Mitigating Condensation Within Enclosures

nVent HOFFMAN

UNDERSTANDING THE CHALLENGES OF FOOD & BEVERAGE PROCESSING ENVIRONMENTS

INTRODUCTION

One of the biggest challenges the food and beverage processing industry faces is condensation. Although enclosures are designed to protect sensitive systems and controls, it is difficult to prevent moisture from collecting and forming condensation within an enclosure (Figure 1).

There are a number of methods employed to alleviate the effects of condensation, but oftentimes residual traces of moisture remain that can result in costly damage to components as well as reduced component lifecycle and performance.

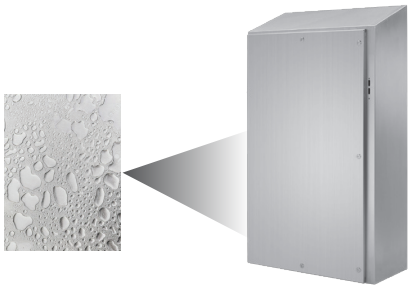

Figure 1. Although the exterior of your enclosure can appear dry, the inside of your enclosure can tell a different story.

HISTORY

The amount of moisture that air can hold increases as the temperature rises. Condensation results when moist air is cooled or comes in contact with a cool surface that is at or below its dew point, which inhibits the air's ability to hold moisture and causes water vapor to condense on available surfaces.

Corrosion, an inherent effect of moisture that results when condensation forms on sensitive electrical and electronic devices inside an enclosure, can lead to the following problems:

- Increased electrical resistance
- Additional generation of heat
- Decreased and inconsistent component performance
- Rusting of critical electrical components
- Increased risk of circuits shorting out
- Dangerous occurrences of arcing and sparking.

In order to ensure optimal life expectancy of components, precautions must be taken to prevent moisture from being allowed to form causing condensation (Figures 2-4).

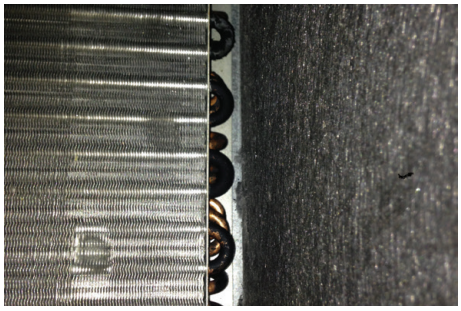

Figure 2. Coil failure inside of an enclosure through the effects of moisture and corrosion.

Figure 3. Corroded wires inside of an enclosure from condensation and corrosion problems.

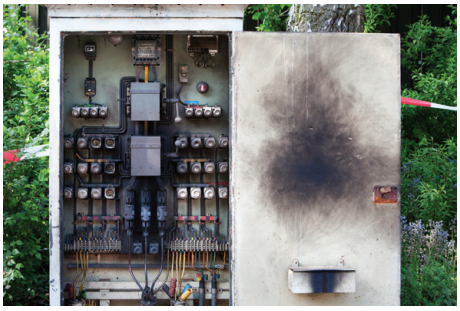

Figure 4. Fried panelboard from moisture built up on sensitive electrical devices.

MITIGATING CONDENSATION WITHIN ENCLOSURES

There are a number of thermal and mechanical forces in food and beverage processing environments that make condensation difficult to avoid.

THERMAL FORCES

- Temperature differentials between the enclosure and the surrounding processing environment can create condensation. When processing ends for the day, equipment is shut down and warm equipment inside an enclosure begins to cool and condense available moisture in the air. Once the washdown process begins, additional moisture is introduced and warms the enclosure back up which then cools and condenses again.
- Conduit pipes from a warm area penetrate the wall or ceiling of a cold processing area and allow the moisture in the air to condense on the inside of the conduit pipe. If the enclosure is the lowest point in the processing area and it is not properly sealed, then the moisture can affect it..

MECHANICAL FORCES

- High pressure washdown forces water into the enclosure through improperly sealed penetrations.
- Temperature variations between the inside and outside of an enclosure can create pressure differentials within an enclosure. This force will allow water to be pulled into the enclosure until either the water source is exhausted or the pressure inside the enclosure equalizes with the outside air.

In wet or humid F&B processing environments, moisture enters an enclosure when the door is opened. Since internal components generate heat within the enclosure, the warmer air inside will pull in moisture from the cooler outside air. Condensation forms when the enclosure surfaces cool to the dew point after processing lines shut down. The best way to combat these harmful occurrences is by using a device to rid both the enclosure and the housed components of condensation. However, finding an effective yet affordable solution, proved problematic.

PREVIOUS SOLUTIONS - AND SHORTCOMINGS

Several methods have been employed to prevent harmful corrosion on enclosure walls and equipment. Food and beverage processors may attempt to rid enclosures of moisture by simply wiping them down with towels. However, this method is only partially effective. Operators often wipe standing water from the bottom of an enclosure but not from the sensitive components themselves.

When water pools in the enclosure, some users drill a small hole in the bottom while mounting the enclosure at a slant to both drain and direct water towards the opening. While this method can be effective, it does not address the issue of moisture on the components themselves. It allows the moisture to re-enter through the very holes that were created to rid the enclosure of water-creating a continuous cycle of condensation. More importantly, any holes in an enclosure not filled with a UL or CSA approved device negate the enclosure's IP or NEMA Type ratings.

Other lower cost methods work on the principle of maintaining the internal temperature to stay above the dew point. An example of this is the use of light bulbs as a heat source, which can minimize condensation. This method poses the following risks:

- Component failure due to non-thermostatically controlled heat
- Possible breaking of the light bulb, which can enter the food supply undetected

MITIGATING CONDENSATION WITHIN ENCLOSURES

COMPLETE MOISTURE MANAGEMENT

Having a better understanding of why moisture problems occur gives us a better picture of how to best solve these challenges. The following chart provides a wide variety of recommendations and solutions to resolve moisture problems within enclosures. If you have additional questions about these recommendations or want to know which solution is best for your application, please reach out to a nVent HOFFMAN Sales Rep!

ENCLOSURE DESIGN		In selecting an enclosure, it is important to examine the application it will be placed in. Then select an enclosure while taking into consideration the certifications, shape, material, hinge type and latching mechanism to decide whether it matches your specific needs.
GASKET MATERIAL		A more robust solution is the use of a solid membrane gasket material such as food grade silicone rubber. It includes a more durable seal and cannot retain moisture within the gasket material which can harbor bacteria.
COOLING SOLUTIONS		Air conditioners resolve heat related component failure and are an effective method to reduce humidity levels within an enclosure. An additional benefit is that the air inside of the enclosure is sealed from the outside, which eliminates contaminants from entering the enclosure.
HEATERS		Heaters provide a sufficient ambient temperature to hold the relative humidity from condensing in the enclosure while processing lines are not in operation. It can also prevent hot washdown water from creating a vacuum inside the enclosure that will draw in liquids.
VENT DRAINS		Vent drains are a simple way to allow liquid accumulated in the bottom of an enclosure to drain out. A rated one-way Type 4/4X Vent Drain will prevent washdown from entering through the drain. It will also provide the benefit of equalizing the pressure within the enclosure, further preventing water ingress.
DEHUMIDIFIERS		Thermoelectric dehumidifiers remove moisture from the air within an enclosure, providing an inexpensive yet highly effective way to protect electrical components from condensation.
THERMOSTATS		Thermostats can be used to control heating or cooling equipment, or both. This may be useful when enclosed components are producing excessive amounts of heat during production and then need to be heated to prevent condensation when equipment is idle.
HYGROTHERMS		Electronic hygro-therms sense ambient temperature and relative air humidity, then adjusts a connected device to maintain temperature and humidity set points.
HYGROSTATS		Mechanical hygrostats control relative air humidity inside enclosures to prevent condensation and corrosion that can damage components. It can also be connected to an enclosure heater, cooling fans, warning lights or other devices. The critical relative humidity level for most components is 65 percent. Above that level, condensation can form and cause electronic equipment to malfunction.
CORROSION INHIBITORS		Although corrosion is impossible to completely eliminate, corrosion inhibitors provide an advantage when battling residual traces of moisture inside of an enclosure. Inhibitors contain a special chemical combination that vaporizes and condenses on all surfaces in an enclosed area. Vapors will redeposit as needed in the event that condensation reoccurs. These vapors reach every part of an enclosure, protecting all interior components. Spraying, wiping or greasing are not required.

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