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No. 1202-CF
Revised: July, 2005

Alkaline Substrates and Polymeric Finishes

Alkalinity of Cementitious Materials

Alkaline substrates present a unique challenge for polymeric coatings and textured finishes. Alkaline materials are those which have a pH greater than 7. Alkalinity can adversely affect adhesion, color uniformity, long term durability, and fade resistance of polymeric finish materials. All portland cement-based materials, such as concrete, concrete masonry and traditional or one coat stucco are alkaline. The reaction of portland cement with water produces calcium hydroxide ($Ca(OH)_2$), or "free lime", which is an alkaline material, as a byproduct. Calcium hydroxide will sometimes be carried to the surface of concrete or stucco by moisture migrating through the material. The lime is deposited on the surface as the water evaporates, and the lime will combine with carbon dioxide (CO_2) in the atmosphere to form calcium carbonate ($CaCO_3$). This is sometimes seen on the surface of concrete or masonry as a white chalky deposit and is called efflorescence. This same conversion of lime to calcium carbonate, called carbonation, occurs within the mass of the cementitious material over time, and lowers its alkalinity.

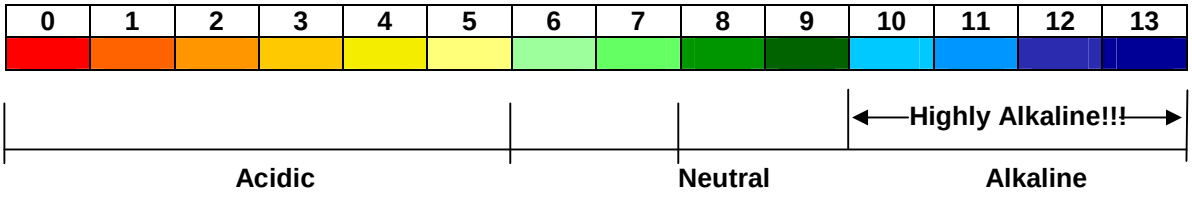
The Importance of Neutralization

The important thing to realize is that FRESHLY PLACED CONCRETE, MASONRY, AND STUCCO SURFACES ARE HIGHLY ALKALINE!!! The pH range of freshly placed portland cement products is in the range of 12.5 to 13. When applying a polymeric finish to an alkaline surface, THE ALKALINE CONDITION MUST BE NEUTRALIZED before application of finish to prevent possible color instability or other performance problems. Neutralization will occur naturally over time by the carbonation process as the surface is exposed to carbon dioxide and moisture. The conversion of $Ca(OH)_2$ to $CaCO_3$ causes a lowering of the pH, which gradually becomes neutral when all of the lime is converted. The rate of carbonation depends on the quality of the concrete or stucco and their exposure to moisture. Carbonation is usually limited to a measurable depth along the exposed surface of the material. Thin layers of material, such as stucco, may carbonate completely, but this could take years. Detergent wash water or cleaning agents used to prepare concrete surfaces for finishes may also affect the condition of the surface and its degree of acidity or alkalinity.

pH Testing

One way to determine if the surface is neutral is to test the pH. pH is a measure of the concentration of hydrogen ions in solution, which is an indication of alkalinity or acidity. The more hydrogen ions that are present, the more acidic the solution is. Testing can be done in a number of ways, most commonly by depositing a few drops of an appropriate indicator (i.e., phenolphthalein) on the surface. Phenolphthalein solution will change to a pink or purple color in conditions where the pH is greater than 9. If the pH is less than 9, the solution will remain clear (other pH indicators will have different color indications). Alternatively litmus paper can be used with distilled water. When the surface is wetted with distilled water and the water is then placed in contact with red litmus paper it will change color from red to blue if the water solution is alkaline. Some litmus papers are calibrated to read pH with a corresponding color scale which can be visually matched to determine the pH (Figure 1). The actual color scale will depend on the paper used. Most paper kits have color comparison charts on the packaging. It is best to use a paper that measures pH of a cementitious surface to at least half a point within the range of 7 to 14.

Figure 1. Typical pH color scale indicates degree of acidity or alkalinity of a material. pH of 10 or more is considered highly alkaline and unsuitable for application of polymeric finishes without neutralization or pre-treatment with a primer-*sealer.*



What to Do with an Alkaline Surface Condition

If the surface is highly alkaline, a pH of 10 or more, then the surface must be neutralized before applying a polymeric finish. One way to neutralize the surface is to wash with a dilute acid cleaner followed by a thorough rinse with potable water. Note: caution must be taken when handling acid cleaners. Improper acid washing techniques will damage the surface and inhibit proper bonding. For this reason acid cleaning is not always the favored method to neutralize an alkaline surface.

Another possible treatment is to use a primer-*sealer* that creates a barrier over the alkaline surface. This type of primer in effect masks the alkaline surface condition from the finish product that goes over the primer. Assuming the primer is successful in masking the alkaline condition, there is no further threat to the finish, unless water enters into the construction from leaks, water vapor condensation, or by some other means. Water intrusion will potentially dissolve alkaline materials and carry them towards the finished surface where they again threaten the color stability and possibly other performance characteristics of the finish.

Helpful Tips to Prevent Problems Associated with Alkalinity

The best means to prevent alkaline disturbance of finishes is to:

- Allow for minimum 28 day cure of Portland cement based materials.
- Check the pH of surfaces to verify that the surface is neutral or no higher than 9 before application of finishes.
- Avoid using patch or repair materials with high lime concentrations.
- Patch surface defects in concrete with dry pack mortar or appropriate cementitious repair product within several days of stripping forms so the degree of hydration of the concrete and patch material is similar, and to maximize hydration time before application of finishes.
- Neutralize highly alkaline surfaces before applying coatings or textured finishes.
- Prevent water penetration or water vapor condensation through proper design and construction detailing.
- Use a primer-*sealer* if an alkaline surface condition persists, followed by standard acrylic primer. Verify neutral pH of the primed surface before application of finish.
- Finish surfaces with acrylic or silicone enhanced acrylic finishes, which provide the best resistance to alkaline attack when compared to oil or alkyd-base finish materials.

References:

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