Proper surface preparation is an essential preliminary step for any coating application. It is false economy to skimp on surface preparation in the belief that the coatings applied will compensate for surface deficiencies. This is especially true of high-performance coating materials.

Surface preparation must provide a surface that is compatible with the coating material to be applied, as specified by the coating manufacturer. The major considerations concern requirements for the cleanliness of the surface and the surface roughness (also called the surface profile or anchor pattern) to be obtained. Compared to a smooth surface, an appropriate anchor pattern actually increases the amount of surface to which the coating may adhere.

As much as one-half to two-thirds the cost of a coating project is often devoted to surface preparation and labor, and this is justified by the importance of surface preparation to the long-term performance of the coating system. In some cases, achieving best practices in surface preparation may be limited by factors that are difficult to control. These may include insufficient time or funding to complete the job or restrictions based on concerns for possible product contamination, fire hazard, or other critical considerations. It must be recognized that when there is a lesser degree of surface preparation, coating system longevity will likely be compromised.

Principles of Coating Adhesion

Cleaning a metal surface is performed to achieve two basic objectives:

- To obtain a hard, continuous surface that will remain stable as a coating substrate
- To provide a cleaner metallic base to which the coating material will adhere more strongly

Heavy abrasion of the surface with wire brushes, carborundum, or other materials can attain some part of these goals. In this way, a firm oxide surface is produced, which is much less likely to be contaminated with atmospheric pollutants (particularly chlorides, sulfates, and nitrates) than the original surface. If the remaining scale is firm, dry, and not excessive in thickness, a heavy coating can be applied to cover the rough substrate and keep active atmospheric species from diffusing to and through the scale. Unfortunately, even in a normal atmosphere, when a metallic surface is cleaned, it can still be badly contaminated. Oxygen is immediately adsorbed, and the cleaning procedure can leave some undesirable residue, with the result that the original scale or other foreign material may not be fully removed. Clearly, if all solid foreign material could be removed from the metal surface, a much improved adhesion would be achieved.

Of the methods available to provide the cleanest and largest effective surface per unit area, the use of abrasive blasting typically produces a surface closest to the ideal surface profile. However, the best of blasted surfaces can still be badly contaminated with residual metal oxides, extraneous dirt, particles of the abrasive materials, and adsorbed gases on the metal. Consequently, it is necessary to construct coating formulations with the maximum capacity to compete for and lock onto the available bonding sites. For this reason, coating materials containing polar molecular components, such as OH, and, particularly C=O functional groups, provide the best adhesion to a metal substrate.

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Surface wetting properties of liquid coatings are obviously important for good adhesion. The coating material must remain stable to maintain adequate adhesion. If embrittlement occurs through oxidation, cross-linking, or volatilization of a portion of the coating (such as plasticizers), the resulting shrinkage stresses in the coating can pull it from the surface. Any loss of adhesion from such sources is obviously undesirable.