A new technology from Chemetall, called Oxsilan has been successfully used in commercial operations at numerous automotive and component manufacturers for several years. In terms of quality, it is comparable to the zinc phosphating process, and can give higher productivity, multi-metal capability and considerably lower process cost.

Technical limitations call for a rethink

1919 was the first time that a vehicle with a phosphated body left the Ford production line. Back then, corrosion protection based on phosphating was revolutionary. “Today, phosphating is a process that has proved to be successful in millions of cases and that has been permanently developed further and improved”, says Dr. Peter Schubach, Vice President Technology at Chemetall. “For a long time, the drawbacks of phosphating are now becoming considerably more relevant”, he adds.

This has driven the search for alternatives. The more stringent legislation for handling nickel and other heavy metals, the expensive cleaning and removal of phosphates and sludge as well as the ever more varied metal combinations used in car bodies and automotive components are taking the phosphating process to its technical limits. These fundamental problems cannot be solved by simple process optimisation. The process has been largely perfected over the years so that the limitations can only be overcome with a technological change.

Stable and robust chemistry

Since 2006, Oxsilan has proven to be a successful substitute technology for the pretreatment of automotive components. The process has been developed by Chemetall, which has been active in the pretreatment of metals since the beginnings of the phosphating process. “The basic materials for our new technology are silanes”, explains Dr. Schubach. The silanes are hydrolyzed and converted to polysiloxanes. In the coating process, the silanol groups react e.g. with the metal hydroxides on the substrate to form a chemical bond. On the metal substrate, the polysiloxanes and the metal additives form a cross-linked network, building up a thin layer. “Around 100 nm is already sufficient to achieve the same level of corrosion protection as the roughly ten times thicker zinc phosphating layers”, Dr. Schubach stresses.

This reduced layer thickness not only has a positive effect on the material consumption. Also the pretreatment time is reduced so that more car bodies or automotive components can be treated in the same period of time. The numerous functional groups present in the polysiloxanes contribute to the good adhesion of the subsequently applied paint. In addition, they offer a considerable potential for further modifications and optimisations.

Growing number of OEM customers

By 2009, Chemetall had more than 30 lines worldwide successfully operating with the Oxsilan technology for the pretreatment of automotive components. Like many other plant managers and engineers, who have successfully implemented the Oxsilan process, Michael Schmidt, Opel Area Manager Plant Kaiserslautern confirms: “Our expectations have been exceeded. With the implementation of the Oxsilan technology we could significantly reduce our overall process costs and improve our competitiveness while retaining the same high quality of our components.” In view of these positive experiences, Oxsilan’s numerous advantages and the reliable fulfilment of necessary specifications, this innovative process was also introduced in car body pretreatment. Besides Opel, Daimler, PSA, Renault and Hyundai have also changed their components or body pretreatment to Oxsilan in many of their plants. The fact that only in very rare cases considerable retrofits of the phosphating plant are necessary contributed to the rapid spread of this technology during the last two years. Experience has shown that system changes can often be implemented in the context of a regular chemical cleaning.

Clean, green and even coating

“Despite the simple and stable chemistry of the process, some key issues require specialist know-how to meet the requirements for corrosion protection, paint adhesion and process robustness,” remarks Dr. Schubach. Cleaning represents one of these key issues. Due to the aggressive process conditions in the zinc phosphating process (35 °C and pH 3), contaminations or oil residues remaining on the surface are simply removed from the metal surface by pickling. The mild conditions of the Oxsilan baths (room temperature, pH 4-5) offer this possibility only up to a point. This means, that in this process there are higher demands on cleaning.

However, the use of effective cleaning agent components, such as silicates or borates, is excluded in many Oxsilan applications and prohibited in some countries. For this reason, Chemetall developed specific cleaning agents with selected additives to achieve excellent cleaning results.

The rinsing stage has a similarly sensitive influence on the paint quality. Here, the chemicals used are crucial. Although the goal is “only” to adjust the correct pH value and electric conductivity, experience has shown that achieving this depends heavily on the chemicals employed. Through specific fine-tuning, challenges such as flash rust can be prevented.

The problem known as “throwing power” of the cathodic electro dip (CED) also affects the Oxsilan process. Since the contact resistance of an Oxsilan layer is significantly lower than the one of a zinc phosphate layer, the electrical stages would theoretically be sufficient to achieve the required paint thickness in the CED process. However, in the cavities of a car body, the effective voltage drops due to the Faraday Effect. Therefore these difficult-to-access surfaces would not be sufficiently painted. “To realize a sufficiently thick e-coat on the inside together with a reasonable thick exterior layer, Chemetall has designed the chemistry of the Oxsilan bath in such a way that good results for the throwing power are achieved”, explains Dr. Schubach. This success also convinced the CED manufacturers of the future potential of the new silane-based technology: as a consequence they developed special paint systems for the thin-film technology which now achieve an excellent throwing power performance.

Besides the technical benefits, the commercial advantages are likewise convincing. A view of the relative process costs confirms this, as per the table above. The considerably lower costs for energy and disposal are likely to gain in significance over the coming years. After all, even optimists do not expect prices for energy and environmental protection to drop.

Cost comparison (percent)

|                        | Zinc phosphating | Oxilan process |
|------------------------|------------------|---------|---|
| Chemicals costs        | 100              | 100     |
| Heating costs          | 100              | 70      |
| Electricity            | 100              | 70      |
| Rinsing water          | 100              | 30      |
| Waste disposal         | 100              | 15      |
| Maintenance costs      | 100              | 20      |

New era in metal pretreatment

As energy costs and environmental rules tighten and mixed metal usage increases so all parts of the paint process must respond. Simon Duval Smith looks at a viable alternative to conventional phosphating.

After almost 100 years of making vehicles, the ever more stringent environmental legislation as well as the trend towards an increased use of light-weight metals are giving phosphating processes a hard time.