HVAC Design Consideration for Corrosive Environments

An Online Continuing Education Course for Engineers

Course Number: HV-3002

Credit: 3 Hours / 3 PDH / 3 CPD

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HVAC DESIGN CONSIDERATIONS FOR CORROSIVE ENVIRONMENTS

Corrosion alone accounts for approximately 40% of all equipment failures in industrial facilities. Facilities located in potentially corrosive outdoor environments such as seacoast, industrial sites, heavily populated urban areas, some rural locations, or combinations are exposed to various threats of salt laden corrosive elements, various air borne molecular contaminants (AMC) and water vapor (as a result of high relative humidity). In addition, some other micro environments laundry facilities, diesel-burning devices/exhaust piping, sewer vents, traffic, pool areas, water treatment facilities and , household cleaning agents etc. can also produce corrosive atmospheres.

Contaminants in an environment typically result in the creation of electrolytes that facilitate the corrosion process. Electrolytes are substances that are electrically conductive when dissolved in water. These pollutants, in combination with other factors such as wind direction, humidity, water, fog, temperature, proximity to pollutant source, and dust or particle contamination, may result in the premature failure of equipment. Premature corrosion of air conditioning heat exchangers, specifically condenser coils can be a serious problem in harsh seaside or industrial environments; coils installed in these environments have been known to fail in less than a year. The result is the costly replacement of the coil and/or the entire unit. If these units are improperly applied or left unprotected, they can experience rapid corrosion from exposure to aggressive elements. However, measures can be taken to identify potentially corrosive environments prior to equipment selection.

This course discusses the HVAC design considerations for corrosive environments. This course is split into 4 sections:

PART I	Overview of Corrosion Basics
PART II	Identification of Potential Corrosive Environments
PART III	Design Standards (ISA)
PART IV	HVAC Design Considerations

PART I- OVERVIEW OF CORROSION

Expressed simply, corrosion is the deterioration of metal by reaction with its environment. More specifically in context with air borne contamination, the corrosion is defined as the deterioration of metal due to the presence of acid gases in tandem with elevated humidity and temperatures. Corrosion can proceed in a general manner (general corrosion) or in a more localized manner (galvanic corrosion, pitting corrosion, formicary corrosion), depending on conditions and the material systems used.

Galvanic Corrosion: The necessary conditions for galvanic corrosion occur when dissimilar metals, in contact, are exposed to an electrolyte. Electrolytes are substances that are electrically conductive when in solution. Common electrolytes may include chloride contaminants from sources such as seawater, road salts, pool cleaners, laundry facilities and household cleaning agents. These electrolytes are typically sodium or calcium chloride-based compounds. An understanding of the environment in which HVAC/R equipment is being applied is essential to the proper selection of materials and protection means.

General Corrosion: General corrosion is the degradation of metal caused by a reaction with the surrounding environment. Since general corrosion consumes metal and typically forms metal oxides, unsightly surface conditions usually result. As an example, copper is susceptible to attack from sulfur-containing gases. Unprotected metal will continue to react with the contaminant resulting in corrosion. Under severe, prolonged conditions, the metal continues to corrode until the integrity of the material and equipment is jeopardized. Unprotected copper tubes in polluted industrial environments can lead to tube leaks and failure of the refrigeration system. Sulfur and nitrogen based electrolytes in combination with chloride environments are often the cause of accelerated corrosion of these metals.

Understanding Problem

In process sensitive areas like server rooms, control rooms, and data centers, large quantity of microprocessor-based equipment is present. Given the harsh climates and diverse industrial environments, these sensitive areas are exposed to multiple threats, such as fire, dust particles, gaseous contamination, temperature and humidity.

To an extent, the HVAC design is meeting the challenge posed by fire, humidity, temperature and dust particulate contamination. Unfortunately, the potential damage to electronic equipment caused by the corrosive effects of gaseous contaminants has been largely ignored. Since the problem of corrosion is primarily due to air borne molecular contaminants (AMC), proper design guidelines mandate the removal of all such contaminants from the air stream. Not all the locations are same; the ambient conditions need to be carefully assessed before deciding on the HVAC design.

In today's business environment, a company's dependence on its information & data processing systems is un- debatable. Corrosive gasses can damage these systems that can have crippling effects both on cost and productivity. The common fault occurrences could be:

- Erroneous information;
- Interrupted operations;
- Sporadic electrical hiccups ;
- Ghost signals;
- Lost data;
- Loss of ferromagnetism (stored information) on disc drives;
- Mechanical failure (head crashes, wear) can occur on data tracks;
- Damage to pin connectors on circuit boards, IC plug-in sockets and wire wrap connections;
- Disruption of electric current & circuit failure.

In extreme cases, corrosion may lead to prolonged disruption or even complete shutdown of an entire process operation. Replacing damaged electronic components can substantially increase the operational costs.

To preclude any potential damage to electronic equipment and to avoid any acrimonious debates over warranty coverage, and, more importantly, to ensure there is no loss of system's integrity in the first place, the sensitive areas should be protected by effective air filtration systems.

The severity of the environment (i.e., humidity, temperature, types and levels of gases) will determine the speed of failure. The importance of knowing and preventing corrosion is thus very important.

HOW CORROSION OCCURS

All the metals have specific relative electrical potential. When metals of different electrical potential are in contact in the presence of moisture, a low-energy electric current flow from the metal having high (least noble) position in the galvanic series to the one having the lower (most noble) position. This phenomenon, called galvanic action, is a direct contributor to the material degradation, or corrosion, of metals. Moisture in air or humidity is conduit to corrosion.

Root Causes

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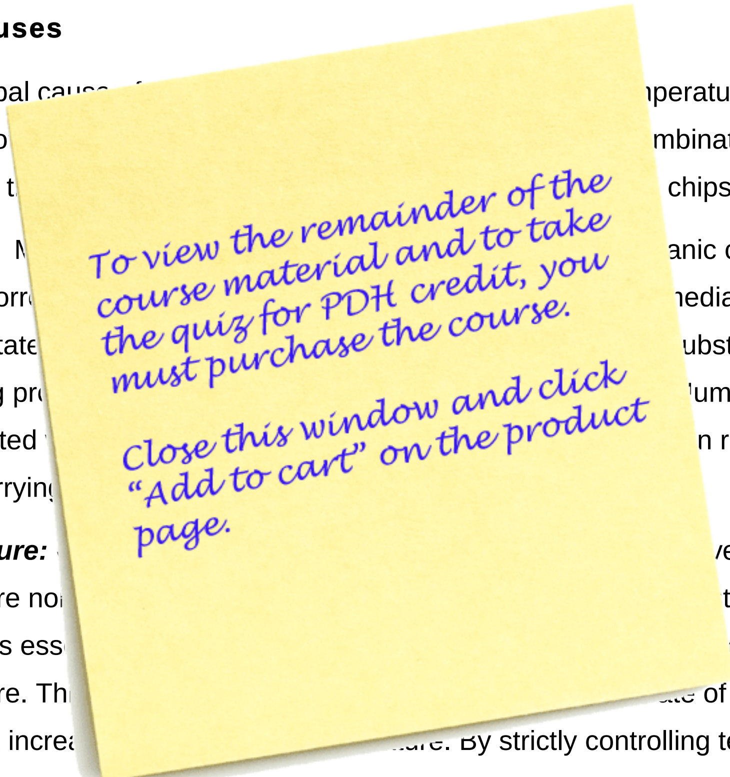

Humidity: … …anic corrosion. A galvanic corr… …nedia, to reach a dynamic state… …ubstance with good conducting pr… …umid air contaminated … …n rate as the air's current carryin…

Temperature: … …e, with increased temperature no… …tablished that corrosion is ess… …enced by temperature. Th… …of control equipment increa… …re. By strictly controlling temperature and humidity, the cond… favorable to corrosion can be diminished. This represents one essential component of corrosion control.

Corrosive Gases: Not all gases cause corrosion. Specifically, we are concerned with three types of gases:

1. Acidic gases, such as hydrogen sulfide, sulfur oxides, chlorine, hydrogen fluoride (HF) and nitrogen oxides;
2. Caustic gases, such as ammonia;
3. Oxidizing gases, such as ozone

Of the gases that can cause corrosion, the acidic gases are typically the most harmful. For instance, it takes only 10 parts per billion (ppb) of chlorine to inflict the same amount of damage as 25,000 ppb of ammonia.