

# Predict<sup>®</sup>-RT: Real Time Corrosion Prediction and Management

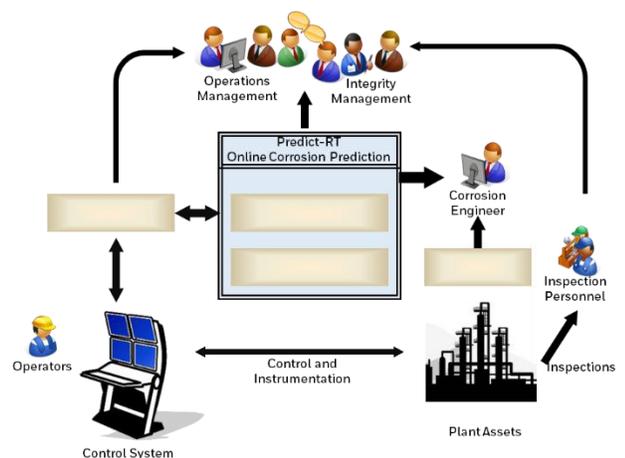
## Product Information Note

**Moving from traditional to real-time corrosion management based on online, real-time corrosion prediction and management, Predict-RT is Honeywell's framework for online corrosion rate predictions**

Traditional corrosion measurement and monitoring methods, including inspections and weight loss coupons, represent off-line, manual processes that lack the ability to capture the “present” state of criticality of a corroding system. These methods are inspection-based and rely on a reactive response. Unfortunately, once corrosion damage has occurred, it cannot be “undone” and too often the corrective actions are taken with little understanding to “when” the root cause was present.

Recent technological advances in corrosion monitoring provide operators with the ability to correlate monitored corrosion rates with changes in process variables. An important benefit of such real time monitoring is the ability to see corrosion events “as they happen” and not after the fact. As such, they enable plant personnel to make changes to operating conditions before excessive corrosion damage has been accumulated; at the moment the damage is occurring, not days or weeks after the corrosion event.

Recent advances in corrosion modeling and prediction have enabled Honeywell to develop easy-to-use and high-value software programs that provides plants an ability to predict corrosion and to select the optimum metallurgy for their units. These prediction models utilize extensive engineering data and numerical modeling to support rigorous quantification of corrosion in refineries based on multiphase flow modeling, ionic / thermodynamic/phase behavior modeling and integration with comprehensive laboratory data.



Predict-RT Framework: Making Honeywell's Corrosion Prediction Models available to everyone

## FEATURES & BENEFITS

- Intelligent Corrosion Analytics
- Pipe wall thicknesses and corrosion allowances
- Inspection and Turnaround Planning
- Identify risks by alerting you to locations where wall thickness is a concern
- Improve inspections through accurate forecasts showing when corrosion allowances will reach thresholds
- Extend asset life by identifying operating variables accelerating corrosion
- Increase revenue by safely taking advantage of opportunity crudes and showing how to manage flexible crude slates for optimized throughput.

Predictive modeling applications have been developed in the following process applications:

- Predict-SW: Sour water (NH<sub>4</sub>HS) corrosion in refinery units (hydro-processing, sour water strippers etc)
- Predict-Amine: Corrosion in Amine Units (MEA, DEA, DGA, MDEA)
- Predict-Crude: High temperature Naphthenic acid and sulfidation attack in Crude and Vacuum Distillation Units
- Predict-SAA: Corrosion in Sulfuric Acid Alkylation Units
- Predict: Corrosion of carbon steel in CO<sub>2</sub>/H<sub>2</sub>S production/transmission environments

These software applications allow engineers to quickly find the answers to difficult corrosion problems by:

- Pinpointing parameters contributing to corrosion and helping develop effective mitigation methods
- Effectively characterizing and predicting corrosion and identifying appropriate resistant material (when carbon steel is not applicable)

A complementary aspect of real-time monitoring is the availability of real-time corrosion prediction models, working in tandem with the control system and process data historian, to provide quantified corrosion rates at multiple process locations without the need to install additional corrosion monitoring devices.

These online, real time predictions represent “virtual” monitoring points that further enhance the ability of the operator to closely correlate process upset conditions to detrimental changes in system corrosion behavior.

### **Honeywell Predict-RT**

The application of Honeywell’s Corrosion Prediction Models in real-time allows operators to look at corrosion as an operating process variable. This results in dynamically updated predicted corrosion rate data as the operation conditions change. This scenario provides both maintenance and operating teams with the

capability to leverage their existing process data and see the impact of process transients on corrosion rates and long-term asset integrity.

### **Predict-RT: A Superior Approach to Solving Corrosion Issues**

For decades, corrosion engineers working in refineries have been using old methods to quantify corrosion and applying these approximate rules without accounting for complex contributions of transient operating conditions, flow dynamics and flow regimes.

Predict-RT gives refinery engineers and plant managers insight into the integrity of their assets, providing them with a real-time view of internal corrosion in piping and equipment. Combining field-proven corrosion prediction and refinery process data models, the tool provides at-a-glance visibility into cumulative corrosion damage and instantaneous rates across the plant.

With minute-by-minute quantification of corrosion, Predict-RT lets you run refinery assets more safely, more efficiently, and longer, while driving enhanced profitability:.

- Identify risks by alerting you to locations where wall thickness is a concern
- Improve inspections through accurate forecasts showing when corrosion allowances will reach thresholds
- Extend asset life by identifying operating variables accelerating corrosion
- Increase revenue by safely taking advantage of opportunity crudes and showing how to manage flexible crude slates for optimized throughput.

### **Productive and Safer Operations**

- Build corrosion intelligence from process data by using corrosion analytics
- Evaluate process data and make the right decisions on direction for process changes and minimize the impact of corrosion
- Maximize throughput while limiting corrosion and operational risk

*With minute-by-minute quantification of corrosion, Predict-RT lets you run refinery assets more safely, more efficiently, and longer, while driving enhanced profitability*

- Quickly identify high corrosion rate locations
- Identify and extend actual process operating boundaries
- Help with inspection and turnaround planning by identifying the dates where critical thicknesses will be reached.
- Instantly compare corrosion rates for multiple alloys
- Identify locations for real-time monitoring
- Promote collaboration and data sharing between Maintenance and Operations teams
- Extend equipment life and increase reliability and availability
- Integrate operational data into Maintenance and Inspection planning

The screenshot shows a dashboard with a sidebar on the left containing navigation options: DASHBOARD, REAL TIME STATUS, ALLOWANCES, THICKNESSES, and INSPECTION PLANNING. The main content area is titled 'CURRENT REAL TIME STATUS' and displays a summary for a 'Refinery' unit with 28 points and 3 exceptions. Below this is a 'CURRENT EXCEPTIONS' table.

Unit	Entity Name	Corrosion Rate	Corrosion Rate Limit	In Exception Since
03CDU	03CDUCFD1	1.0600 (mmpy) <span style="color: red;">■</span>	1.0000 (mmpy)	02-26-2017
03CDU	03CDUWCD4	1.5200 (mmpy) <span style="color: red;">■</span>	1.0000 (mmpy)	01-19-2017
03CDU	03CDUCFD2	1.1700 (mmpy) <span style="color: red;">■</span>	1.0000 (mmpy)	01-10-2017

Predict-RT Dashboard: Helps engineers quickly identify problem areas

## Predict-RT Features

### Predict-RT: Intelligent Corrosion Analytics

#### Corrosion Rates

Our corrosion models use commonly available process variables such as pressure, temperature, flow rates and much more. All refineries have control systems with numerous pressures, temperatures and flow rates amongst others: all Predict-RT is doing is adding intelligent analytics to the data you already have available at the refinery. This allows you get updated corrosion rate data in real time.

#### Pipe Wall Thicknesses and Corrosion Allowances

Since corrosion damage is the integrated sum of corrosion rate over time, wall thicknesses and corrosion allowances can be tracked between your inspections.

Pipe wall thicknesses and corrosion allowances are updated on a daily basis. Never before were you able to assess today's asset integrity without the need for additional inspections or costly instrumentation.

#### Inspection and Turnaround Planning

Look into the future and identify when corrosion allowances or wall thicknesses reach critical thresholds: Using corrosion rates based on the latest operating data, relevant insight on when critical risk levels are reached are available to the inspection and turnaround planning teams. This forecasting allows:

- Early mitigation steps to be enacted in order to successfully extend asset life
- Inspections schedules to be updated to address high-risk areas
- Maintenance work to be planned and executed so that operations can be sustained until the next turnaround
- Identified high-risk areas to be included in the work scheduled for the next turnaround

## Predict-RT: Corrosion Prediction Modules

### Predict -SW-RT

Refinery sour water corrosion problems and failures may manifest in multiple units, including hydrotreaters and hydrocrackers, as well as sour water strippers and FCCU units.

Predict-SW-RT uses the offline Corrosion Prediction Software Predict-SW 3.1. This Software System encapsulates inferences, experimental results, and research data from two phases of a Joint-Industry Program (JIP) sponsored by industry-leading refining and engineering companies. For the first time, these research results have been made available in an easy-to-use, high-value, real-time online corrosion rate prediction program. This latest release incorporates data and predictive capabilities for both NH<sub>3</sub> and H<sub>2</sub>S dominated conditions.

Predict-SW-RT uses these inputs either as commonly available process data or as design parameters:

- Operating conditions such as pressure, temperature and H<sub>2</sub>S, NH<sub>3</sub> and NH<sub>4</sub>HS concentrations
- Cyanide concentration and chemical concentration
- Application information like pipe ID, corrosion allowance, etc
- Process flow rates and properties including vapor, sour water and hydrocarbon properties

*The application of Honeywell's Corrosion Prediction Models in real-time allows operators to look at corrosion as an operating process variable. This results in dynamically updated predicted corrosion rate data as the operation conditions change. This scenario provides both maintenance and operating teams with the capability to leverage their existing process data and see the impact of process transients on corrosion rates and long-term asset integrity.*

Based on this information, Predict-SW-RT generates:

- Predicted corrosion rate for 14 materials (expressed in MPY or MMPY)
- Flow induced wall shear stress
- Flow parameters such as superficial liquid velocity, superficial gas velocity etc

For more information on Predict-SW 3.1, refer to the product information note.

### Predict-Amine-RT

Predict-Amine-RT uses the offline Corrosion Prediction Software Predict-Amine 4.0. This software system encapsulates inferences, experimental results, and research data from the JIP initiative. It incorporates data and predictive capabilities for various Amine solvents (MEA, DGA, DEA and MDEA) commonly used in the refining and gas processing industries.

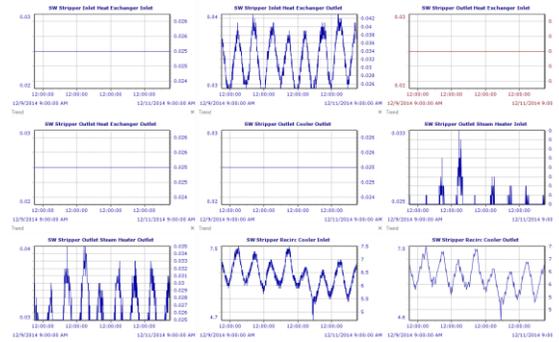
Predict-Amine-RT uses these inputs either as commonly available process data or as design parameters:

- Operating conditions such as pressure, temperature, type of solvent, etc
- Amine type and gas loadings for CO<sub>2</sub> and H<sub>2</sub>S
- Application information such as pipe ID, corrosion allowance, etc
- Process flow rates and properties including vapor and liquid amine properties

Based on this information, Predict-Amine-RT generates:

- Predicted corrosion rate for six materials (expressed in MPY or MMPY)
- Flow induced wall shear stress
- Flow parameters such as superficial liquid velocity, superficial gas velocity, etc.

For more information on Predict-Amine 4.0, refer to the Product Information Note.



### Predict-Crude-RT

Naphthenic acid and sulfidic corrosion (termed crude corrosivity) in crude refining are key corrosion mechanisms contributing to asset degradation and failure in the atmospheric distillation unit, vacuum distillation unit, transfer lines, and side cut piping. Accurate quantification of corrosion due to these factors is critical to safe crude unit operations and gives refiners the ability to work with opportunity crudes with confidence and safety.

Predict-Crude-RT uses the offline Corrosion Prediction Software Predict-Crude® 2.0. This software system encapsulates inferences, experimental results, and research data from JIP. This four-year research program resulted in the development of a quantitative engineering database and decision-support model to predict crude corrosivity in naphthenic acid and sulfidic dominated systems, as a function of critical environmental parameters Total Acid Number/Naphthenic Acid Titrant (TAN/NAT), sulfur (H<sub>2</sub>S) content, temperature, hydrocarbon content, flow regimes and wall shear stress.

Predict-Crude-RT uses the pertinent inputs needed to quantify crude corrosivity for CDU or VDU side cut piping. These inputs are the commonly available environmental and operating factors such as:

- Naphthenic acid content and H<sub>2</sub>S level (active sulfur) – from crude assay
- Pressure, temperature and stream information

Predict-Crude-RT generates:

- Predicted corrosion rate for eight materials (expressed in MPY or MMPY)
- Flow results (flow regime and wall shear stress)
- Dominant corrosion mechanism (Naphthenic, Sulfidic or Mixed)

For more information on Predict-Crude 2.0, refer to the Product Information Note.

### **Predict –O&G–RT**

CO<sub>2</sub> and H<sub>2</sub>S corrosion (termed acid gas corrosion) in oil and gas production environments are key contributors to asset degradation and failure.

Predict-O&G-RT captures the effects of key critical environmental and operating parameters that influence corrosivity and characterize their effects on corrosion rates, utilizing extensive laboratory data, phase behavior models and fluid dynamic characterization.

Predict-O&G-RT uses pertinent inputs needed to quantify the relevant production or transmission environment. These inputs are the commonly available environmental and operating factors such as:

- Application or process data (pressure, temperature, gas oil and water flow rates)
- Speciation data (acid gas concentration and water analyses)
- Project data (service life, corrosion allowance, well or stream information)

Predict-O&G-RT outputs the following corrosion and water characteristics:

- Predicted corrosion rate, expressed in mpy or mmpy
- Pitting probability
- In-situ pH
- Computed system dew point and water phase distribution
- Quantification of liquid water
- Scaling products and saturation pH

For more information on Predict, refer to the product information note.

### **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 for 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 our Center of Excellence (COE). 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 tailored services. Utilized in Joint Industry Programs and customized testing, this facility can simulate any service environment.

## For More Information

Learn more about Honeywell's Corrosion Solutions, visit [www.honeywellprocess.com/Corrosion](http://www.honeywellprocess.com/Corrosion) or contact your Honeywell Account Manager, Distributor or System Integrator.

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