in the field is placing the heaters in an industrial oven overnight at 121-204°C (250-400°F) depending on the size of the heater. When the application requires heaters quickly, a field bake-out can be an option. This will ensure no nuisance tripping of the GFIs and will permit the heaters to pass hi-pot tests.

Low-Voltage Controller Bake Out

In applications when SCR power controllers are used, a way to optimize heater performance is to utilize the low voltage start-up feature – if offered. The Watlow POWER SERIES controller has such an option called *heater bake-out*. During the heater bake-out step, the POWER SERIES gradually increases voltage to the heater while monitoring the output current. When the heater achieves full output before the bake-out time is completed, the user then knows the heater is dry and it can be put into regular service.

The key difference between standard soft start and the bake-out option is since soft start is active for only one second, for instance, there is not enough time to use this lower voltage to bake out any moisture inside the heater. If an MgO-insulated heater element shuts down for a

long period of time (or sits in storage), it can absorb moisture. If full power is applied, excessive current can blow fuses and cause irritating tripping of the GFI. The heater bake-out feature soft starts the load to remove moisture from the heater and prevents blown fuses. The bake-out option offers additional user-enabled programming options such as allowing the user to input parameters based on application needs, including a specified bake-out time period. Occasionally due to high moisture content, the bake-out cycle time may not be long enough. If the output current reaches a user-specified trip point during the bake-out—as it would if arcing occurred in the heater—the SCR shuts off the output and activates an alarm. After the heater bake-out, the SCR automatically switches to the user-selected control mode (phase angle or zero cross).

Special Insulation

While it is common to apply low power to the heater to dissipate the moisture from the MgO insulation prior to assembly, this is a short-term solution since the MgO can readily wick in moisture if the right conditions exist. Another choice is to opt for an insulation that can better handle the moisture. Watlow offers a feature on various heaters called Improved Insulation Resistance Value (IIRV) treatment. This process coats the MgO insulation. The treated insulation fends off moisture when sitting for long periods of time. It is also ideal for heaters that are exported to customers around the world, which is when moisture tends to penetrate the heaters.

Align Testing Procedures

When a heater fails a field hi-pot test with excessive leakage it might be attributed to moisture in the heater. UL® and CSA have guidelines for testing heaters prior to shipping. This test criterion was established to protect the user and the user’s equipment. If additional internal hi-pot testing is required at the customer’s site, they are encouraged to align their test procedure to that of the UL® testing standard. The hi-pot test parameters below are typical for testing strip heaters.

Heater Voltage	One Second Test Voltage	Milliamp Setting
Less than or equal to 250V	1250 V~(ac)	*
Greater than 251V	2 times rated voltage + 1000V, 20	*

	percent	
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* Maximum allowable leakage (compensated) shall be 4 milliamps (mA) per 100 in².

Safety – Ground the Heater

Do not forget to ground the heater. Any electrical device, including heaters, can leak current to its sheath or short circuit to the sheath. Leakage current is a small amount of electric current which passes through the electrical insulation of heaters, motors or other electrical devices. The leakage current may be strong enough to cause a shock or cause sensitive electronic devices to not operate properly.

An electrical or safety ground is used to protect people from being injured as well as keeping equipment from being damaged (See Figure B). As the name implies, it *grounds* electrical current in case of a short circuit. It is a wire attached to the metal part of an electric device and connected to a metal rod which is driven into the ground. The ground functions as an alternate return path for electricity. The ground path effectively *drains* off any leakage current or short circuit current into the earth.

Heaters can be manufactured with a ground wire or a ground terminal as an added safety feature. The third lead or terminal on the heater is where the connection is made. Additionally, when measuring resistance between the terminals (or leads), the ground will measure *open* or a very high resistance between one terminal and the two other terminals.

It is important to fully understand the application when utilizing electric heaters. In addition, it is always worth the extra steps to ensure safety and protect expensive equipment. Whether it involves grounding the device, baking the moisture out of the heater, choosing the proper insulation, or proper testing, the peace of mind of knowing the right steps were taken specifying and applying heaters can go a long way.

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