***Hold the Blast, Control the Dew Point***

a technical presentation for
Technical Drying Services

**Abstract:** Controlling the dew point at 5 degrees F below the surface temperature of the steel surface during the blasting, cleaning and coating process is required to meet many paint manufacturer's specifications. Overhead transparencies will detail the psychrometric conditions and required airflow of meeting dew point requirements through the use of dehumidifiers during the blast, clean and coating cycles. Slides of actual jobs will show how to effectively use portable industrial desiccant based dehumidifiers to meet dew point specifications and hold the white metal blast in all weather conditions. Crews can then complete the entire blast in one cycle, before moving on to the cleaning and coating operations without the four-hour requirement to complete the entire process.

**Presentation**: The role of dehumidification in improving coating performances.

**Introduction:** Ensuring maximum performance of today's coatings requires proper surface preparation. Part of the preparation process requires the precise control of humidity conditions during the blasting, cleaning and coating cycles. A recent NACE (National Association of Corrosion Engineers) / SSPC (Steel Structure Painting Council) joint technical committee has sent to the NACE Unit Committee T-6A, and SSPC Group Committee C.2 a report on the current information in the field about why and how humidity and temperature control are being used to achieve higher quality coating / lining projects.

This paper will address the use of desiccant dehumidification to assure good quality coatings by meeting paint manufacturer specifications; to enable the blast, clean, and coat cycle to be done at any time of the year regardless of ambient conditions; to enable the contractor to reduce the project time by up to thirty-five percent; to enable the owner to reliably predict the downtime of tank; and expand the useful life of the coating.

**Specifications:** From the preparation of the surface to the complete application of the first coat of the coating, the "white metal" steel is exposed to the internal environment of the tank. Past practices involved the requirement to blast, clean and coat in one shift, or four hour period in order to avoid the deleterious affects of rust bloom. Now, with the availability of desiccant based dehumidifiers, the coating manufacturers specification of maintaining the dew point at the surface of the steel to be coated, 5 degrees F below the temperature of the steel, can be achieved and maintained constantly.

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This specification is already stated under NACE 6A192. However, the NACE technical committee report mentioned above summarizes that quality, productivity rates and scheduling can be improved with the use of dehumidification and temperature control equipment. The precise control of the humidity prevents rust bloom during periods when the white metal blast is exposed to the environment for even short periods.

The Systems and Specifications Steel Structures Painting Manual, Volume 2 chapter on surface preparation specification NO. 10, "Near White Blast Cleaning", also clearly recognizes the value of humidity control as follows:

"A.7 Rust-Back - Rust-back (rerusting) occurs when freshly cleaned steel is exposed to conditions of high humidity, moisture, contamination, or a corrosive atmosphere."

"A.9 Dew Point - Moisture condenses on any surface that is colder than the dew point of the surrounding air. It is, therefore, recommended that the temperature of the steel surface be at least 5 degrees F (3 degrees C) above the dew point during dry blast cleaning operations."

Additionally, there are other currently used specifications which call for controlling conditions in order to extend the life of the coating system: EIL, Standard specification for shop & field painting; British Standard, BS-4232; and Swedish Standard, SIS-05 5900-1967 / ISO-8591-1-1988.

**Humidity Control:** The primary purpose of controlling the humidity during the blasting, cleaning and coating process is to prevent rust bloom which results from condensation on the steel surface that is being coated. Additionally, with a precise control of relative humidity the electrolytic cycle can be broken, and rates of corrosion are significantly reduced even in industrial areas where high levels of contamination accelerate corrosion.

The term "hold the blast" is commonly used in the field to refer to the prevention of rust bloom from forming between the blasting and coating cycles. As a result, general "rules" have been established that have attempted to meet the paint manufacturers specification to maintain a 5 degree F differential between the air dew point and the surface temperature of the steel to be coated. Other "rules" have been used such as maintaining 40 percent relative humidity (RH); maintaining a 10 degree F dew point differential between the air inside and the air outside of the tank being coated; or, the entire blasting, cleaning and coating process should be done within a four hour period. It should be realized, that these rules are the means to meeting the specifications, but may not generate the end result which is to prevent the formation of rust bloom .

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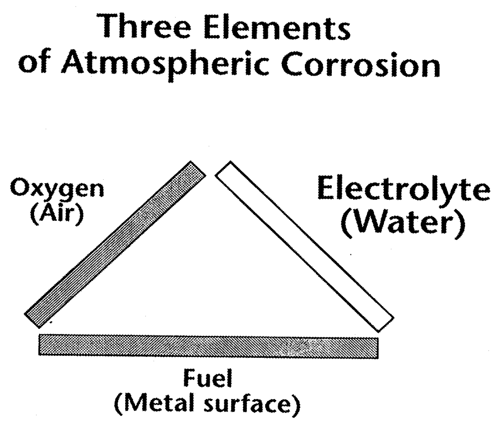
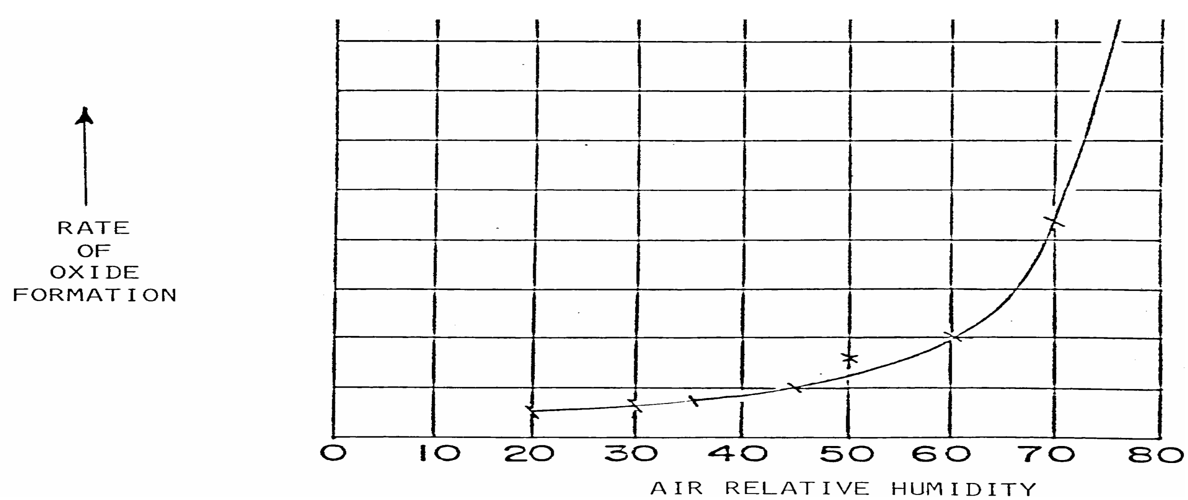
In addition to corrosion from condensation, rust bloom is also caused when there is an electrolytic cell consisting of an anode, cathode, and an electrolyte. When this cycle is broken by the removal of any one of these three items, corrosion can be reduced significantly. In this case, the electrolyte which completes this corrosion circuit is moisture.




The following chart provides a simple description of the rate of corrosion as a function of relative humidity:



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**Psychrometric Variables:** To understand what these “rules” potentially accomplish, the psychrometric variables of the blasting and coating environment should be examined. These include the surface temperature of the steel, air dew point, and air temperature inside the tank; and, air temperature, air dew point and projected rate of change in ambient conditions outside of the tank. The primary purpose of understanding the effect of these variables, is to determine the proper level of relative humidity that must be achieved and maintained inside of the tank to prevent rust bloom from condensation.

-Inside surface temperature of the steel. The temperature of the steel itself is affected by the inside temperature of the air during working conditions, outside air temperature, evaporative cooling that may take place during rain, and the radiational heating and cooling created by the day / night cycle.

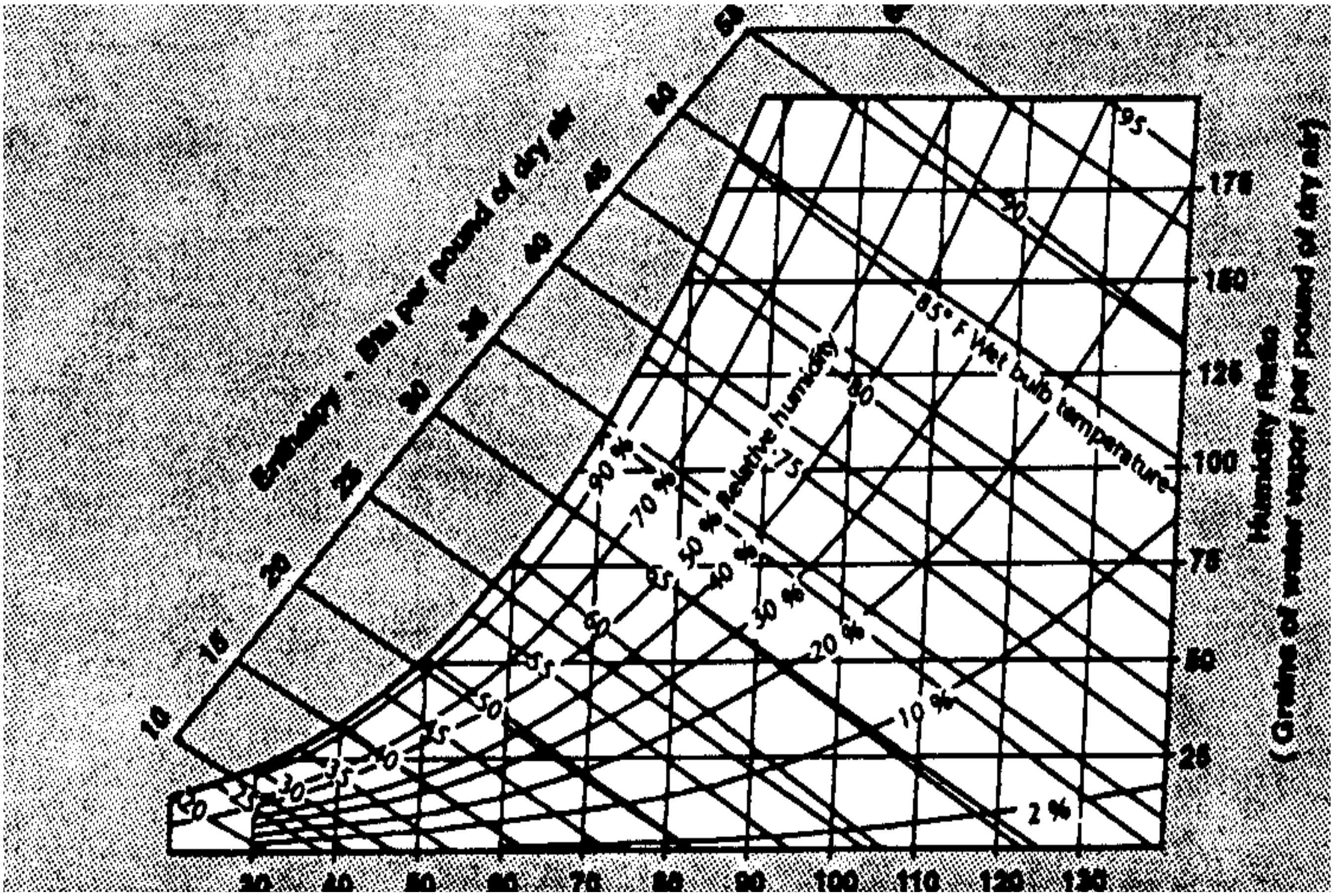
-Inside air dew point. The dew point is the temperature at which the air achieves 100 percent humidity. Additional cooling below the dew point will create condensation. The inside air dew point is likely to be uniform throughout an enclosed tank but variations can occur in areas where air infiltrates in from the outside, standing water evaporates and in tall tanks where moisture has the tendency to rise .

-Inside air relative humidity. The inside relative humidity is only useful to know at the surface of the material to be coated. At a constant moisture level in the air ( or humidity ratio which is expressed in grains of water vapor per pound of air) , the relative humidity varies widely with the temperature of the air.

-Outside air temperature. The outside air temperature will change with the day - night transition. Additional changes can be caused by the evaporative cooling effect of rainstorms. Various geographic areas may have wider swings in temperature depending on the time of year.

-Outside air dew point. The outside air dew point will change if temperatures fall and moisture has been condensed. It potentially increases during the day as rising temperatures create a re-evaporation.

-Outside air relative humidity. The relative humidity is a function of the amount of moisture and temperature. As a given volume of air increases in temperature, that volume has a greater potential for holding more moisture…thus, a lower relative humidity. As the temperature decreases, the relative humidity increases to a point (100%) where the moisture will condense out of the air as the temperature continues to fall. The below noted chart was invented by Richard Mollier and displays the properties of an air-water mixture:




The Psychrometric Chart, also referred to as the IX Diagram, invented by Richard Mollier

**Dehumidification:** Dehumidification is the removal of moisture from air. There are basically two types of dehumidification units which can be applied to the blasting and coating environment: refrigeration and desiccant.

-Refrigeration dehumidifiers achieve their purpose by cooling an air stream below the dew point, thus removing moisture through condensation. This is achieved by the movement of air over a set of refrigeration coils which cool the air considerably below the dew point. Often, the cooler air is reheated which then provides a lower relative humidity.

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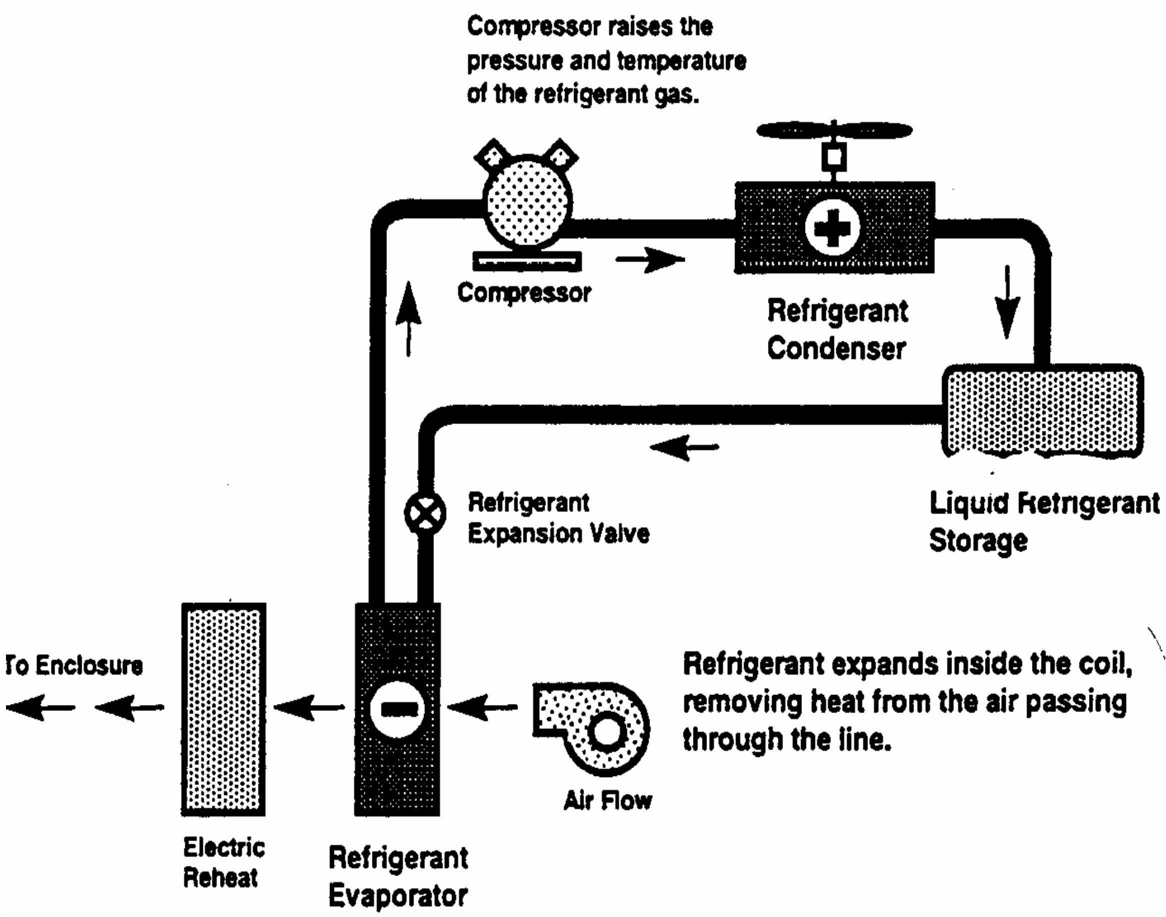
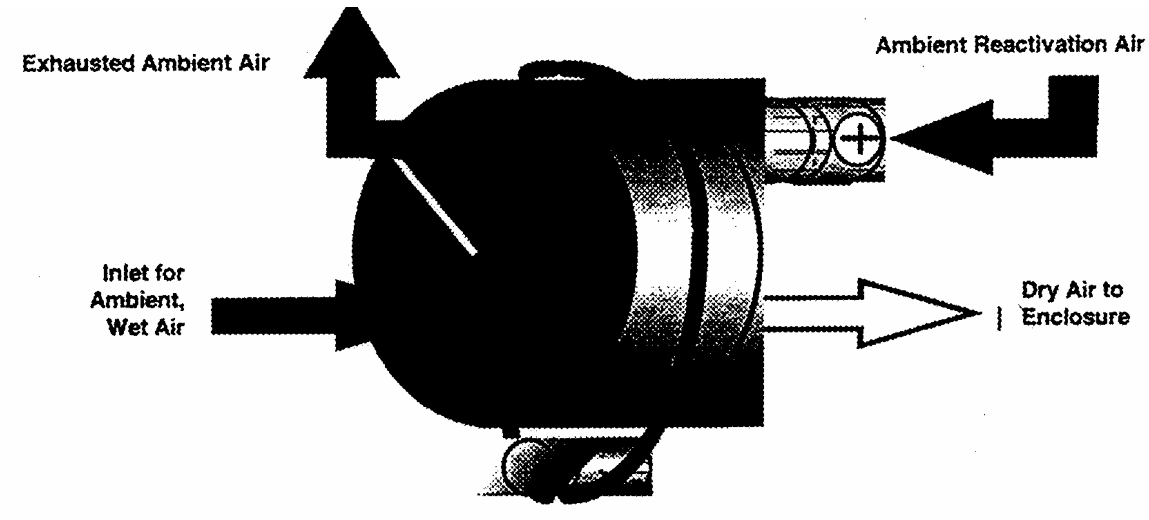
The advantage of a refrigeration dehumidifier is that it can be efficient at high temperatures and high relative humidity. However, the disadvantage is that it is limited to use in warm temperatures to prevent the freeze up of the coil which normally occurs when the ambient temperature is below 65 degrees F. They also have a very limited dew point depression during fast weather changes. Below is a typical drawing of refrigeration type dehumidifier:




-Desiccant dehumidifiers. A desiccant is a material with a high affinity for moisture. Solid-sorption dehumidifiers utilize either granular beds of desiccant, or a fixed honeycomb structures impregnated with desiccant. In either case, an air stream is passed over the desiccant in a dehydrated state. The desiccant absorbs the moisture from the air stream, leaving it in a relatively dry state. The desiccant is then regenerated with heated air which drives off the water returning the desiccant to its dehydrated stated. The moisture remains in a vapor phase.

The advantage of using a desiccant based dehumidifier is that it performs well regardless of weather conditions. Additionally, it has the capability of providing a deep dew point depression for fast response to changes in weather, and it is simple, reliable and effective.




**Sizing the dehumidifier:** In order to meet the requirements of most geographic areas, a simple sizing method has been developed to determine the cfm of air required from a desiccant dehumidifier. According, two air changes per hour is considered acceptable and can be determined as follows:

The flow capacity of a dehumidifier for a given number or air changes per hour is calculated using the formula shown in Equation 1.

$$\frac{(Vi)(RAC)}{60} = X \tag{1}$$

Where:

* Vi is the internal volume of the space minus the volume of any obstructions in $ft.^3$
* RAC is the required air changes per hour
* X is the air-flow capacity in $ft.^3$/min. (cfm) that corresponds with the specified air change rate

Or, for DH equipment with a capacity expressed in $m^3$Ihr, the flow capacity is calculated using the formula shown in Equation 2:

$$(Vi)(RAC) = X \tag{2}$$

Where:
* Vi is the internal volume of the space minus the volume of any obstructions in $m^3$
* RAC is the required air changes per hour
* X is the air-flow capacity in $m^3$/hr. that corresponds with the specified air change rate

Example:
Find the capacity of dehumidification equipment which can dehumidify a 110-ft.-diameter enclosed space with a 6.0-ft.-high floating roof.

1. Find the internal volume *(Vi):*

   $Vi = d^2\ /4\ l$

   *Vi* =(110 ft.)(110 ft.)(0.7854)(6.0 ft.)

   *Vi =57,000* ft,3

2. Set the required air changes (RAC) per hour: 2

3. Multiply the internal volume by the required air changes to determine the amount of air needed per hour:
   (*57,000* ft.$^3$)(2) = 114,000 ft.$^3$/hr.

4. Convert ft.$^3$/hour into ft.$^3$/min.:
   114,000 ft$^3$/hr. - 60 min./ hr. = 1,900 ft.$^3$/min.

**Measurement of Conditions:** The purpose of measurement of conditions in the field is to ensure that the dehumidification equipment is able to meet the specifications required to “hold the blast”. The coatings inspector will require periodic documented measurements which will become part of the job record.

There are several physical challenges to obtaining useful measurements when considering the possible broad range of conditions which require measurement. At the job site, such things as radiation, stratified conditions of the air, and close proximity to the steel wall must be considered when taking ambient conditions inside the tank.

Typically a sling psychrometer is used which provides a wet bulb and dry bulb reading. The difference is noted, and the relative humidity can then be determined from the psychrometric chart. However, there are limitations to using a sling in that the dew point must be above freezing, there must be plenty of space to swing the device fast, the wick must be completely clean, and totally wetted. Take several readings and note that the lowest wet bulb is the most accurate.

There are several electronic sensors on the market which provide a direct readout of both relative humidity and temperature. They are fast, relatively consistent, easy to use in ducts, are easy to read, and easily measure the key reading…the humidity conditions near the steel wall to be coated. They also have limitations in that they must be kept clean and calibrated periodically.

The typical error for a sling psychrometer is +5 to +7% rh, while an inexpensive electronic sensor is $\pm$ 3 to $\pm$ 5% rh.

**Conclusion:** The specifications requiring control of humidity are clearly recognized as a method of preventing rust bloom and corrosion during the blasting, cleaning and coating cycle. The maintenance of a white metal blast prior to coating also improves the performance of the coating, and can significantly increase its useful life.

In today's market, there is now rental dehumidification equipment and a technical support service available on a temporary basis to ensure that the coating contractor can hold the blast regardless of ambient conditions. Project time can be easily predicted, paint application specifications can be adhered to, the life and performance of modern coatings can be improved, and crews can more precisely schedule their work time.