

MATERIALS AND CORROSION CONSULTING



INNOVATION

ENGINEERING

OPTIMIZATION

Methodic Corrosion Management with bayPRINCE®

Situation & Challenges

In virtually every industry, performance of materials is a key to success. However, material behavior is determined by the complex nature of the material's interaction with liquids, gases and /or solids at different temperatures and loads. Even minor changes in these parameters can result in significant differences in material behavior. In the past, prediction of material behavior was based upon experience, literature and tests, and system parameters could not be directly and confidently related to material damage rates.



Costs of corrosion are 4% of annual sales volume of 476 billion EUR in Chemical Industry of Europe (EU25)**

Direct costs of corrosion are \$1.7 billion/yr in the Chemical, Petrochemical, and Pharmaceutical Industry in the United States* (8% of total capital expenditures)

50% of direct corrosion costs can be avoided

** according to figures provided by European Chemical Industry Council (CEPIC)

* according to results of a 2-year study CORROSION COSTS AND PREVENTIVE STRATEGIES IN THE UNITED STATES released by Federal Highway Administration (FHWA) in 2002

Costs of Corrosion for Chemical, Petrochemical, and Pharmaceutical Industry of the EU and US

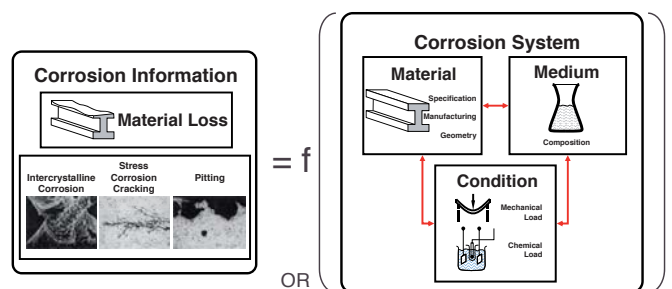
The Innovative Solution

The bayPRINCE® methodology for corrosion management follows a completely new approach. By providing a methodology to identify, analyze and understand the causes for corrosion damage, the bayPRINCE® methodology makes pro-active control of corrosion damage possible and enables the development and continuous improvement of system-specific corrosion management strategies.

The following equation illustrates the basic concept:
Experience + bayPRINCE® = Knowledge + Confidence

The "experience" is the data collected over time about corrosion behavior in process plants. The origin can be for example inspection reports, laboratory corrosion testing or measurements from online corrosion monitoring systems. Such data can be gathered and stored systematically. The Bayer Technology Services corrosion information system KIS for example is such a systematic approach.

With the principle of intelligent, artificial neural nets that rely on trustworthy corrosion data, bayPRINCE® can consider any eventuality of materials corrosion that traditional mechanistic or empirical models are hard-pressed to cope with. This solution will be specific to the modeled corrosion system and facilitates the prediction of likely corrosion rates and active damage mechanisms.



$$y_{\text{Corrosion}} = f(x_1, x_2, x_3, \dots, x_n)$$

From Experience to Knowledge



Bayer Technology Services
Powering Your Performance

Fields of Application

The bayPRINCE® method is broadly applied within two fields:
Plant Maintenance and Optimization

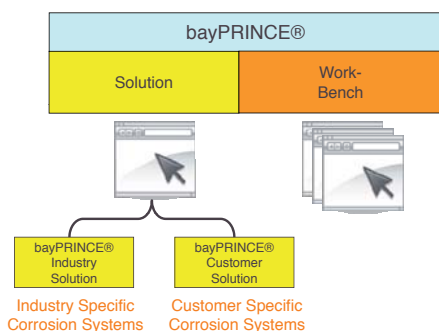
- Definition of safe integrity operating windows
- Condition monitoring and inspection
- Corrosion studies
- Materials selection
- Development and continuous improvement of site-specific equipment reliability strategies

Innovation / Research / Development

- Selecting materials in engineering & construction
- Developing new alloys

Industry and Customer Solutions, Workbench

Application of the bayPRINCE® method finally leads to bayPRINCE® solutions, provided in the form of a software solution. This software solution facilitates the analysis of corrosion mechanisms visually and numerically, for example to investigate material response to defined scenarios, or to perform optimization calculations.



bayPRINCE® Solutions / Workbench

bayPRINCE® Industry Solutions are developed and maintained by Bayer Technology Services for industry-specific corrosion systems, for example for sulphuric acid systems relevant to hydrometallurgy, titanium dioxide production, nitration, sulphuric acid production, and heat recovery in sulphuric acid plants. bayPRINCE® Customer Solutions implement the bayPRINCE® methodology and are designed to characterize the unique corrosion system of a customer. The typical project execution model for developing a Customer Solution is structured into three steps:

Assessment

- Characterize the corrosion system to be analyzed
- Define the data requirements

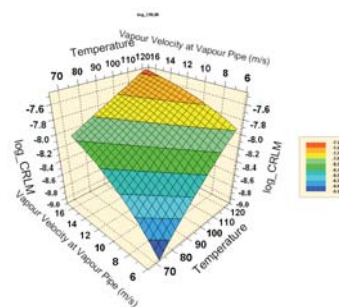
Strategy

- Collect and screen the data that is to be used
- Develop and validate neural net model

Solution

- Transform model into bayPRINCE® solution
- Integrate the bayPRINCE® solution into existing corrosion management processes

The bayPRINCE® Workbench provides the tools that enable the customer to manage corrosion data, develop models and bayPRINCE® solutions independently and whenever needed.



Visualization of a Customer Solution: logarithmic corrosion rate lost mass against temperature and vapor velocity

Benefits

bayPRINCE® will help you to:

- systematically define and collect relevant plant corrosion data
- identify, analyze and understand the causes of corrosion damage in your plant
- continuously improve the methods by which corrosion damage is managed
- optimize and focus corrosion management activities, e. g. inspection and data collection, equipment maintenance strategies
- determine and control the probability of failure due to corrosion damage
- mitigate corrosion risk without additional inspections
- develop risk-based inspection plans
- reduce time spent for decision making in response to actual or planned process changes
- select the most economical materials and avoid over-design as well as under-design
- minimize the effort required to develop materials and to optimize materials selection and performance

Bayer Technology Services – The Corrosion Experts

We are a team of materials engineering scientists and engineers, working in an accredited laboratory (DIN EN 17025) and in the field of materials technology. We offer high-level expertise in materials technology and testing with emphasis on, but not limited to, chemical, pharmaceutical, petrochemical and power engineering. Our multidiscipline approach to managing corrosion- and materials-related risks allows us to understand your plant and to satisfy your materials and corrosion management requirements. As a result of our continuous work as project consultants in close cooperation with plant personnel in production facilities, our know-how is transferred in both directions: from development to practice and from practice to development.

Let us discuss how we may cooperate with your organization for optimum results and maximum profitability.