JUNAIR
SPRAYBOOTHS

DRYING WATER BASED PAINTS IN HOT AND HUMID CONDITIONS

USING QADs

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A QADs™ auxiliary air movement system (AAM) will increase the production capacity of your spray booth while saving you money in energy costs. QADs™ is an advanced AAM system that supplies additional airflow from the corners of the spray booth cabin. This unique system has been designed for use with coatings that are compliant with new low VOC regulations. The clean, filtered and heated air provided by QADs™ creates the ideal environment for the fast, controlled flash-off of waterborne basecoats and the rapid through curing of high and ultra-high solids topcoats. With the paint drying and curing process being so much quicker and more efficient with QADs™ you can save tens of thousands of dollars on your energy costs through the life of your spray booth.

The following information explains how the curing process of paints can be affected during the summer months of the year. It will demonstrate how a QADs™ system can be an asset for businesses that are located in a hot and humid climate**.**

HOW DOES WATER EVAPORATE OUT OF A PAINT FILM?

The water in a water based paint film evaporates out of a paint film in roughly three stages.

a) an initial constant evaporation-rate stage during which the paint particles move freely. This initial evaporation is at close to the evaporation rate of water alone, and is controlled by temperature, humidity, evaporative cooling and surface air flow.

b) an intermediate stage when the paint particles come into contact with each other and the water evaporation rate drops rapidly to 5-10% of the initial rate. This stage is complete when virtually all the water has evaporated and a nascent resin film has formed.

c) a final stage when water escapes the film more slowly by diffusion. The rate of drying is controlled by internal diffusion resistance. The dry surface film undergoes gradual coalescence and becomes increasingly homogeneous by diffusion of polymer chain ends across inter-particle boundaries.

Owing to the fact that the film thicknesses of refinish waterborne basecoats are typically less than 25 microns, flash-off time is relatively short – it is measured in minutes rather than hours.

The evaporation rate of water is directly related to its vapour pressure and this is related to temperature.

SO WHAT IS REALLY HAPPENING TO CHANGE THE EVAPORATION RATE?

Evaporation is a process that can be described by standard equations of chemical kinetics. It is a dynamic competition between water molecules in the liquid (wet paint film) moving to the vapour phase (evaporation) and molecules of water vapour moving to the liquid phase (condensation).

At any given temperature, the rate of evaporation is directly proportional to the concentration of water in the liquid phase, which is constant as long as there is some liquid water present (and it is readily available at the surface of the paint film).

The rate of condensation at any given temperature is proportional to the concentration of water molecules in the vapour phase. 100% humidity is the concentration at which the condensation rate equals the evaporation rate. (The concentration of water vapour that makes 100% humidity depends on the temperature - because the evaporation and condensation rates depend on the temperature.)

So on days when the air being drawn into the spray booth is at a relatively high humidity (the water vapour pressure of the air is high), the condensation rate will be higher and will offset the evaporation rate of water from the paint film. This will reduce the net evaporation rate lengthening the flash-off time.

In this case, the vapour pressure in the air is relatively high; the vapour pressure of the air/wet paint film interface is slightly higher resulting in a low vapour pressure gradient and a low net evaporation rate resulting in slow drying times

When the air being drawn into the spray booth is quite dry (low relative humidity) with a low water vapour pressure, the vapour pressure at the wet paint film/air interface will be high and so the vapour pressure gradient will be relatively steep, resulting in high net evaporation rates and short flash-off times.

WHAT ARE THE MAIN FACTORS AFFECTING EVAPORATION RATE RELATED TO A WATER BORNE PAINT FILM?

These examples of factors influencing the evaporation rate of water in a wet paint film will all come into play during the drying/flashing-off of the waterborne basecoat (although the air pressure can be somewhat ignored)

a) The higher the temperature of the water in/at the surface of the paint film the greater the evaporation rate.
b) The higher the temperature of the air passing over the wet paint film the greater the evaporation rate.
c) The lower the partial pressure of water vapour in the air passing over the wet paint film will cause a higher evaporation rate.
d) The higher velocity of the air passing over the paint film the higher the evaporation rate.
e) The more turbulent is the air passing over the wet paint film the higher the evaporation rate.
f) The lower is the air pressure in contact with the wet paint film the higher the evaporation rate.

The evaporation rate of water from a wet paint film will be lowered if the above factors are reversed i.e. if the temperature of the water in/at the surface of the wet paint film is lowered then the evaporation rate will be lower (drying will take longer)

ARE THERE ANY PAINT APPLICATION ISSUES I NEED TO BE AWARE OF?

a) Certain colors do take longer to dry (regardless of the paint manufacturer) because of the higher pigment binder ratio. The high pigment binder ratio causes the water in the paint film to diffuse to the surface (from where it can evaporate) at a slower rate than other (lower pigment binder ratio) colors.
b) Some colors require higher film builds to achieve opacity and common sense would suggest it would take longer for the water to diffuse to the surface if the paint film were thicker compared to high opacity colors that would be applied at lower film builds.
c) Some paint companies use the "cascade" method to apply the waterborne basecoat. This is the double coat back-to-back method (usually followed by a light 'drop' coat). The issue here is that two coats of waterborne basecoat are more or less applied as one coat versus two coats applied with a flash off cycle between each coat. What is happening here is that some of the water has to diffuse or migrate through a thicker paint film to reach the surface to evaporate and thus dry the paint.
d) In high humid conditions in which the net evaporation rate is lower the three cases above will result in longer drying times.

HOW DOES ALL OF THIS HELP IN SOLVING SLOW DRYING PROBLEMS?

Obviously knowing and understanding what is happening with regard to air temperature, humidity, velocity and turbulence will help in discussing the issues related to the drying/flashing-off of waterborne basecoats.

To flash-off/dry waterborne basecoats it is important to know whether, at certain times of the year, the relative humidity of the air is high. If this is the case then the evaporation rate of water from the wet paint film will be lower and the flash-off time will be longer.

Some waterborne basecoats are applied using the cascade as two single coats with a flash-off between coats. Some waterborne basecoats use the cascade method in which two coats are applied 'back to back' after which a drop coat is applied.

Naturally the flash-off time for this cascade application method will be longer, especially in hot humid conditions, as the water will need to diffuse out of thick paint film before it can evaporate, versus two thinner coats with a flash-off between coats, which allows most of the water to evaporate out of the first coat before the second coat is applied. (With the cascade application method, one longer flash-off time requires shorter application times and the absence of a flash off cycle between the application of the second coat of base).

CAN ANYTHING BE DONE TO SPEED UP THE FLASH-OFF TIME?

QADs™ Automatic is a very sophisticated auxiliary air movement system and can be programmed to optimize waterborne flash-off times regardless of the ambient conditions.

The standard time-temperature settings of a QADs™ Automatic system in flash-off mode are as follows:

Time	5 minutes	2 Minutes
Temperature	36°C	Cool down to spray temp

As stated above, the higher flash-off temperature increases the evaporation rate.

For high ambient temperatures and relative high humidity the flash-off settings should be as follows:

Time	7-8 minutes	2-3 Minutes
Temperature	40-45°C	Cool down to spray temp

The higher flash-off temperature setting will increase the evaporation rate further and the higher air temperature will reduce the relative humidity of the air.

This higher temperature and longer time setting should also be used for waterborne basecoats where the cascade application method is used.

The easiest way to alter the smart relay in the QADs™ Automatic system is to purchase an e-prom chip from us with these new settings and use this chip to alter the flash-off settings on the QADs™ Automatic system. This e-prom chip can be re-used time and again.

In autumn, the original flash-off time temperature settings can be reprogrammed into your QADs™ Automatic systems to save time and energy consumption.

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