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AUTOMOTIVE PAINTSHOP SOLUTIONS

From start to finish

– perfecting the process

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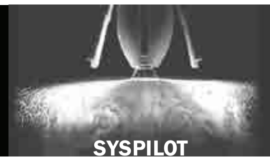


The power of process simulation

The application of physics and digital simulation can improve process design while error detection and online monitoring can prevent faulty production or system downtime writes John Osborne

The basis of all process simulations is the interaction of experience, system knowhow, theoretical considerations and simulation calculations. So say Günther Behr of DaimlerChrysler in Sindelfingen, Germany, and Dr Oliver Tiedje of syspilot Technologies GmbH.

Process control also requires a good knowledge of the individual influences. Provided that the interrelationships and interdependencies are known, conclusions about the source of the fault can be drawn from the parameters being monitored.

Modern electrocoating (EC) is a highly complex process with many still unknown sub-processes. A complete system, for example, includes several thousand different switch signals and parameters that correlate with each other.

The following examples show how beneficial numerical simulations can be in the analysis and optimization of electrocoating tanks.

- Example 1: Simulations were performed to achieve quantified statements on the kind of interdependencies that are difficult to separate from each other in trials. In a real situation there are a number of parameters so simulations were used to find just how great are the individual influences.
- Example 2: In order to be able to plan the experiments quickly and effectively, simulations were used to prepare tests on the throwing power during EC. This made it possible to achieve reliable results with only a comparatively small effort.
- Example 3: Together with the planning department, the optimization of a system in the DaimlerChrysler plant in Bremen, Germany was accelerated and checked for feasibility so that, for example, the optimal parameters were estimated in advance.

One of the challenges of cathodic dip painting is to adequately coat cavities. Electric fields cause the paint to deposit. In cavities, however, these fields are much weaker so that the layer growth is slower. The sillboard on the underside of the car body is a particularly difficult component to coat uniformly. The holes must be large enough to guarantee that this corrosion-sensitive part is sufficiently coated, but the stability

Increasing transfer efficiency by applying science

Dr Oskar Peter Leisin is CEO of syspilot Industrie Consulting GmbH and syspilot Technologies GmbH. The field of syspilot Consulting is design, commissioning and optimization, the field of syspilot Technologies is the development of instruments, equipment, software and digital factory. The cooperation of these two firms results in outstanding technologies and consulting.

> The first of our OEM clients to use powder is BMW. The other companies in Germany are still using solvent, waterborne paints and powder slurry **– Dr Oskar Leisin**

He and Dr Oliver Tiedje, chief developer, explained how the firm's expertise in system know-how, numerical modeling and process design and process optimization has helped automakers apply paint more efficiently.

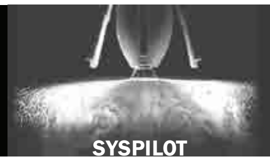
Currently syspilot is working for BMW, DaimlerChrysler, Mitsubishi, Volvo and suppliers. Nowadays new concepts (such as powder coating, integrated paint process), new steps in automation, digital factory and new legal regulations (such as VOC) bring new challenges to automotive coating.

"The first of our OEM clients to use powder is BMW," said Dr Leisin. "The other companies in Germany are still using solvent, waterborne paints and powder slurry."

Powder coating is attractive because superb results can be achieved with it. However, the form in which the paint is applied affects the process design. New criteria have to be created and "the manifold of parameters make the paint process highly complex to optimize and stabilize," pointed out Dr Leisin.

"Powder slurry has some advantages since most of the handling problems have been solved. We have helped automakers in this area by examining the way the paint flows in digital simulations and practical tests," he explained.

By taking the company's advice, some automakers have greatly improved the quality in their paint shops. "Savings by higher transfer efficiencies of, for example, 70 to 90 percent are also possible," commented Dr Leisin. He said that it depends on the robot program, the design of the body, and the shape of the surfaces being painted.



of the car body must not be adversely affected by the holes.

To optimize the coating, additional free anodes were inserted into the bottom of the EC tank. These were aimed at ensuring adequate coating especially of the sillboard and the under body.

Practical benefits of process simulation

The different task areas have several things in common: the influences of the individual parameters should be investigated independently of each other; it must be possible to make the information available quickly and with the utmost practical relevance; the budget is always tight; and high costs, time constraints or difficult testing conditions often make trials impossible.

The Maxwellian equations and Ohm's law dictate the flow of electric current in an EC tank. The Maxwell 3D software package supplied by Ansoft Limited, Munich, Germany operates at high speed and with great accuracy to solve this numerically. By entering the conducting capacities and geometric arrangements, the general program package for the Maxwellian equations can be applied to the problems associated with cathodic dip painting. Kirchhof's laws together with Ohm's law are mapped onto the Maxwellian equations.

The current density or densities inside the sillboard can be output by programming post-process macros. The coating thickness (s) can be calculated at any time (t) by means of a differential equation. The requisite parameters are obtained by applying so-called "fit functions" to the numerical calculations.

In this example, the simple geometry of a model for the arrangement of a test sample (sillboard) and the anodes can be used to reflect the actual relationships. The force line concentrations were calculated with the Maxwell 3D software. The influence of different factors, such as the distance between the sillboard and the anode, can be investigated to find the optimum arrangement of the anodes.

When an EC system for sports cars at DaimlerChrysler was modified, applying simulations and practical optimization details optimized the configuration of the system

When an EC system for sports cars at DaimlerChrysler was modified, applying simulations and practical optimization details optimized the configuration of the system. Simulations made it possible to determine the growth of the paint coat on a car sillboard at any time, at any point of the sillboard and as a function of important parameters.

The results on the effects of distance and hole diameter gained during the test were used to support the design stage. As a means of endorsing the results, an experimental mock-up was developed, a test plan drawn up and the results were reproduced at random in the application testing center. ●

Dr Tiedje believes that improvements in quality and efficiency are being achieved because it is now possible to more accurately understand how paint particles move in paint booths. "The need for process design is growing" and more automakers "are running process simulations. Every big car company is doing some simulation," said Dr Tiedje.

He said that the company can combine the information that it has acquired of a particular paint shop with the knowledge it has built up through the optimum process design.

The result is that the painting process can be improved quicker than if the automaker relied on its internal experts, because of the broader view, the independence from suppliers and the high temporal availability.

That comment should reassure automakers' process experts who are under constant pressure to reduce waste.

*Dr Leisin studied physics at the University of Freiburg in Germany and obtained his PhD there. He worked at DaimlerChrysler in Germany where he was involved in the development of new spraying concepts using paint robots and automation, for example, together with the Deutsche Forschungsgesellschaft für Oberflächenbehandlung e.V (DFO). In 2002 Dr Leisin's achievements were recognized with an award of the DFO.

*Dr Tiedje is the chief developer of syspilot Technologies GmbH. He studied theoretical physics in Kiel and has been a consultant at syspilot GmbH in Böblingen since 2002.

*The DFO is the German Research Association for Surface Treatment and it is the non-profit, neutral, technical-scientific, professional organization for Industrial Coating Technology in Germany and Europe. It aims to promote joint research in technology and application techniques. It also works with universities, colleges and other institutes.

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Syspilot`s Service

Syspilot's core competences can be outlined as follows: comprehensive consulting and active assistance for production facilities, especially paint shops.

Range of Services

Design, Coordination, Commissioning	Production Optimisation	Training, Seminars, Investigations
Plant / Application Design, Specification Sheet, Comparison of bids	Quality, Cycle Time, Consumption Optimisation	Coating Technology, Modern TQM / Diagnostic Systems
Reconstruction / New Construction Coordination	Offline Programming, Model Launch	Studies, Analyses, Development Support, Pilot Plant Trials
Diagnostic Systems Quality Systems	Cost Reduction, Process Optimisation	Simulations, Digital Factory, Knowledge Managment

Thanks to the development of our own commissioning tools and diagnostic techniques as well as close cooperation with premium clients, syspilot always has the latest know-how in the production technology sector at its disposal. We work directly on site and in three-shift operation.

Optimisation: syspilot improves your production with the aim of enhancing quality and minimising costs. Typical examples are the design and optimisation of contour and control programs. As one of the leading providers in the field of production optimisation, we apply cost-efficient simulations, to achieve, for example, the ideal layer thickness of the EC and topcoat or to minimise dirt and bath contamination in the pre-treatment stage (see page 30)

Leading By Competence
Our strength and our success are characterised by the consistent use of advanced analytic and diagnostic technologies.
Our employees' high level of training in the fields of engineering technology and physical science enables us to combine expert knowledge, experience and intuition with a systematic and integrated perspective.syspilot Industrie.

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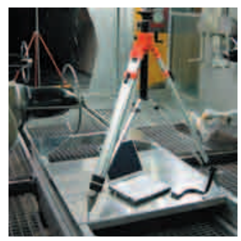
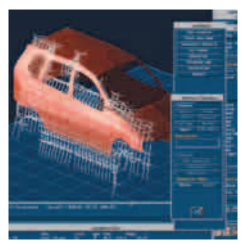

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