White Paper

Surfacing new insights in road paint drying times

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Coating Technology

Waterborne paint

Segment

Traffic paint

While it's well known in the road-marking industry that paint drying times can vary depending upon environmental conditions like relative humidity and air speed, PPG researchers have pinpointed the main factor that determines drying speed for various types of waterborne paints — the temperature of the road's surface.

The company evaluated more than 160 scenarios to give contractors a deeper understanding of the drying variables that impact their striping operations. This data-based insight can help guide no-track drying times to prevent paint transfer onto car tires based on conditions at the time of application. It also can influence the extent of traffic control required. Reduced time, cost, rework and complaints from the driving public can be benefits.

Watching paint dry

Waterborne road paint dries in two stages. Water evaporates in the first stage, causing the paint to dry to a no-pickup condition as the surface dries. In the second stage, the emulsion coalesces after the remaining water is gone to form a durable film.

While environmental conditions impact both stages, the first stage is especially affected. Industry common knowledge has pointed to air temperature, air speed and relative humidity as major variables influencing drying times, with paint type and surface temperature sometimes overlooked.

PPG researchers used highly controlled statistical experimentation to identify the impact of each of the five variables independently and in conjunction with each other. The test used seven non-beaded yellow paints: two high-build paints, two extended-season paints and three fast-dry paints.

The researchers tested more than 160 variable combinations according to the ASTM D711 standard for drying times. The paint was applied to a metal substrate at a thickness of 15 mils, with the substrate temperature controlled using a hot plate. Relative humidity and air temperature were controlled in a walk-in environmental chamber, and air speed was controlled in a plastic chamber using fans and a potentiometer.

Substrate temperature rises to top

The data collected from the extensive testing showed that substrate temperature is the main factor impacting paint drying times — almost twice as important as the second-place air speed factor and nearly five times more critical than relative humidity.

The testing also showed a strong two-way interaction between air speed and substrate temperature, meaning that the effect of air speed changes as the substrate temperature changes. Similarly, there is an important interaction between relative humidity and substrate temperature. The type of paint used had minimal impact on drying time, with fast-dry paints somewhat quicker to dry than the extended-season and high-build paints. Air temperature alone had little statistical significance on drying time, but it will impact road temperature in the field.

The researchers were able to use the data to predict drying times under given environmental conditions in a lab setting. For example, based on our data, a desired drying time of 8.7 minutes can occur under the following conditions:

- 85˚ F surface temperature (impact appears to level off above 100˚ F)
- 60% relative humidity (increase in humidity slows drying time)
- 0.5 mph wind speed (impact appears to level off above 1.5 mph)
- 75˚ F air temperature (change in temperature yields minimal direct impact)

The data model used to analyze the testing results had a 0.90 coefficient of determination (R^2) value, which indicates a high degree of accuracy relative to the actual data.

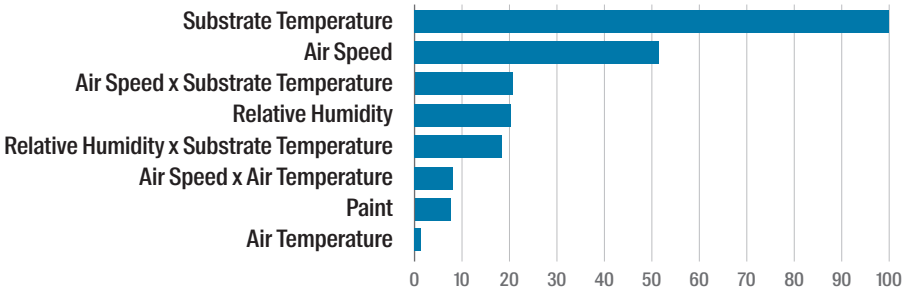
Real-world implications

The insight gained from the study can help striping contractors better plan the timing of their jobs as well as the extent of traffic control.

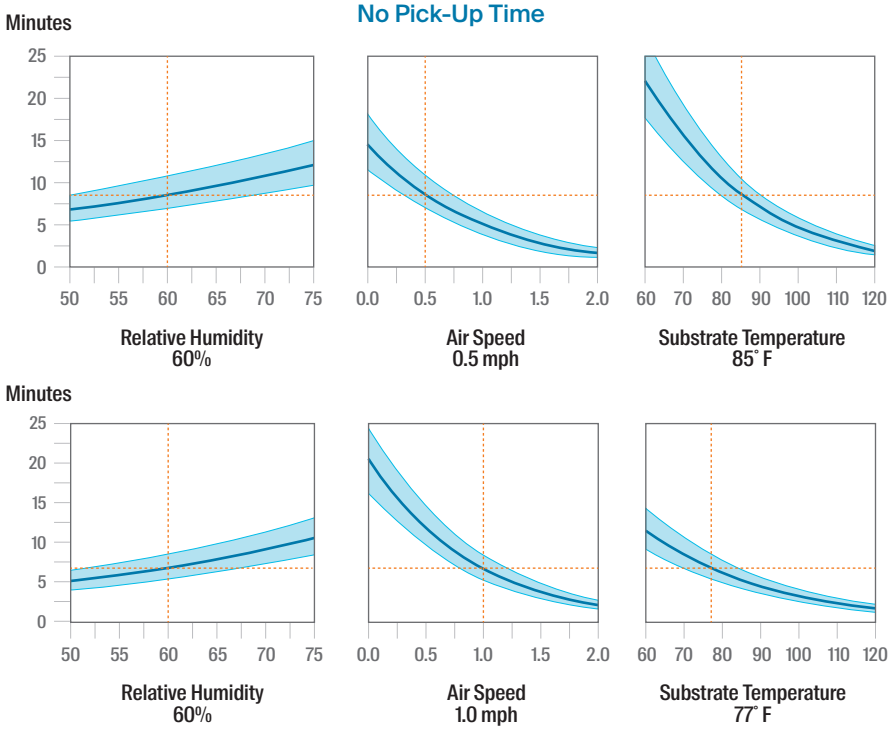
Since the temperature of a road surface rises throughout the day, starting work later may reduce drying times. If that's not feasible, contractors now have the foresight to plan for longer drying times and extended traffic control when the road surface is cooler. This is also the case for portions of the road that are shaded by overpasses and other obstructions that block the sun from heating up the surface. The same applies for cloudy days.

As average daily traffic counts increase, more projects are required to be completed in night conditions. Road temperatures can decrease and relative humidity can increase substantially from the beginning of the night until sunrise. This combination of decreasing surface temperatures and increasing humidity causes drying times to increase. As these conditions change throughout the night, the duration of traffic control that's needed to protect the pavement marking expands.

Factors Affecting Dry Time by Relative Importance



No Pick-Up Time



At a fixed 60% relative humidity, a representative waterborne traffic paint dries at about 7-8 minutes of no pick-up time at 85° F road surface temperature and 0.5 mph air speed. If road surface temperature is lowered to 77° F , the same drying time can be achieved by increasing air speed to 1 mph.

Beyond better control of projects, the study's data can support other changes for the industry. For example, using equipment to heat the road immediately prior to striping would raise the surface temperature and potentially enable faster drying.

An 'aha' moment

Taking a deeper look into the conditions impacting paint drying times for waterborne paint has resulted in an "aha" moment for the road-marking industry. Common sense has always pointed to air temperature, but the data now reveals how critical surface temperature is as a factor.

With this new insight, contractors have another tool to help achieve more efficient and cost-effective striping operations — and they don't have to look beneath the surface to find it.

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