

Arrogate Defender™

NACE Testing of Proven Internal & External Coatings



The oil and gas industry has worked to protect oilfield equipment from the different operational environments for safety and environment for both the operator and the service provider, and to improve longevity of CAPEX equipment and rental equipment. Huge strides have been made over the past 2-3 decades in equipment grades, strengths, connections, and protective coatings.

Plastic and epoxy coatings have been applied to the internal diameter of tubing and drill pipe over this time period as a protection from corrosion. With more than 20 years of global service, TK-34XT™ liquid epoxy coatings have proven to be a very reliable product for drilling, completion, fracking, acid stimulation, and high temperature (in excess of 400 °F) applications. It has been the standard for drill pipe, completion pipe, and work strings for the past 20 years.

Tubular coatings for the external diameter to mitigate corrosion have been more challenging for the industry due to durability during operations, flexibility for inspection, and cost drivers. Black Diamond has introduced an external coating, Arrogate Defender™, which has met these challenges for the industry and has saved significant cost, time, and tubular life with no operational issues.

TK-34XT™ internal coating is normally applied a single time after the pipe manufacturing process. Arrogate Defender™ external coating is to the external surface after minimal surface preparation. It requires no sandblasting before application can be applied directly to rust after the removal of loose material. The coating is applied with an airless spray system providing a complete and uniform coverage. The external coating is reapplied between deployments.

Arrogate Defender™ was engineered to withstand acids, salts and caustics without any loss in strength. Its exceptional toughness, UV resistance and moisture penetration resistance result in unparalleled performance in the toughest environments and operations.

As the industry explores new areas and further develops existing fields, H₂S has become more prominent in the design parameters. In existing fields where water flooding has created a mild presence of H₂S, this can still pose a challenge for equipment and even for permitting the projects. In exploration areas having increased levels of H₂S or CO₂ has always been very challenging for equipment, safety, as well as regulatory. The common internal coatings such as TK-34XT™ have never been declared as sour service protection especially because it is not always declared "new condition". Although relatively new to the industry Arrogate Defender™ has a proven record in sour service environments.

The major goal when operating in a sour service environment is to control the environment so there is no, or minimal, contact of the equipment with wellbore fluids containing H₂S or CO₂. It is often a challenge to control the grade of all equipment in service to the level of protection (or design). High concentrations of H₂S with increased exposure time will cause an issue with any grade of metal. As the internal and external coatings are not a perfect shield for the tubulars, they are a barrier. Especially in a mild sour service environment, Region 1 or Region 2, where higher grade tubulars could be deployed with applied internal and external coatings and the environment controlled. Posed with this challenge, NACE testing has been completed on TK-34XT™ internal coating and Arrogate Defender™ external coating to prove performance in sour service environments.

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Tests

Two tests were conducted per NACE TM0177-2016 Method A tensile test to determine the sulfide stress cracking (SSC) resistance of various steel samples coated and uncoated. The pipe manufacturer's standard vendors for test sample preparation and NACE testing were used for this project. NACE samples were prepared from the weld area of V-150 grade pipe. The weld area seems to be of most concern among operators and the NACE samples would include 135ksi tool joint, 150ksi pipe, and HAZ areas. Solution D was chosen for Test #1 which is defined as 7% H₂S and 80% stress level for 720 hours of exposure. For Test #2, solution A with a 100% concentration of H₂S and 80% stress level for 720 hours of exposure time was chosen. Test #2 also include samples with scratched TK-34XT™ to resemble wire line scrapes on IPC and abraded Arrogate Defender™ samples to resemble wore down/used coated tubulars.

7% H ₂ S Test Results				
Specimen	Type of Coating	Stress Level (ksi)	Result	Hours at Failure
1	Uncoated	96	Failed	123.6
2			Passed	N/A
3			Failed	328.8
4	Arrogate Defender™	96	Passed	N/A
5			Passed	N/A
6			Passed	N/A
7	TK-34XT™	96	Passed	N/A
8			Passed	N/A
9			Passed	N/A

100% H ₂ S Test Results				
Specimen	Type of Coating	Stress Level (ksi)	Result	Hours at Failure
1	Uncoated	96	Failed	209.7
2			Failed	186.1
3			Failed	235.7
4	TK-34XT™	96	Passed	N/A
5			Passed	N/A
6			Passed	N/A
7	Arrogate Defender™	96	Passed	N/A
8			Passed	N/A
9			Passed	N/A
4	Scratched TK-34XT™	96	Passed	N/A
5			Passed	N/A
6			Passed	N/A
7	Abraded Arrogate Defender™	96	Passed	N/A
8			Passed	N/A
9			Passed	N/A

Conclusion

This testing is positive for the coatings in that all Arrogate Defender™ and all TK-34XT™ samples passed even when scratched or abraded. These results show that the coatings create a barrier to the metal. For sour service environments, possibly Region 1 and Region 2, the coatings could be beneficial for deploying higher grade tubulars for operations, especially in conditions where higher strength tubulars are required, and no sour service options are readily available. This can lower the total cost of ownership for both operator and service provider by using available tubulars with proper coating.

These coatings have proven themselves extremely successfully as barriers to corrosion in standard environments of salt-based fluids from seawater to heavy completion fluids with no additional chemicals. With the benefit of both the internal and external proven coatings, the testing demonstrates benefits as a barrier when exposed to a sour service environment. When the environment is controlled by pH and scavengers, the potential for improved mitigation is increased.

Note: The coating manufacturers are not promoting these coatings as sour service products. There will always be imperfections in the coating process and imperfections due to normal handling and operations. The operator must always evaluate the risk in these environments. The testing will benefit the operator in developing the risk analysis.