

Predict[®]-Pipe: Assessment of Internal Corrosion in Pipeline Systems

Product Information Note

Predict[®]-Pipe 5.0 is the latest release of the industry-leading pipeline corrosion evaluation software suite designed to accurately quantify corrosion in natural gas and liquid petroleum pipeline systems.

Predict[®]-Pipe is the latest release of the industry-leading pipeline corrosion evaluation software, enabling easy and accurate Internal Corrosion Direct Assessment of Dry Gas (DG-ICDA), Wet Gas (WG-ICDA) and Liquid Petroleum (LP-ICDA) pipelines exposed to corrosive environments due to water or solids accumulation. Predict-Pipe incorporates Honeywell's latest Predict[®] Internal Corrosion Predictive Model (ICPM) technology, and bundles new features including an updated user interface.

Predict-Pipe addresses the most significant issues in pipeline corrosion management:

- **Identification of segments** with propensity for water hold up and associated corrosion quantification in dry gas transmission pipeline systems that are exposed to corrosive environments due to water condensation / accumulation (DG-ICDA)
- **Assessment of corrosion rates** in onshore and offshore wet gas pipelines and other piping systems that normally carry natural gas with condensed water, or with water and liquid hydrocarbons (WG-ICDA).
- **Identification of segments** where solids and/or water tend to accumulate and quantification of associated corrosion at such locations in liquid petroleum pipelines (LP-ICDA)



Predict-Pipe: Pipeline Corrosion Results Summary for Wet Gas Internal Corrosion Direct Assessment

FEATURES & BENEFITS

- Dry-Gas ICDA module to model natural gas pipeline systems carrying dry gas
- Enable line assessments where alternative methods (Inline Inspection, hydrotesting) may be impractical
- Wet-Gas ICDA module to model natural gas pipeline systems carrying wet gas, that may often contain produced or condensed water
- Accurately identify critical segments with potential for corrosion damage
- Liquid-Petroleum ICDA module to model pipeline systems carrying liquid petroleum, that may contain produced or condensed water as well as suspended solids
- Facilitate detailed examination of pipelines through appropriate identification of assessment sites
- Realize significant savings in inspecting and managing transmission pipelines
- Implement proactive corrosion management systems to prevent potential for failure

Dry Gas Internal Corrosion Direct Assessment (DG-ICDA): NACE SP0206

Dry Gas Internal Corrosion Direct Assessment (DG-ICDA), is an industry-standard methodology designed to provide preventive maintenance and protect against costly pipeline failures.

Gas transmission pipelines under normal operating conditions carry under-saturated gas processed by upstream dehydrating units. These pipelines are generally operated with no protection or inhibition and rely on the performance of the dehydrating units to process gas within acceptable standards. It is typical for some instability or other process disturbances to result in near saturated gas or have some liquid water carryover in such pipelines. These upsets lead to water accumulation in some parts of the pipeline farther downstream, or cause water condensation due to pressure and temperature changes along the length of the pipeline.

Wet Gas Internal Corrosion Direct Assessment (WG-ICDA): NACE SP0110

Wet Gas Internal Corrosion Direct Assessment (WG-ICDA) is a structured process that combines pre-assessment, indirect inspection, detailed examination, and post-assessment to evaluate pipeline integrity threats as a result of internal corrosion.

The goal of WG-ICDA is to identify locations with the greatest likelihood of internal corrosion, due to factors such as water content, flow regime, liquid holdup, and temperature and pressure changes. Predict-Pipe automates the indirect inspection step of WG-ICDA as per NACE Standard Practice Document SP0110,

Predict-Pipe identifies the most probable locations (MPLs) along a WG-ICDA region to determine the position of assessment sites. These assessment sites are selected where internal corrosion damage has been identified through:

- available historical information
- flow modeling to determine liquid holdup
- flow regimes, and
- Internal Corrosion Predictive Models (ICPMs) to evaluate internal corrosion rates.

Liquid Petroleum Internal Corrosion Direct Assessment (LP-ICDA): NACE SP0208

Liquid Petroleum Internal Corrosion Direct Assessment (LP-ICDA) is a structured process that combines pre-assessment, indirect inspection, detailed examination, and post-assessment to evaluate pipeline integrity threats as a result of internal corrosion.

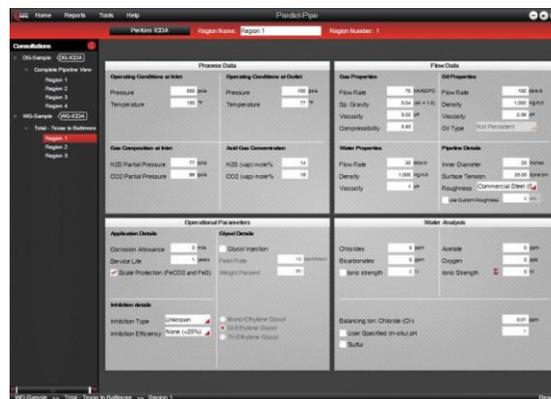
The goal of LP-ICDA is to identify locations with the greatest likelihood of internal corrosion. Predict-Pipe automates the indirect inspection step of LP-ICDA as per NACE Standard Practice Document SP0208,

Predict-Pipe identifies the most probable locations (MPLs) along a LP-ICDA region to determine the position of assessment sites. These assessment sites are selected where internal corrosion damage has been identified through:

- available historical information
- flow modeling to determine flow regimes and liquid water holdup
- water accumulation and solids deposition,
- Internal Corrosion Predictive Models (ICPMs)

Corrosion Prediction Made Easy

Predict-Pipe offers an intuitive user interface that takes little time to master and delivers results quickly. In a simplified manner, the user interface requests the required inputs needed to identify and quantify corrosion in the relevant pipeline environment.



A typical WG-ICDA region input screen in Predict-Pipe

These inputs include 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)

Once the input data are entered, Predict-Pipe provides valuable results to support pipeline analyses and inspection:

- predicted corrosion rate profile, across a pipeline segment
- computed system dew point and water phase distribution
- quantification of liquid water hold up
- Key parametric factors driving water retention and corrosion

In addition, a multiphase Flow Model enables the user to evaluate the effects of flow occurring in a particular section of a pipe. The Flow Modeling feature takes into account inclined flows for both uphill and downhill flow, and then calculates a two-phase Reynolds Number, a friction factor, and accounts for effects of liquid hold-up and wall shear stress on predicted corrosion rates.

Predict-Pipe incorporates both the environmental (electro- chemical) and fluid dynamic parametric effects on corrosion.

Distance (ft)	Corrosion Rate (mpy)	Liquid Holdup (ft)	Wall Loss (%)	Segment Classification
0	76.83	387.75	1.26	737.80
108.75	76.43	391.64	1.21	808.30
Average			1.24	807.96
207.50	76.5	401.38		Yes
424.02	76.65	442.25	4.87	808.60
433.25	72.96	442.95	4.82	808.60
542.81	73.84	449.82	0.94	808.60
545.58	75	449.55	1.36	808.60
594.4	73.82	447.48	4.86	808.60
791.75	72.22	442.22	0.76	808.60
868.64	72.21	439.14	4.86	808.60
961.9	72.9	424.68	4.86	808.60
1098.31	74.82	401.24	4.86	808.60
1192.86	72.21	474.13	4.86	808.60
1214.09	71.68	349.24	4.86	808.60
1433.16	72.81	329.69	4.86	808.60
1638.35	72.27	339.81	4.86	808.60
1843.62	72.26	336.92	4.76	807.22

WG-ICDA assessment site pre-selection summary table

New Enhancements for Predict-Pipe

With the latest release of Predict-Pipe makes identification of critical segments and corrosion prediction even easier with the following enhancements:

- New Liquid-Petroleum ICDA module to model on-shore and off-shore pipeline systems carrying liquid petroleum,

Features

- Predict-Pipe provides an advanced modeling system to identify pipeline segments where corrosion severity is the highest. This is achieved by integrating multi-phase flow modeling with advanced corrosion prediction from Predict model. This enables informed financial and engineering decisions built on real material performance data. Predict-Pipe offers several unique attributes:
- rigorous water phase behavior calculations coupled with the ability to account for the effects of glycol (MEG, TEG and DEG)
- ability to accurately model momentum transfer effects (flow regimes, void fractions, pressure drops and shear stresses)
- ability to accurately determine scaling effects due to formation of iron carbonate and iron sulfide scales as a function of temperature and pH
- improved rules to account for variation of water content in oil and gas systems (production and transmission)

Building a NACE Compliant Work Process for Internal Corrosion Direct Assessment

Utilization of an advanced ICDA tool such as Predict-Pipe promotes a company or site to evaluate corrosion problems consistently and with high accuracy and repeatability. Predict-Pipe is built upon a framework of standard industry practices (NACE SP0206, SP0110, SP0208) and an-depth, comprehensive foundation of corrosion data / knowledge, including proprietary data from hundreds of laboratory tests that constituted a Joint Industry Project (JIP) on Multiphase CO₂/H₂S corrosion, extensive literature information, accurate multiphase flow modeling and the industry's most comprehensive database on steel corrosion rates.

Segments	Pipeline Length (Kcs)	Low Wall Loss < 20%	Moderate Wall Loss 21-40%	High Wall Loss 41-60%	Severe Wall Loss > 60%	Minimum Number of Final Assessment Sites per Pipeline Segment
Available for Selection	2,699	15	4	6	55	80
Required as per Table 3 from NACE Paper	0.1 - 10	1	1	1	1	4
Actually selected sites	2,699	0	0	0	5	5

Final assessment sites NACE SP0110 compliance validation

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 or contact your Honeywell Account Manager, Distributor or System Integrator.

Honeywell Process Solutions

1250 West Sam Houston Parkway South
Houston, TX 77042

Honeywell House, Skimped Hill Lane Bracknell,
Berkshire, England RG12 1EB UK

Building #1, 555 Huanke Road, Zhangjiang Hi-Tech Industrial Park, Pudong New Area, Shanghai 201203

www.honeywellprocess.com/corrosion
predict@honeywell.com

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