CASE STUDY

think simulation | getting the chemistry right

Oil & Gas

Corrosion Analysis

Optimizing Materials Selection for O&G with Physical Models and Experimental Results

OLI Systems has worked with DNV GL to solve a number of complex challenges in multiple sectors. This project was designed to assist oil and gas companies in selecting the right materials to enhance production and reduce corrosion risks. OLI Systems and DNV GL modeled extreme field environments utilizing the most critical conditions, and conducted experiments on a number of metal alloys. The results have enabled companies across the Oil and Gas sector to optimize materials selection for their unique environments by accelerating research, improving corrosion management, and reducing cost.

Industry Trends

Optimizing operational design

In the Oil and Gas (O&G) industry, corrosion is a primary concern at all stages of production. Corrosion is affected by a number of environmental factors and materials specifications. Unfortunately, it can also be incredibly difficult to predict. In the past, empirical models have been developed to help O&G companies identify corrosion issues and estimate potential risks and treatments. However, these models lack the precision needed to design and maintain operations at peak performance of materials.

Corrosion management begins with materials selection. Choosing the right operating materials is a key step in asset and process design phases in order to mitigate issues like corrosion and stress corrosion cracking (SCC) which can lead to catastrophic failure, downtime, exorbitant spending, and subsequent environmental impacts. O&G companies run extensive tests to determine how materials perform under a variety of environmental conditions. Because different metals have unique performance and reactions to chemicals, materials selection can make or break success, particularly in extreme environments. To optimize this process, companies need a new generation of corrosion modeling and simulation tools to create the most effective, economic design.

Business Challenge

Increasing asset reliability

DNV GL is an international classification, quality assurance, and risk management company that helps clients in industrial sectors improve the safety and sustainability of their businesses. DNV GL's mission is to combine the best technical and operational expertise in order to guide economic decision-making and prevent failure. For O&G customers, this requires advanced risk management and mitigation strategies to ensure greater safety, reliability, and performance.

In this study, DNV GL set out to streamline materials selection for O&G industry clients. The typical process requires a battery of tests covering numerous conditions and metals to assess their resistance and slowly narrow the list to determine the highest-performing material. These processes take at least two years to complete. DNV GL needed a more accurate modeling approach to enhance and accelerate materials selection, reduce risk, and create productive and sustainable operations.

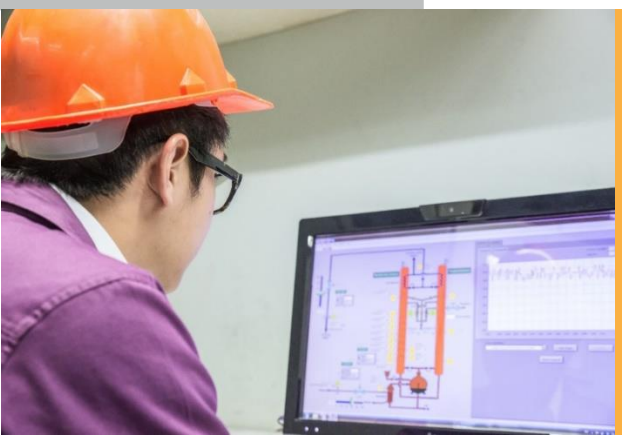
Approach

Analyzing risk with thermodynamic models

DNV GL has employed OLI Systems' modeling and simulation software to optimize materials selection and access severity of environments. OLI Systems' state-of-the-art models and extensive water chemistry expertise would enable them to predict corrosion behaviors for different metals by visualizing the most critical conditions, instead of having to qualify one metal at a time under all possible conditions. The goal was to reduce the number of required tests to significantly speed up asset and process design.

DNV GL also planned to utilized OLI Systems' modeling tools to increase the precision of test results, allowing them to create a more in-depth image of corrosion behaviors. Rigorous physical models provided deeper, more accurate insights compared to outdated empirical models at extreme conditions. Tools incorporated with physical models and experimental results create the most effective, accurate, and economic design.

Solution



> "OLI Systems' modeling capabilities were key to exacting these results. The insights will transform materials selection."
>
> **Liu Cao**
> *Senior Research Engineer*
> *DNV GL*

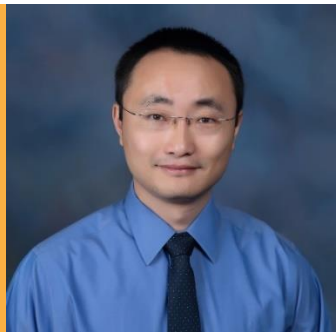
Enhancing corrosion prediction for peak performance

OLI Systems collaborated with DNV GL to explore new ways to expedite corrosion testing while honing materials selection. For the joint project, DNV GL provided experimental test data for specific alloys and selected environmental conditions which were compiled in a massive metrics database. OLI Systems employed its industry-leading OLI Studio: Corrosion Analyzer and extensive water chemistry analysis to physically model the results to generate and optimize parameters. This allowed them to prescreen conditions and materials in order to identify key material specifications and environmental factors linked to corrosion—including alloying composition, temperature, pressure, and numerous chemical contaminants. The model embedded in the Corrosion Analyzer can also be used to extrapolate beyond the limited number of experimental conditions.

OLI Systems designed test matrix based on the parameters required to predict the performance of a single material in simplified sour environments—specifically its resistance to localized corrosion and SCC. These results were then used to predict the performance of multiple materials in complex sour environments. DNV GL successfully validated each of these predictions in the laboratory. According to Liu Cao, Senior Research Engineer at DNV GL, "OLI Systems' modeling capabilities were key to exacting these results. The insights will transform materials selection."

> "OLI Systems software saves you from extensive lab testing and enables you to focus on selecting the right materials. With OLI Systems, the process is much faster and simpler."

Liu Cao
Senior Research Engineer
DNV GL



OLI Systems accelerates materials selection

Over the past five years, OLI Systems and DNV GL have worked to create a massive database of test parameters to predict a number of corrosion resistant alloys (CRAs) in a wide range of sour environments. The collaboration yielded revolutionary data insights that do not exist anywhere else on the market. In conjunction with rigorous physical modeling, the database equips DNV GL to analyze specific operating conditions and materials, accurately predict corrosion risk, and spot-check results to empower clients with significantly faster, more informed materials selection. Additionally, these powerful tools enable clients to extrapolate a broad range of application conditions from a small number of test conditions, which further accelerates the process—from testing to deploying solutions in the field. In fact, this comprehensive solution can help O&G companies complete the entire process within one year.

Now, DNV GL's clients can determine which tests are necessary to rapidly arrive at a solution. With these tools, they can predict corrosion performance, access SCC susceptibility, and identify corrosion risks in a manner of minutes; implement any required changes almost immediately; and make highly effective, preventive design decisions. This approach also enables clients to study the effects that vary in environmental conditions and alloy compositions. These game-changing capabilities are a proven method to determine whether an alloy can be safely used beyond their current limits (as specified in ISO 15156/NACE MR0175). According to Liu Cao, "OLI Systems software saves you from extensive lab testing and enables you to focus on selecting the right materials. With OLI Systems, the process is much faster and simpler."

The successes of this project were published in *CORROSION* in a series of papers to explain the physical models. "Modeling Localized Corrosion of Corrosion-Resistant Alloys in Oil and Gas Production Environments: Part I. Repassivation Potential" and "Modeling Localized Corrosion of Corrosion-Resistant Alloys in Oil and Gas Production Environments: Part II. Corrosion Potential" were authored by Andre Anderko and George Engelhardt of OLI Systems and Feng Gui, Liu Cao, and Narasi Sridhar of DNV GL. A third paper in *CORROSION* was published in 2016 by Liu Cao, et al., titled "Localized Corrosion of Corrosion-Resistant Alloys in H_2S-containing Environments," to introduce the experimental approaches and outline the entire project by applying the OLI modeling tools to a wide range of CRAs. As results of this excellent work, Liu Cao received the A.B. Campbell Award for the best paper by a young author at 2018 NACE International's CORROSION Conference.

for more Information: www.olisystems.com