

SSPC: The Society for Protective Coatings

MONITORING AND CONTROLLING AMBIENT CONDITIONS DURING COATING OPERATIONS*

Introduction

The locally prevailing air temperature, the moisture content in the air (% relative humidity), and the temperature at which moisture will condense on surfaces (dew point) are commonly called the ambient conditions. If these conditions are not within the ranges required by a coating specification during surface preparation or coating application, problems in obtaining a protective film with a long-term performance are likely to occur.

Because of concerns for these problems, specifications require the monitoring of ambient conditions using specialized instruments and test methods before the start of work and periodically during the work. Measurement of these conditions is especially important when weather conditions change during the course of a work shift.

Common Coating Defects Related to Adverse Ambient Conditions

Some of the most commonly occurring coating defects related to unfavorable ambient conditions are discussed in the next few paragraphs. The tendency for such defects to occur is often related to changes in local weather after the work has begun.

Low Temperatures

Adverse effects of low temperatures are most commonly related to the complete and proper curing of coatings within a reasonable amount of time:

Slow curing of coatings. Slow curing will permit the accumulation of wind-borne dirt, mildew spores, and other undesirable surface contaminants. It will also increase the time during which the painted surfaces must be isolated from traffic or other construction work to avoid damage or contamination.

Incomplete curing. Many latex coatings applied below 40 °F will not coalesce to form durable films. Also, thermosetting coatings that cure by chemical reactions of two parts or by reaction with oxygen in the air will have a much longer curing time and may never cure completely.

Improper curing. At low temperatures, many thermosetting (e.g., two-part) coatings may cure by mechanisms other than that intended by the formulator.

Incomplete leveling. Low temperatures may reduce the viscosity (fluidity) of a coating applied to a surface, so that it cannot level properly (flow together to form a uniformly thick film). When brushing, incomplete leveling may result in brush marks in the cured film; when spraying, incomplete leveling may result in orange peel (irregular thicknesses in the cured film resembling an orange skin).

High Temperatures

Adverse effects of high temperatures on coatings are usually related to their accelerated drying or curing rates:

Re-rusting. High temperatures accelerate the rusting of cleaned steel.

Rapid drying of lacquers. Coatings called lacquers form a protective film on substrates merely by evaporation of the solvent in which their resins are dissolved. Accelerated evaporation of the solvent during spray application at high temperatures may result in an inability of the wet film to flow together (level) to form a continuous film of even thickness. This results in dry spray (formation of a rough surface with pinholes or voids).

Rapid drying of latex coatings. Latex coatings (dispersions of resins in water) form a protective film by coalescence of their resins as the water evaporates. If temperatures exceed those recommended by the manufacturer, rapid drying will cause a low quality protective film to be produced.

Rapid curing of coatings. Most coatings cure to form a protective film by a chemical reaction, either between separately-packaged paint components, or with water or oxygen in the air. These chemical reactions are accelerated at high temperatures to cause more rapid curing of coatings. Rapid curing often results in significant shrinkage, stresses, and other harmful effects on the coating.

Effects of exotherm. The reaction of separately-packaged chemically-curing coatings generates a heat called exotherm when the two parts are mixed together. This exotherm, along with a prevailing high temperature, may further accelerate the curing rate to cause harmful effects on coatings. Also, the exotherm may reduce the viscosity significantly to interfere with normal application or curing of the coating. The greater the volumes of Parts A and B that are mixed together for application, the greater will be the exotherm and its harmful effects.

* Although this monograph has undergone peer review, it is not an official SSPC standard developed through SSPC's standards development process.

Reduced induction time. The induction time for two-part, chemically-curing coatings is the time required to produce an exotherm that will cause the chemical curing of the coating to continue to completion. Induction times will be shortened or may not even be necessary at high temperatures.

Reduced pot life. The pot life of two-part, chemically-curing coatings is the period of time after mixing and induction (if any) during which the coating can successfully be applied. If the pot life is exceeded, the mixed product is too viscous (thick) for proper application. In addition to the high ambient temperature, the exotherm will further reduce the pot life.

Reduced recoat window for topcoating. Two-part, chemically-curing coatings can only be topcoated successfully in the limited time range specified by their manufacturer. If the next coat is applied too soon or too late, harmful results will occur to the protective film. The recoat window of time will be significantly reduced at high temperatures.

Wrinkling. At high temperatures, alkyd and other drying oil-containing coatings that cure by reaction with oxygen in the air may react rapidly at the coating surface to form a skin that will not permit further oxygen penetration to cure the underlying coating. Shrinking of the skin results in wrinkling of the coating surface to form rows and furrows with uncured coating beneath. Wrinkling is more likely to occur if these coatings are applied in a thick heavy coat.

Pinholes in topcoats of inorganic zinc-rich coatings. When topcoating inorganic zinc-rich coating films, rising temperatures may cause air or solvent vapors entrapped in the pores of the films to be emitted and rise to the surface of the wet topcoats. This will cause pinholes to form in the topcoats.

Outgassing from concrete. Rising temperatures during the coating of bare concrete may cause air entrapped in its pores to be emitted and rise to the surface of the wet film to leave pinholes in it. Sealing of the concrete will reduce the tendency to form pinholes by outgassing.

Low Humidities

Harmful effects of low humidities are usually associated with changes in coating curing rates:

Incomplete curing of inorganic zinc-rich coatings. Solvent-borne inorganic zinc-rich coatings require moisture from the air for curing. On dry days, it may be necessary to spray water onto these coatings for complete curing.

Curing of polyurethane and polyurea coatings. Single-part polyurethane and polyurea coatings cure by reaction with moisture in the air. Unless the humidity is above 20%, the coatings will not cure satisfactorily.

Curing of water-borne coatings. On hot, dry days, water-borne coatings may cure so fast that they do not produce durable films.

High Humidities

Flash rusting. High humidities will greatly accelerate re-rusting (flash rusting) of cleaned steel. This is why dehumidifiers are often used to reduce the humidity in closed spaces.

Reduced bonding strength. Moisture condensed on cleaned surfaces, with or without rusting, may reduce the bonding strength of the coating to the surfaces.

Blushing of lacquers. High humidities may cause solvent blushing during spray application. The rapidly evaporating solvent reduces the temperature at the surface of the wet coating film to the dew point, and moisture condensation occurs.

Blistering. Condensed water on surfaces being coated may cause blistering of the coatings.

Improper curing of coatings. If the ambient humidity is over 80%, moisture in the air will react so rapidly with the single-part (moisture-curing) polyurethane and polyurea coatings, that these reactions compete with the intended curing reactions, and durable protective films cannot be achieved. Because of their reactions with moisture, exposure to air of moisture-curing polyurethane and polyurea coatings should occur only during actual application.

High Dew Points

It is a common rule that the surface temperature must be at least 5 °F above the dew point and not falling to prevent moisture condensation. Harmful effects of moisture condensation on protective films were discussed in the previous paragraph.

High Winds

High winds (above 15 miles per hour) at job sites may also have harmful effects on coating operations:

Contamination of cleaned surfaces. Winds may blow dirt, dust, and other debris onto cleaned surfaces. Unless removed before painting, this contamination will reduce the bond strength of coatings applied to the contaminated surfaces.

Contamination of uncured coatings. Wind may blow dirt, dust, and other debris onto the uncured coating. This will produce an unsightly appearance to finish coats. If a topcoat is to be applied over the contaminated coating, the contamination will reduce the bonding strength of the topcoat to the undercoat.

Overspray. High winds make control of overspray more difficult. Wet paint mist may be carried outside the paint area onto automobiles or other unintended surfaces.

Exterior application of paint should cease when wind velocity reaches 25 miles per hour or more, either in gusts or at a steady state. Where surfaces can be shielded from wind by artificial deflection means, work may continue.

Ambient Conditions to Monitor/Track

Relative Humidity and Dew Point

Instruments used to measure percent relative humidity and dew point are called psychrometers. The three basic types of psychrometer are:

Sling psychrometer. A sling psychrometer has two thermometers, the bulb of one of which is fitted with a wick, each soaked in water. As the thermometers are whirled through the