The Effect of Cold Temperature on Acrylic Stucco

Introduction

Ever since the advent of acrylic coatings, there has been great discussion about the consequences of applying paint or stucco in freezing or near-freezing environments. Most people experienced with coatings, either on the technical side as chemists or on the practical side as applicators, support the notion that applying an acrylic coating in cold weather has a negative impact on the integrity of the coating. This article will describe the process of acrylic film formation and explain the mechanics of what happens when an acrylic coating, particularly stucco, is applied in cold conditions.

The Mechanism of Coalescence

An integral part of acrylic stucco is the binder, sometimes called the resin or the polymer. It is all these binder, or polymer particles that "come together" or coalesce to form the final film that becomes the dried coating. All waterborne coatings, including stucco, rely on the process of coalescence to form this film. Coalescence occurs in several steps, all of which are important in achieving a physically durable coating that is water-repellent and colourfast.

When stucco is still in its liquid state, the particles of polymer are evenly distributed and spaced-out. After application, the water in the stucco will begin to evaporate. As this evaporation occurs, the polymer particles will begin to coalesce, coming closer together as the water between them leaves. This process continues, with the polymer particles becoming gradually more densely packed. When the particles achieve a network that is tight enough, they will deform to increase the contact area between them. Once this has occurred, the particles will begin to "fuse," or bond with each other to form longer polymer chains. The bonding will eventually result in a dry, solid and continuous film.

The Effect of Low Temperature on Coalescence

The main factor involved in the successful formation of the coating film is temperature. Temperature effects film formation in two main ways.

A polymeric material has a transition temperature (or glass-transition temperature, T_g), which is defined as the temperature at which a polymer changes from a soft, pliable substance to a hard, brittle one. This property is directly related to the minimum film-forming temperature (MFFT); generally, these two values are the same, but they can differ by a few degrees. The majority of the polymers used in stuccos have a MFFT that is around or above 4 °C (~ 40 °F), which is what most stucco manufacturers recommend as the lower temperature limit for application. Below a polymer's MFFT, good film formation will not occur, since the material is no longer soft and flexible; the particles cannot bond and may only stick mechanically to one another. This situation creates a crumbly, discontinuous film that is not very adhesive or durable.

Furthermore, these low temperatures retard the evaporation rate of the water in the stucco. Since the coalescence rate is dependent on the evaporation rate of the water, film formation is greatly hindered in low-temperature conditions. If the water in the stucco freezes, the coalescence process will come to a halt, thus preventing film formation by keeping the polymer particles apart. Prolonged freezing temperatures will render the polymer in the stucco ineffective as a binder; the polymer particles will prematurely "set-up" in small broken groups instead of

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gradually forming a continuous film structure. Tests in the Imasco laboratory indicate that most polymers in acrylic stucco permanently lose their ability to form a continuous coating after a freezing cycle of 8 – 12 hours.

If a cold weather situation is compounded with a high relative humidity, the result can be even more detrimental. A high humidity environment will negatively affect the coalescence rate by slowing the evaporation rate even more. The movement of water vapour from the coating to the atmosphere will be hampered due to the high concentration of water vapour already in the air. So, if a stucco is applied on a cold and humid day, the set time of the coating will be long, the adhesion to the substrate will be poor and the final film will be weak, crumbly and not water-repellent.

Conclusion

Although some polymers possess lower minimum film-forming temperatures, most do not, especially the ones commonly used in stuccos. It is not economically feasible for manufacturers to incorporate such polymers into acrylic stucco. Furthermore, a polymer with a lower T_g (and hence MFFT) may also decrease a coating's resistance to ultraviolet degradation).

Therefore, it is strongly advised that acrylic stucco not be applied in temperatures less than 4 °C (~ 40 °F), since most of the polymers in stuccos will not have a MFFT below this value. Generally, the higher above the MFFT the application temperature is, the better the film formation. It should be noted that, in the case of extremely high temperatures, application of acrylic stucco can present a problem due to a decreased "open time," since the coating will dry very quickly in this situation.

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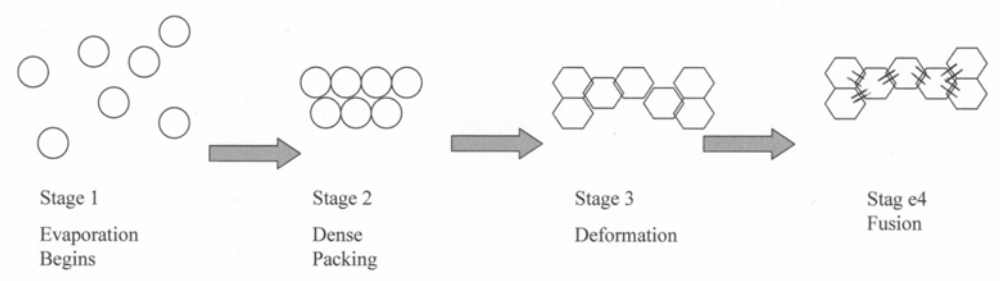

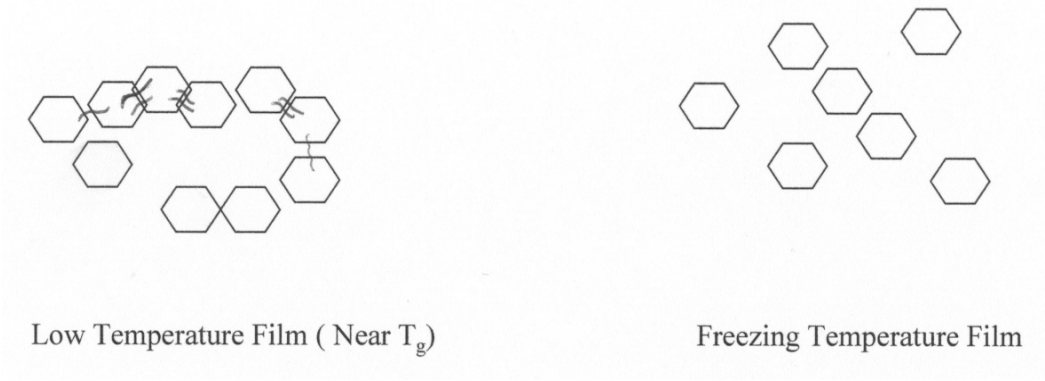

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