Corrosion Prediction and Material Selection for Refinery Alkaline Sour Water Systems

Product Information Note

Accurately predict ammonium bisulfide corrosion across refinery units

The Predict®-SW 4.0 Corrosion Prediction Software System encapsulates inferences, experimental results, and research data from three phases of a Joint-Industry research program (JIP) sponsored by industry leading refining and engineering companies. For the first time, these research results have been commercially made available in an easy-to-use and high-value software program. This latest release incorporates data and predictive capabilities for ammonium bisulfide corrosion for all refinery applications.

The Sour Water Phase I, Phase II and Phase III JIPs developed a quantitative engineering database and decision-support model to predict corrosion in H_2S and NH_3 dominated alkaline sour water systems as a function of critical environmental parameters, such as, NH_4HS concentration, H_2S partial pressure, NH_3 partial pressure, cyanide content, temperature, hydrocarbon content, and chemical treatments integrated with characterization of multiphase flow regimes and wall shear stress. Predict-SW 4.0 is the resultant product of this extensive industry-leading research and is designed to:

- Predict corrosion rates for a wide range of applicable conditions for fourteen commonly used refinery materials, including carbon steel, stainless steels, nickel alloys (including C276 and monel)
- Analyze corrosion rates through graphically simulated inlet and outlet balanced piping networks for air coolers/heat exchangers
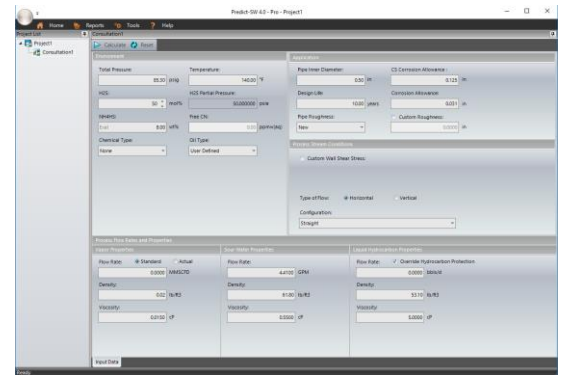

Figure 1: Predict®-SW 4.0 program input interface, showing relevant inputs required for corrosion prediction
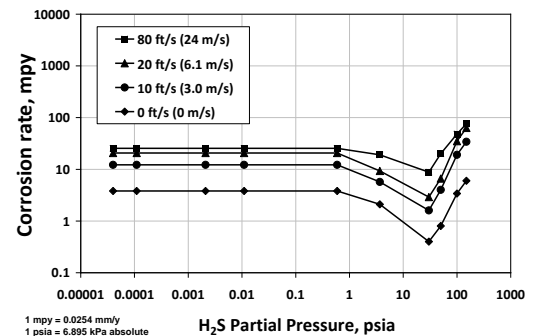

1 mpy = 0.0254 mm/y
1 psia = 6.895 kPa absolute

Figure 2: Extensive experimental data correlating corrosion rate to process parameters (*Carbon Steel, 1% NH4HS, 130 F (55 C)*)

BENEFITS

- Effectively characterize and predict corrosion rates and identify appropriate corrosion resistant material (when carbon steel is not applicable)
- Access to extensive consulting and development support from Honeywell industry experts in using/customizing Predict-SW

- Easy to use graphical interface simplifies the task of utilizing Predict-SW
- Designed to support appropriate development and implementation of Integrity Operating Windows (IOW)
- Pin-point parameters contributing to corrosion and develop effective mitigation strategies

- Easily perform analysis of complete piping systems with corrosion prediction and flow modeling for horizontal/vertical pipe sections
- Extensive on-line, in-depth technical help documentation assists the user in correlating the significance of different process parameters to corrosion rates

- Quantify corrosion in alkaline sour water systems as a function of NH_4HS concentration, velocity (wall shear stress), H_2S and NH_3 partial pressures, cyanide and other relevant process parameters
- Account for effect of light and heavy hydrocarbons
- Perform flow modeling, compute wall shear stress and analyze flow regimes in multiphase flow
- Correlate flow effects with corrosion rate based on extensive lab data and flow modeling
- Study parametric effects with Sensitivity Analysis and Multipoint Analysis tool
- Access lab-data used to support system decision-making and analyses
- Supports generation of extensive data reports, multiple case analyses and data-sharing across platforms
- Facilitates optimization of inspection programs and identification of inspection locations, as well as aiding in RBI studies
- Quantify, characterize and analyze sour water systems helping to prevent un-scheduled shutdowns

Corrosion Prediction Made Easy

Predict-SW 4.0 offers an intuitive user interface that takes little time to master and delivers results quickly. The user interface presents pertinent inputs needed to quantify corrosion in sour water systems. These inputs are the commonly available process data such as:

- Operating conditions such as pressure, temperature, H_2S and NH_4HS concentrations
- Free cyanide and chemical concentration
- Application information like pipe ID, corrosion allowance, etc.
- Process flow rates and properties for vapor, sour water and hydrocarbon
- Users can make fact-based financial and engineering decisions with real material performance data using Predict-SW

Once the input data is entered, Predict-SW 4.0 performs an in-depth analysis and generates:

- Predicted corrosion rates for applicable materials (expressed in MPY or MMPY)
- Flow induced wall shear stress
- Flow parameters such as superficial liquid velocity, superficial gas velocity etc.
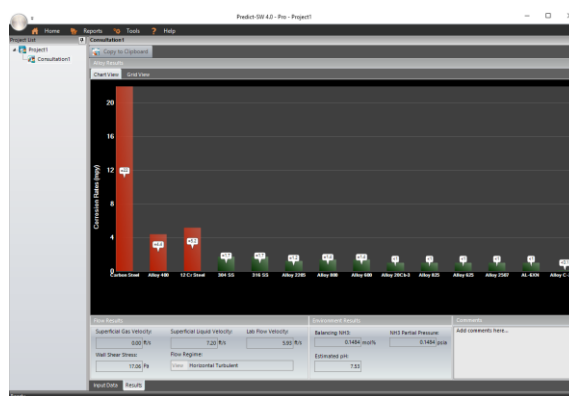- Visual flow regimes occurring in particular section of a pipe

Figure 3: Predict-SW 4.0 program output interface, showing corrosion predictions

Predict®-SW 4.0 is the only program of its kind for the refining industry correlating real experimental data to process conditions, with the ability to predict corrosion rates in alkaline sour water systems and selection of appropriate materials

Improvements with Predict-SW 4.0

The Predict-SW 4.0 software has been re-engineered to provide substantial new data, a completely revamped prediction model with greater accuracy and data from all three phases of the Sour Water JIP.

The new model provides a meaningful synthesis of the complete Phase I through Phase III data set, engineering re-analysis of the Phase II and III data trends using H_2S tie-in plots and enhanced levels of accuracy in addressing all relevant parametric effects.

Features

Predict-SW 4.0 offers the following critical functionality:

- Prediction and assessment of corrosion rates in alkaline sour water systems as a function of key process parameters
- Data for up to fourteen materials ranging from carbon steel to Alloy C-276

- A flow modeling module with updated friction factor correlation that correlates key insights into understanding contribution of typical flow-induced corrosion parameters
- Ability to accurately model momentum transfer effects (flow regimes, void fractions, pressure drops and wall shear stresses) to support improved corrosion prediction
- Support analysis of H_2S-dominated and NH_3-dominated alkaline sour systems through in-depth data and interpretation of iso-corrosion curves and tie-in plots
- Improved rules and data to account for more accurate corrosion rate predictions at very low H_2S partial pressures (<1 psia)
- Account for effects of light and heavy liquid hydrocarbons
- Ability to assess corrosion in balanced piping systems for heat exchanger inlet and outlet piping using the new three dimensional model generation and analysis tool
- Ability to incorporate effects of Free Cyanide in NH_3-dominated alkaline sour systems
- Study parametric effects with sensitivity analysis tool
- Perform Multi Point Analysis using MS Excel
- On–the-fly and secure, electronic access to actual laboratory test data and corrosion plots
- Supports generation of extensive data reports, multiple case analyses and data-sharing across platforms
- Extensive Online Help System that guides users to effectively use the software and accurately interpret program results
- Availability of Real-Time (RT) version of Predict-SW that may be easily linked to any process historian (such as Uniformance® PHD) and/or DCS to provide real time corrosion rate prediction data

Analyzing piping network with ease

State-of-the-art functionalities in graphical piping simulation have been integrated into Predict-SW 4.0 providing users the ability to map piping networks for air-cooler/heat exchanger banks. A typical piping network with straight piping and Elbows can be easily recreated in Predict-SW 4.0 and results at each location may be analyzed with the click of a button.

This tool provides users the capability to analyze the entire piping system for corrosion rate prediction including bends, elbows, weld protrusion etc. and view corrosion rates for different materials, different locations all on the same screen with ability to filter data as needed. Corrosion rates for each material and calculated wall shear stress can be further analyzed.
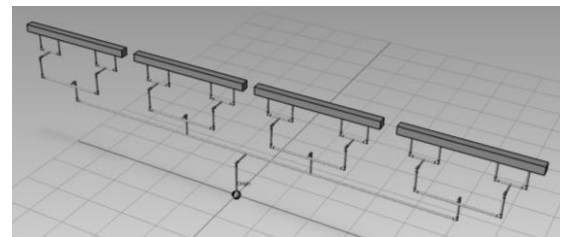

Figure 4: Predict-SW 4.0 Piping Network

Secure Access to JIP Data

Users can securely and electronically access the actual laboratory test data utilized within Predict-SW 4.0 to make predictions.
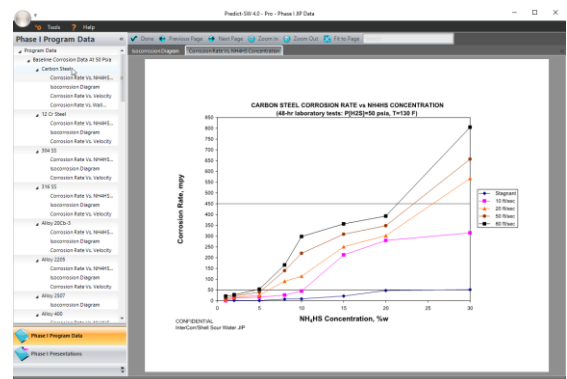

Figure 4: Predict-SW 4.0 JIP data for carbon steel

Benefits Guardianship Program

This product comes with worldwide, premium support services through Honeywell's Benefits Guardianship Program (BGP). BGP is designed to help our customers improve and extend the usage of their software applications and the benefits they deliver, ultimately maintaining and safeguarding their software investment.

Honeywell Predict® Corrosion Suite

Honeywell Predict Corrosion Suite provides next generation corrosion management solution or oil and gas and refining industries seeking to move from reacting to corrosion damage to a more proactive and effective approach, Honeywell Predict Corrosion Suite provides the next generation of corrosion management solutions. Unlike conventional corrosion management methods, we employ unique prediction models that encapsulate deep expertise and extensive process data to correlate corrosion rates to specific process units, damage mechanisms, and operating conditions. Using Honeywell's tools, global major companies have achieved significant operational and business benefits.

The Honeywell Predict Corrosion Suite is a unique solution for today's industrial facilities, driving a paradigm shift in tackling difficult corrosion problems, and enabling efficient and safe operations. These software tools help users move away from a reactive response to corrosion based on qualitative, manual inspections, to a proactive, reliability-centric predictive approach based on quantitative information from soft sensors, sound process deviation management, and "what-if" scenario analysis tools.

Why Honeywell?

Your operation can benefit from partnering with a proven leader in corrosion asset integrity and preventive/predictive corrosion management. Honeywell has extensive intellectual property in the corrosion field, including unique corrosion prediction and material selection models, and patented corrosion monitoring technology. Our deep expertise includes an in-house team of experts with decades of experience in developing corrosion solutions. Honeywell's IP-based models are licensed and used by many global oil & gas majors, and our company has a recognized track record of world-class execution of projects.

Honeywell has also established a unique corrosion knowledge community through the Corrosion Center of Excellence (COE) in Houston, TX, USA. We assist customers with expert local and remote support. Our state-of-the-art corrosion and materials research and engineering laboratory provides a host of standard and customized services. Utilized in Joint Industry Programs and custom testing, the Honeywell Corrosion Lab is a one-of-a-kind world class facility designed to accurately simulate complex experimental conditions relevant to process applications.

[1] *The original research programs were "Prediction and Assessment of Ammonium Bisulfide Corrosion Under Refinery Sour Water Service Conditions Phase I, Phase II and Phase III". The programs were conducted from March 2000 to December 2013 and were jointly sponsored by a group of refining and engineering companies, led by Honeywell corrosion scientists and modeling experts.*

For More Information

Learn more about Honeywell's Corrosion Solutions, visit
www.honeywellprocess.com/Corrosion or
contact your Honeywell Account Manager, Distributor or System Integrator.

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