Eliminate Moisture in Electrical Cabinets and Save Maintenance and Component Expenses

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Eliminating Moisture Inside Electrical Cabinets and Motors

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Lee has over 30 years of experience in pneumatic and filtration technologies for the food and beverage and industrial manufacturing industries. At Parker IGFG, one of his primary focus areas is on compressed air treatment solutions for food safety compliance. Lee has an B.S. in Business Administration and Management and an MBA from the University of New Hampshire.

Objective

On many food processing and wet processing applications, the presence of moisture in electrical cabinets, motor housings and related equipment can lead to a variety of costly problems including premature component failure and poor product quality. Engineers have tried a range of creative measures to eliminate moisture build up and maintain clean dry air for their applications, most of which are not effective. A safer and more effective solution exists by providing dry compressed air to electrical cabinets and motor compartments on a 24 hour/day, 7 day/week basis. This paper discusses the extent of the problem and poses an optimal solution.

Introduction

The presence of moisture in electrical cabinets, motor housings and related equipment can lead to corrosion, premature component failure, costly down time and extensive repairs. Wet electrical cabinets are a significant problem in most, if not all, food and beverage facilities. The use of NEMA (National Electrical Manufacturers Association) Standard 4x rated enclosures is not an adequate defense against moisture build up. Moisture in the warm, dark internal environment of an electrical cabinet leads to microbial harborage points that can go unnoticed and create serious contamination problems. The presence of condensation inside an electrical cabinet or motor compartment can create water puddles at the base of the cabinet and condensation on the walls and components. The presence of water leads to contact corrosion which can compromise electrical connections resulting in significant down time and expensive repairs. These effects can be especially problematic since the ambient temperature changes during the day. Service technicians must also be especially careful to shut down power before servicing these wet cabinets due to the increased chance of electrical shock. While the presence of moisture in electrical cabinets and motor compartments is a problem in essentially all wet process industries, it is especially critical in food processing because of the daily high pressure wash downs.

The Problem

Downtime due to failed electrical components

Downtime due to failed electrical components can cost thousands of dollars. Typically, a component fails in the middle of a production run. Maintenance personnel must interrupt their work to get production back on line. Routine maintenance progress is then delayed or overlooked to handle emergencies caused by wet cabinets. This contributes to further equipment failures. Maintenance moves from emergency to emergency dealing with problems which can be easily prevented. Lost production, spoiled product, idle workers, emergency maintenance and component costs can add up quickly. It becomes a vicious cycle.

Plant and controls engineers have tried many types of work arounds, most of them ineffective. They have used consumer hair dryers to dry touch panels or used rolls of paper towels to wipe the insides of electric panels. Other solutions such as light bulbs and drilled out drainage holes do not adequately solve the problem either. Manufacturers have tried a number of approaches for drying electrical cabinets and motor compartments, including dehumidifiers, heaters, heaters with a fan, vortex coolers and air conditioners.

Electronics perform best and last longest in a cool dry environment. Heaters and light bulbs create a hot, humid environment.

Premature component failures are not mitigated by these means and drainage holes defeat the NEMA 4x and UL rating of the cabinet and create entry points for water from wash down. Moreover, these holes only release moisture that accumulated on the floor of the cabinet and do not address the moisture that condenses on the surfaces of the electronic components.

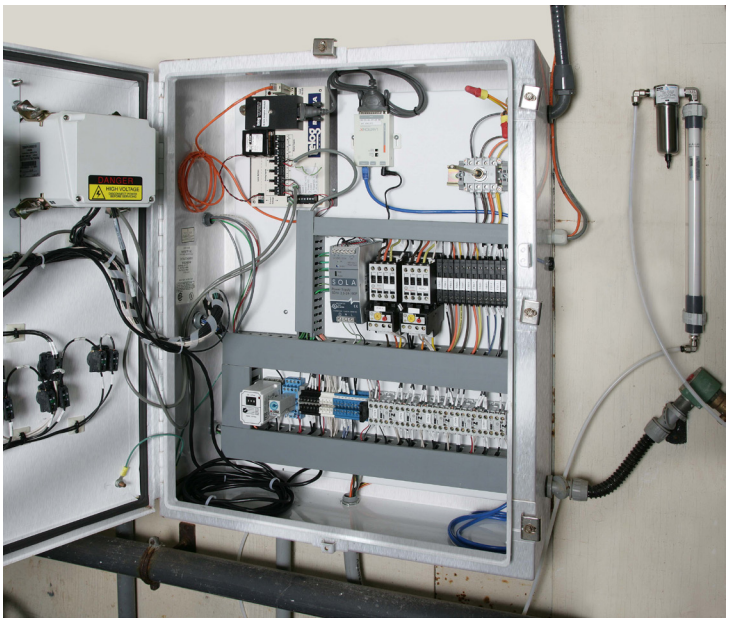
In addition, OSHA requires that devices such as heaters and air conditioners should be powered down during the wash down procedure at the very time when drying is most needed. After the drying device is powered on again, it takes a period of time (if ever) to re-dry the cabinet.

The Solution

Purge with a cabinet dryer

Many facilities find success by purging the compartment with air dried by a cabinet dryer system.

A cabinet dryer can create a completely dry atmosphere, removing water and other deleterious materials such as compressor oils and particulate matter. Any moisture that gets into the cabinet is quickly evaporated by the dry purge from the cabinet dryer.



How the Cabinet Dryer System Works

House compressed air is filtered and dried in a two step process. First, a coalescing filter removes the liquids and particulate matter with an efficiency of 99.99% at 0.01 µm. The liquids drain to the bottom of the housing and are emptied via an automatic drain.

Fig. 1. Coalescing Filter – Used to remove oil and water droplets, particulate matter from compressed air. The liquids drip to the bottom of the filter housing and are automatically emptied by a drain assembly

The compressed air then passes into a membrane module that consists of a bundle of hollow membrane fibers which are permeable to water vapor.

As the compressed air passes through the center bore of these fibers, water vapor permeates the walls of the fiber and dry air exits from the other end. A small portion of the dry air is redirected along the shell side of the membrane fiber carrying away the moisture that accumulates on the outside surface of the fiber. The water vapor is then vented to atmosphere as a gas, not a liquid.

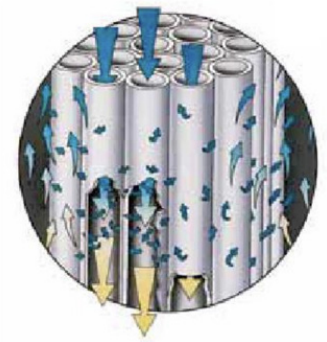


Fig. 2. Permeation Membrane – Used to remove water vapor from air. The membrane bundle contains a large number of membranes to provide enhanced surface area. The water-laden air is carried away by a small portion of the dry air (regeneration flow).

The dry air is then directed through an airline to purge the cabinet interior, evaporating moisture and venting it down the interior or the electrical conduit.

The combination of a coalescing filter and a membrane dryer provides air with a dew point of -7°F (-22°C) for saturated inlet air of 100°F (38°C) and 100 psig. The input temperature range is from 40-120°F (4-49°C) and the inlet pressure range is from 60 to 150 psig (4-10 bar). Flow and outlet pressure is controlled by a built in orifice. The system is rugged enough to hold up under severe wash down environments.

The coalescing filter is housed in an assembly to provide ease of operation and maintenance.

Fig. 3. Cabinet Dryer Assembly

The auto-drain feature allows liquids to automatically empty so that the filter can continue to remove liquids for an unlimited time without loss of efficiency or flow capacity.

The only required maintenance for cabinet dryers is periodic replacement of the filter. This is typically done without tools by simply unscrewing the bowls (captive O-rings are used to minimize the need for spares) and removing the element. The overall assembly does not contain any moving parts and is extremely reliable and quiet in operation.

> *"The initial cost of a cabinet dryer system is minimal and operating costs are correspondingly low, especially when compared to the cost of the components it protects."*
>
> — Lee Scott, compressed air and gas treatment product manager, Parker Industrial Gas Filtration and Generation Division

Comparing a Cabinet Dryer to Other Methods of Drying

Using a cabinet dryer can often solve problems that manufacturers find difficult by other methods.

Success story

A Parker Balston Cabinet Drying System was installed on a metal detection application for a multinational producer of brand-name meat products. Before Parker installed the dryer, the producer found it necessary to stop production three times a week to remove moisture from the detector. According to the plant engineering manager, "once we installed our dryer system, the problem went away. The dryer has been in place for more than a year, with no maintenance issues."

Heaters and Fan Heaters

Placing a heater or a light bulb in the electrical compartment is perhaps the simplest approach to drying an electrical cabinet. Using the heater, the temperature of the cabinet is increased and the humidity increases, but the absolute amount of water vapor in the cabinet remains constant. If the power is shut off or the heater or bulb fails, the temperature returns to ambient and water vapor may condense, which creates problems for components inside the cabinet. High humidity shortens the life of many electrical components.

Similarly, the power to the heat source must be shut off during wash down procedures, leading to the possibility of condensation inside the cabinet. Heat from the lamp can lead to premature component failure; in some facilities, a fan is used to expel the warm air from the cabinet. The fan introduces an additional component to the system that consumes power, may fail, and provides a point of water entry since it is open.

Vortex Cooler

A vortex cooler is a mechanical device that separates compressed gas into a hot and a cold stream that then provides cold air, passed through the electrical compartment, to remove water vapor. The basis of a vortex cooler is a swirl chamber into which the pressurized gas is introduced. A conical nozzle is placed at the end of the tube and only the outer layer of the gas, which is cool, escapes at that end. Since cooled air has lower water content than ambient air, the amount of water vapor in the cabinet is lowered. Unfortunately, the operating expenses of a vortex cooler are quite high. A typical vortex cooler provides 8 scfm of air and requires a 2 HP (1490 Watts) compressor output and therefore incurs a considerable expense for power.

Dehumidifiers and Air Conditioners

Dehumidifiers remove water vapor from air and maintain the ambient temperature, while air conditioners remove water vapor and cool the air. Dehumidifiers occupy valuable space inside a cabinet. Air conditioners require a significant amount of electricity to operate and contain refrigerants which may be environmental hazards. In addition, they contain moving parts that can lead to maintenance issues.

Cabinet Dryer Systems

Cabinet dryer systems employ a coalescing filter and a hollow fiber membrane module and offer a number of significant benefits over the alternative methods of drying previously described. They effectively reduce the water content of the air and can be used 24 hour/day, 7 days/week, even during wash down periods in the food industry. No electricity and no refrigerants are required, just a small stream of compressed air. The cabinet dryer system introduces no additional heat into the cabinet.

Comparison chart for drying methods

Method	Pros	Cons
Heaters & fan heaters	Decreases liquid water; inexpensive.	Unreliable; inefficient; heat from lamp leads to component failure. Increases humidity.
Vortex Cooler	Decreases water vapor.	High initial cost and operating expense.
Dehumidifiers & Air Conditioners	Removes water vapor and decreases ambient temperature.	Costly due to electrical needs; contains refrigerants which may be environmental hazards; Higher maintenance; Takes up space.
Cabinet Dryer	Removes water vapor 24/7, even during washdown no electricity or refrigerants required. Reduces downtime, increases ROI.	None

Avoiding Downtime, Saving Costs

What to Know

A major benefit of a cabinet dryer is that it can dramatically reduce downtime due to maintenance emergencies.

When an emergency occurs, it may be necessary to stop the process and maintenance personnel must be re-deployed to remedy the problem. This can cost thousands of dollars per hour and have a deleterious effect on the plant's throughput. Lean staff resources are diverted from routine maintenance activities to deal with premature component failures. Other equipment suffers due to lack of time to perform routine maintenance.

In contrast, the use of a cabinet dryer eliminates emergencies. **Cabinet dryers have no moving parts and the only maintenance that is required is the biannual replacement of a filter.** This can be performed on a scheduled maintenance basis during routine system shutdowns, rather than on an emergency basis. As a typical example, a meat processing plant in the Midwest was getting errors from their metal detector, due to moisture. After installing a cabinet dryer, the plant found that it was possible to operate with no failures. By simply replacing the filter on a routine maintenance basis, the plant avoided emergency repairs and kept production moving.

Success story

A meat processing plant in the Midwest that used a heating element to keep a control panel dry realized that it was replacing the touch pad every three weeks. After replacing the heating element with a cabinet dryer, the plant found that it was possible to operate for six months or more at a time with no failures.

The operating cost of a cabinet dryer system is also considerably lower than that of alternative systems for maintaining a dry electrical cabinet.

Q. Won't a cabinet dryer waste a lot of air?

A: The cost of lost down time far exceeds the cost of compressed air. At $0.07/kwh the Parker Balston CD0005 Series Cabinet Dryer costs $0.16/day, the Parker Balston CD0010 Series costs $0.32/day and the CD0030 Series costs $0.96/day. Compare that to the cost of an hour's worth of lost production and the cost of electrical components.

Success story

A production engineer at a mid-Atlantic manufacturer of meat tenderizers, food packaging equipment, and food processing systems, reported that there were essentially no operating costs for its membrane dryer after Parker Hannifin installed the system, except to periodically replace the filter cartridge. Replacement cartridges are quite inexpensive and maintenance personnel should typically replace them on an annual basis. Maintaining a dry cabinet also reduces the possibility of corrosion and replacing components.

Conclusion

The use of a cabinet dryer to reduce the presence of moisture and condensation provides an effective, reliable and inexpensive approach to the problem of premature component failure due to moisture in electrical cabinets, control panels or motor compartments.

Cabinet dryers require only compressed air, do not need electricity, and have no moving parts. They can be operated 24 hours, 7 day a week, 365 days a year and can function during food industry wash down procedures with a minimum of maintenance requirements. The combination of a coalescing filter and a membrane filter provides air with a dew point of -7°F (-22°C) for saturated inlet air of 100°F (38°C) and 100 psig leading to a relative humidity of 30% or less. This ensures that the cabinets will be kept bone dry.

Manufacturers looking for reliable, cost-effective solutions to eliminate moisture from electrical cabinets and other equipment should consider the advantages of installing cabinet dryers in their applications.

Other industries have seen benefits too. These include pulp & paper, steel, wastewater, mines and vision based control systems.

For more information, contact Parker Hannifin at 1-800-343-4048 or visit www.parker.com/igfg.

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