Phosphating

The process of phosphating aluminum and steel parts is typically listed as a conversion coating because the process involves metal removal as part of the reaction. However, it is not like anodizing or black oxide in that the phosphate coating is actually a precipitation reaction. The final surface is a layer of very fine phosphate crystals adhering to the surface of the metal.

For paint and powder coatings, a phosphate coating has two main functions. First, the coating provides improved paint and powder coating adhesion since the phosphate crystals act as organic coating anchoring sites. Second, the phosphate layer acts as a corrosion barrier should the organic coating get scratched. In rust creep testing, the rust creep is reduced when phosphate is present under the paint layer or powder coat layer compared to no conversion layer under the organic coating.

Phosphate can be used as a stand-alone coating for other purposes such as lubricity in parts forming but the other functions are beyond the scope of this report.

The most common phosphating chemistries are iron phosphate, zinc phosphate, and manganese phosphate. There are also other phosphating chemistries such as Plaforizing™ which are non-traditional in their chemistry and application since they are single step and typically an organo-phosphate that react with both the organic contaminants and the metal surface.

The main thrust in recent years for improving the phosphate process is to reduce the temperature requirements for the phosphate bath. Some chemistries have been developed that work well at room temperature. In general, there has been a trend from high temperatures, 90 F to 200 F, to much lower temperatures, 70 F to 140 F, resulting in energy savings.

Most phosphating lines are single tank (Plaforizing™ from Carpenter Chemicals, Enviroprep from Calvary Industries, and Ferrox Series from Foster Chemicals), three step, or five step processes. The three and five stage processes are:

Three Stage Process:
1. Clean/phosphate
2. Rinse
3. Rinse/seal

Five Stage Process:
1. Clean
2. Rinse
3. Activated rinse
4. Phosphate
5. Rinse
Or
1. Clean
2. Rinse
3. Phosphate
4. Rinse
5. Seal

The single step processes will be more conservative of both water and energy compared to the three and five stage processes. In the case of the Enviroprep by Calvary Industries, the chemistry is phosphate free but still serves as a surface preparation stage for paint and powder coating.

The three and five stage systems can typically be made more water efficient with flow optimization of the rinses, rinse recirculation, and rinse counterflow, and in some cases, reactive rinses. These systems can sometimes be made more energy efficient by switching to lower temperature phosphating chemistries.