Understanding Elevated Temperature Makes Polymer Overlay Placement Easier

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"Competitive advantage is at the heart of a firm's performance in competitive markets." Michael E. Porter

Temperature is a critical factor in polymer overlay placement and cure. Despite the technological advancements in coating and polymer concrete overlayment, there are still elevated temperature related issues that create application and cure problems. These problems can result in dissatisfied customers, reduction of project profitability and in some situations create serious difficulties and catastrophic financial loss.

Often it's said "Why isn't there time to do it right the first time." With temperature related issues, it could be a lack of experience or knowledge, not a product problem or that a crew member made a mistake in application of the polymer. Project conditions are often unforeseen, challenges can develop quickly and the consequences show up after the project is considered finished.

By understanding how temperature relates to your project, you will be able to put better practices into use. Moreover, combined with proper selection of the polymer products or systems you will have begun to solving those costly temperature issues, and have a more professional looking overlayment. Remember, there are no magic or cure-all products. What makes the difference is knowledge and understanding of how to place overlays under various temperature conditions and in different environments. With proper training and technical factory support you can expect predictable and satisfactory results.

Develop a Project Strategy

Every member of the crew should understand the specific project objectives and challenges. Understanding provides the necessary background and alignment that will allow the installation team to complete the work successfully. It is important that the crew be made aware of the environmental conditions that exist at at the start of each day. In addition, the crew should remain vigilant as the work progresses because conditions can change rapidly.

Understanding Temperature

In physics, temperature is a physical property of a system that underlies the common notions of hot and cold. Temperature is one of the principal parameters of thermodynamics, and is the unique physical property that determines the direction of heat flow between two objects placed in thermal contact. If no heat flow occurs, the two objects remain at the same temperature. Otherwise, heat flows from the warmer object to the colder object.

Temperature is measured with thermometers that may be calibrated to a variety of scales. In most of the world (except for Belize, Myanmar, Liberia and the United States), the Celsius scale (°C) is used for most temperature measuring purposes. The entire scientific world (these countries included) measures temperature using the Celsius scale. Many chemical and engineering fields in the U.S., especially high-tech ones, also use the degrees Celsius scales. Contractors, engineers and others in the U.S. still commonly rely upon the Fahrenheit scale (°F) personally or when working on projects. In the United States, the Fahrenheit scale is widely used. On this scale the freezing point of water corresponds to 32°F and the boiling point to 212°F.

Obviously, temperature is the measurement of hot or cold. While "feel" is the most common and immediate way in which we measure temperature, it is entirely unreliable. As a system receives heat, its temperature rises. Conversely, a loss of heat from the system tends to decrease its temperature. Essentially, the process of cooling involves the removal of energy.

Temperature is an intensive property of a system, meaning that it does not depend on the system size, the amount or type of material in the system. By contrast, mass, volume and entropy (the measure of energy in a system), are extensive properties that depend on the amount of material in the system.

The Role of Temperature
While most people have a basic understanding of the concept of temperature, its formal definition is rather complicated. Temperature plays an important role in almost all fields of science, including physics, geology, chemistry and biology.

Heat transfer is the transition of thermal energy from a hotter object to a cooler object. In this sense "object" refers to a complex collection of particles within coating or polymer overlays. These overlays are capable of storing energy in many different ways. Heat transfer always occurs from a higher-temperature object to a cooler object. As determined by the second law of thermodynamics, where a temperature difference exists between objects in proximity, heat transfer between the two cannot be stopped, it can only be slowed.

Reactivity vs. Temperature
By exposing polymers to a heat source such as the sun or any other heat source, in mixed or unmixed component state, the components will increase to the elevated temperature. When mixed at the elevated temperature, the polymer will rapidly increase its temperature, above the manufacturer's recommended specification. This action sets up opposing conditions that must be considered. The first of these is reactivity. Two-component polymers such as epoxy typically obey Arrhenius law, which in effect states that when the threshold of energy of a reaction is exceeded for every 10 degrees centigrade rise in temperature, the reaction rate doubles.

The significance of this is that if the polymer is mixed at the typical desired room temperature in the mid 70°F range and the potlife (working time) is 30 minutes, by rising the temperature to 90°F before mixing the components together the potlife is reduced by approximately 50%, or 15 minutes of working time. Understanding potlife curves vs. temperature will assist in your product placement.

Recommendations for Elevated Temperatures Conditions
Storage: Do not store the polymers or aggregate in direct sun light. The infrared heat will increase the polymer temperature inside the pail typically as much as 30°F above ambient temperature.

Product selection: Selection of a slower curing polymer system will typically have a longer potlife. When exposed to elevated ambient temperatures the longer potlife will typically provide sufficient time for placement.

Batch sizes: Reduce the batch size by 50% in volume on the first and second batches when elevated temperatures exist. Keep a time record of the placement times of each batch. Adjust the batch size up or down in size and still provide a safety time zone for placement.

Shorten potlife: Elevated temperature will cause a shortening of the potlife. In addition, a larger mixed mass of polymer will create its own elevated temperature because of exotherm and have a shorter potlife. This chemical process can occur when the polymer mass is within the desired temperature range for application or at elevated temperatures. Controlling the product pre-conditioning temperature and the mass batch size will allow a controllable application.

Mixing location: Locate the mixing station as close as possible to the placement area to reduce hauling time. Do not mix the polymers in direct sun light.

Clear communication: The person in charge of the mixing must have clear directions from the person in charge of the product placement when to provide the next mixed polymer batch.

Hot surface applications: Application of polymers on concrete with elevated temperature will increase the reactivity and could cause poor adhesion. The reactivity can become so fast that the quick curing process sacrifices the wetting-out capabilities of the polymers. Wetting the surface to create proper adhesion can only happen in the liquid stage (application stage) before the gel stage develops. On hotter surfaces, the cure develops so fast that the gel stage is not typically detected by the applicators; it's wet, then tack-free. It is like missing a portion of the curing development. If this happens, there will be a good chance of system failure in the near future.

Remember on all sun-exposed concrete, indoors or outside, the exposed concrete surface will be many times greater in temperature than shaded concrete or the ambient temperatures. In the polymer overlay business, the substrate temperature is one of the most important temperatures to know and record.

Viscosity change: Products that are exposed to elevated temperatures will have a reduction in viscosity. Viscosity is the measurement of fluidity of the product. As the viscosity is reduced many properties of the system maybe be altered that could affect the final use properties.

The first indication is normally that the ambient temperature is rising, and the polymer unit spreads easier and goes further. The advantage is that it wets the surface out good, but its surface thickness is thinner than designed because it wicked into the concrete mass and broadcast media. Without the surface buildup of polymer, it will not accept the correct amount of media being broadcast into the wet surface. To correct the problem and develop the proper thickness another broadcast or two will be needed consuming more material and labor than planned. When the cured system is thinner it has reduced durability, water and chemical protection and a shorten life cycle. It cannot be claimed as a LEED® "Green" sustainable system.

Two profit saving approaches: Alternate approaches would be to start early in the morning when the surfaces are cooler and before the heat develops from the sun getting higher in the sky. A second alternative approach would be to wait until the sun drops over the horizon and the concrete starts to cool down and make the overlay placement in the evening or during the night. Either of the approaches should allow you to bring the project to completion on time and within budget. The crew will also be happier working in cooler temperatures.

Another tip that works for indoor daytime applications: Ever had bubbles in your overlay in certain spots only, but not all over the floor? This typically happens in areas where the sun enters the building through a door, window or skylight window in the ceiling. The prevention is simple, before starting the surface preparation portion of work cover the area of entry with black plastic, cardboard or other material that the sun cannot penetrate.

This allows time for the concrete temperature to equalize in the exposed areas to the adjacent shaded areas. It is very important to stop thermal movement before polymer application. Remove the cover material after the product is tack-free and the project is at its end.

Vertical applications: Thinner polymer creates a serious issue of sag control when vertical applications are required on coving, stair raisers, ceilings and walls. It is very difficult to apply he materials when sag occurs, and nearly impossible to evenly broadcast flake or aggregate into the wet polymer. Controlling the product viscosity starts by controlling the temperature where it is stored; keep the products and aggregates preconditioned for at least 24 hours inside an air-conditioned building. Take out only small quantities when the temperatures are rising.

Thermal movement during polymer placement and cure: Some projects must be placed during the day that cannot be protected from the sunrays. The rising and dropping sun exposures on the concrete surface will cause thermal movement. This occurrence will cause the concrete pores to open and close, allowing gasses to vent out causing bubbles or pulling in wet coating causing a crater in the coating or bridging the pore with the higher viscosity formulas.

Successful treatment: Immediately after the surface preparation is completed seal the concrete surface with a 100% solids epoxy, to fill the exposed pores and to penetrate into the concrete mass. This treatment creates the monolithic attachment to the concrete, seals the concrete surface and prevents future bubbling. It is best if possible to apply this penetrating epoxy as the concrete is cooling down or before the temperature starts to spiral upwards.

CAUTION: Do Not Use Solvent or Wateborne products for this application.
The hot concrete surface could cause solvent to flash off to fast and not penetrate properly, or surface cure the polymer so fast that solvents will be trapped within the polymer lower area of coverage. Waterborne products have poor and nearly no penetration into the concrete surface. When the product cures, a porous film develops allowing out-gassing to occur when the next polymer lift is placed as a thin coating, thicker broadcast or trowel down system.

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Improve the performance of your company by distinguishing its core competencies, the pathways to opportunity. Knowledge will prove to be your competitive advantage. Learning and training is the on-going process that will provide you with the tools for success. Crown's "Polymer Overlay College™" is the ideal way to become a hands-on polymer expert.

Contact us for the next available training class dates: 888.732.1270 or register on-line: www.crownpolymers.com/tech

Floyd Dimmick, Sr. is co-founder and the Technical Director of Crown Polymers, a manufacturer of concrete repair products and decorative, institutional, educational, industrial and commercial floor and wall systems. He has designed and applied polymer products for over 45 years, and has received patents in the USA and Canada. He teaches 10 to 12 polymer classes for contractors annually and has numerous published papers and book chapters on concrete repair with polymers. He is a member and was past chairman of polymer overlay committees of ACI and ASTM and may be reached at info@crownpolymers.com