EMERGING NEEDS FOR CORROSION CONTROL AND PREVENTION THROUGH DESICCANT DEHUMIDIFICATION

Rajnish Joshi-Executive, Vice President, Bry-Air (Asia) Pvt. Ltd.

Bry-Air (Asia) Pvt. Ltd., 20, Rajpur Road, Delhi-110054 (India)

ABSTRACT

It is estimated that hundreds of thousands crores is lost every year due to corrosion!

Most materials, particularly ferrous metals, are subject to corrosion (inorganic). Traditionally, corrosion prevention has been seen as a need for industrial equipment and components, but as the world, today is beginning to depend more and more on light and sophisticated equipment such as computers, high energy batteries and telecommunication equipment, which are subject to comparatively less gross rusting, but are sensitive to microscopic corrosion, another 'front' for corrosion prevention has been 'opened'.

Also, organic corrosion of hygroscopic material is another major area of production losses.

Over the years the most commonly adopted practice for corrosion prevention on metals has been use of anti-corrosion coatings; but anti-corrosive coating is not feasible for preventing microscopic and organic corrosion.

Thus, new methods for corrosion prevention need to adopted for corrosion prevention.

Also, are must remember that corrosion does not occur in dry air and the rate of corrosion is dormant between 30-35% relative humidity. The critical level is 45% above which the rate of corrosion accelerates, thus, it is important control humidity levels between 35-40% relative humidity to control.

This paper will focus on the economic aspects of corrosion, emerging areas/applications where corrosion prevention is becoming a "must" as well as the corrosion phenomenon and it's prevention though humidity control.

EMERGING NEEDS FOR CORROSION CONTROL AND PREVENTION THROUGH DESICCANT DEHUMIDIFICATION

Rajnish Joshi-Executive, Vice President, Bry-Air (Asia) Pvt. Ltd.

Bry-Air (Asia) Pvt. Ltd., 20, Rajpur Road, Delhi-110054 (India)

CORROSION AND IT'S ECONOMIC ASPECTS

It is estimated that hundreds of thousands of crores else lost every year due corrosion.

Being wide in its range of effect and almost inseparable from the technological activity, corrosion has a wide impact on the economics of technology.

Corrosion is one of the main causes of breakdowns in machinery and material leading to loss of man-power, material and money. This has been a matter of great concern both to the industrials and the state.

Also, as the world is beginning to depend more and more on light equipment such as computers, high energy batteries and sophisticated telecommunication equipment, another aspect of loss due to corrosion has been identified; while these are less subject to gross rusting, they are very sensitive to microscopic level corrosion. The fact that these circuits consists of very little material to begin with, means that small amounts of corrosion create disproportionately larger problems.

Another major area of concern is product or spoilage due to organic corrosion.

CORROSION PHENOMENON & TYPES OF CORROSION

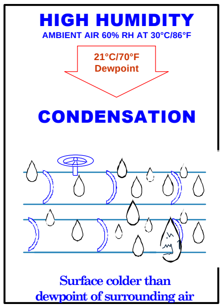
In general, it is safe to assume that most materials, particularly ferrous metals, are subject to corrosion. By this we mean that every substance eventually changes from one form to another as a result of chemical reactions. Many of these reactions, particularly those which depend upon oxygen, are catalyzed and accelerated by moisture.

Corrosion does not occur in dry air. It is the invisible water vapour in the air which is the cause of rusty bolts and industrial foe of product quality and storage.

A certain amount of water vapour is always present in the air. This water vapour or moisture in the air is measured in terms of relative humidity.

The basic problem arises from the fact that water vapour will condense, on any surface, colder than the dew point temperature of the surrounding air mass.

Thus, the common factor between unlike group of products as corroded machine parts, erratic computer data and bad quality leather items is surprisingly- the root cause of all defects in these products- Moisture. And that creates havoc in apparently dry airconditioned areas.



Also, sudden changes in temperature, within the room affect the internal humidity environment and lead to condensation on any surface. This subsequently leads to corrosion.

Condensation Causes Corrosion and Corrosion Causes Waste.

TYPES OF CORROSION

Inorganic Corrosion, commonly identified as "rust", is defined as destruction of metal or alloy by chemical or electro chemical reaction with its environment.

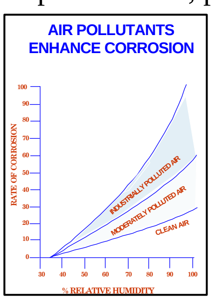
Though corrosion is a complex function of many factors, the three most important are –

- a voltage differential between pure and impure areas.
- physical conditions of temperature and humidity
- oxygen in the air.

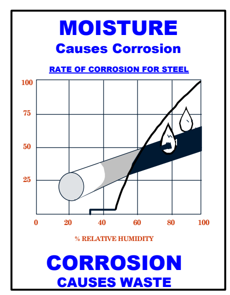
With iron or steel, the ferrous ion may react with hydroxyl ion in water to form ferrous hydroxide and with oxygen to produce ferric hydroxide (rust).

Accelerating and Intensifying Factors

In pure air almost no iron corrosion occurs, at relative humidities even upto 99%. However, pure air is seldom encountered in practice. Contaminants present in the air like sulpher dioxide, particles of charcoal etc. enhance the corrosion rate.



The comparative rates of corrosion in relatively clean and polluted air in shown in the figure. The critical humidity level which is at 45% is approximately same for clear and polluted air, however the rate of corrosion is faster where surfaces are exposed to polluted air in combination with high relative humidity.



ORGANIC CORROSION

Organic Corrosion is most familiar as …. Mould…. Mildew… Fungi

Mould, Mildew and Fungi are all different types of bacteria. Outdoor air is well endowed with this bacteria, which lie dormant until suitable conditions of temperature humidity are achieved. In general the bacteria spores will not germinate below 60% RH. The actual temperature conditions for germination may vary widely between different types of moulds, but high temperatures along with high moisture level speed up the growth of spores.

Thus, micro-organism growth is injurious to material: as it not only results in decomposition but also mechanical weakening of the products like leather and other organic material. **In most cases bacterial growth can be arrested if RH is maintained below 35%.**

PREVENTION OF CORROSION

(a) Methods of preventing the atmospheric corrosion of metals fall into two broad categories:

(i) The choice of a suitably resistant metal or alloy or combination of materials, or the provision of a protective coating which supplements or enhances the protection given by the air-formed oxide film on the metal surface.

(ii) The control of the environment by the exclusion of water or aggressive contaminants, or by the introduction of a corrosion inhibitor.

(i) Method that belong to the first of these categories are appropriate in relation to the intended use of metals, since here there are few opportunities of controlling the environment, and the composition of the metal and its **protective coating** must be chosen accordingly.

Protective coatings have been traditionally used to provide corrosion protection. **The life of such coatings, however, critically depend on the surface preparation**. The surface on **which these coatings are applied have to be free from all impurities** including rust, mill scale, salts …. **and most critically moisture**. To produce such surface various techniques are employed including sand blasting, shot blasting, etc.. This activity not only clears the impurities but also creates an anchor profile, which improves the adhesion between the coating and the substrate. It is imperative, however that from preparation of the surface to the application of the first coat, the surface should be subject to certain environmental factors. The term, '**hold the blast**' is commonly used and refers to the prevention of rust bloom from forming between the blasting and coating cycles.

When we blast the surface i.e. the metal surface, then the naked pure metal is exposed to the atmosphere. And if surface temperature of the metal is lower than the dew point of the air surrounding it. Immediately condensation and subsequently flashing of the metal occurs and the metal surface is covered with rust bloom. If coating is carried over such a surface then the entire exercise if surface preparation goes to a waste. Coating life is reduced to less than one – third of the normal life and the quality produced is very poor.

Corrosion prevention organizations have formulated certain basics to be adhered to while carrying out surface preparation and coating. It has defined that **a differential of at least 5°F be maintained between the surface temperature and the air dew point while carrying out such operations** (with the metal temperature being higher). The specifications of all major organizations like NACE, SSPC, EIL, BS, SS etc. call for the same.

Dehumidification comes to the rescue here and all structures (with existing vapor barriers and where they can be created with ease) must be dehumidified while being blasted or coated so as to prevent all the problems mentioned above.

Dehumidification helps in maintaining a differential of at least 5°F even during night (while surface temperature drops) and during high humidity periods like Monsoons etc.

The coating life is increased dramatically and quality achieved excellent.

Dehumidification
"Hold the Blast"

- Oil and Petroleum Tanks
- Offshore Drilling
- Large Production Structures
- Fertilizer Storage Tanks
- Chemical Plants
- Nuclear Plants
- Chemical Transport Equipment *Ships, Barges, Tanks, Cars etc.*

(ii) The second method, to prevent is to control relative humidity to a level where it not only prevents condensation but is reduced to a critical level below which corrosion does not occur corrosion. The controlled space is to maintained at a specific relative humidity and temperature so that the products or material in the controlled space cannot absorb moisture from the surrounding atmosphere. Thus the products are also protected from corrosion. As a general rule, rust and other oxidizing type corrosion reactions will not occur if the relative humidity in the area is maintained at or below 40% RH. Materials or product residing in this atmosphere need not be coated with oil or other surface protecting materials, and can thus be kept in ready-to-use condition.

INORGANIC CORROSION
RUST

GROSS	MICRO
Marine	Computers Storage
Defence	Telecom Equipment
Water Works	High energy Batteries
Precision Parts	Light Weight Component Material
Sand-blasting	Electronics
Power Plants	
Nuclear Waste Storage	
Oil Tanker & Ship Layup	
Ball Bearing Storage	
Ammunition Storage	
Tire Creel Rooms	
Turbine Layup	
Galvanized Steel Storage	
Protecting Box Beams in Bridges	
SCR Motor Control Centers	

Some of the corrosion prevention applications do not have coincidental temperature control. Humidity control is maintained to achieve protection of the area or products in the area, as this constitutes a much more economical method than air conditioning. An example of this is a waste pumping station or sewage plant, where the primary humidity control problem is the maintenance of a dewpoint within the space which is lower than the temperature of the liquid which is being circulated or stored there. In this way, condensation of moisture on the outside of pumps and piping is eliminated, thus significantly reducing the cost of painting and other maintenance normally required to control corrosion.

ORGANIC CORROSION

- Mold
- Mildew
- Fungus

- Seeds
- Archives
- Museums
- Libraries
- Cheese
- Leather
- Chemicals
- Pharmaceuticals
- Breweries
- Distilleries

(b) Method of preventing organic corrosion. The ideal method to retard bacteria growth thereby limit organic corrosion is again to maintain relative humidity levels below 35-40% RH as well as keep temperature low.

METHODS FOR CONTROL OF RELATIVE HUMIDITY

In order to maintain a controlled environment in an enclosure at the desired RH level, supply air to the enclosure has to be dry enough to offset the moisture ingress into the enclosure. The process of physically removing moisture from the air is called dehumidification.

Lowering of RH can be accomplished in several ways, viz.:

a) Heating of air;
b) Application of vacuum
c) Refrigeration;
d) Chemical/Desiccant Dehumidification

Heating the air increases the temperature, and since RH is a function of temperature, apparently lowers the RH without actually removing the moisture from the air. It is impractical to maintain such conditions, hence this approach is not desirable and not followed. Futile attempts have been made to supplement such efforts by placing bags of desiccant in the enclosure for static adsorption, but these are not effective without provision for reactivation.

Vacuum systems essentially work on the principle of humidity denial rather than humidity control. The environmental barrier and its very complex sealing, by virtue of its design, dictate a very heavy (a few tons) approach, which makes site handling almost impracticable. The energy consumption for creating and maintaining the vacuum is also very high. This approach, therefore, has been more or less abandoned the world over.

Refrigeration system of dehumidification does actually remove moisture, by condensing it, but has some inherent limitations unless one makes major compromises in application needs.

The limitation are:

a) It is suitable for maintaining RH upto 45% or above;
b) It continues to pump heat into the enclosure, since the heat of compression is rejected continuously within
c) High ambient temperature reduces the efficiency of the condensing system and requires high energy consumption for RH control.

Chemical dehumidification emerges as the best choice for RH control. Chemical/ Desiccant Dehumidification based on the principle of physical adsorption reduces the moisture content and dewpoint of the air.

The principle behind chemical/desiccant dehumidification is that the desiccant is exposed to the moisture laden air, from where it is extracted by the desiccant and held.

EQUIPMENT OPTIONS FOR ADSORPTION-BASED DEHUMIDIFICATION

The size of the enclosure in which the RH is to be controlled, the supply air quantity and the degree of dehumidification required vary from situation to situation. Therefore, it is necessary that a wide range of equipment be available to meet the specific requirements of a given situation.

Adsorption-based dehumidification systems operate on the principle of an adsorbent bed rotating between two sections, a ‘process’ section in which the supply air is dehumidified, and a ‘reactivation’ section in which the adsorbed moisture is removed and the bed is regenerated for a fresh process cycle. The operating principle of an adsorption based dehumidification system is schematically shown in Figure.