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PORTER R. RITCHIE, M.S., P.E.
SENIOR STAFF CONSULTANT

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Mr. Porter Ritchie is a Senior Staff Consultant for ESi. Mr. Ritchie has over nine years of experience in failure analysis, metallurgy, and materials characterization. As a licensed metallurgical engineer within the energy industry, Mr. Ritchie has evaluated metallurgical issues involving pipeline infrastructure, refining equipment, and wind turbines.

Mr. Ritchie is skilled at using both nondestructive and destructive examination techniques to distinguish between various failure mechanisms such as corrosion, fatigue, stress corrosion cracking (SCC), hydrogen assisted cold cracking (HACC), and brittle or ductile overload. Additionally, he has experience with several characterization methods including magnetic particle testing, fractography, metallography, optical microscopy, electrochemical testing, and hardness mapping.

Mr. Ritchie holds a Master of Science in Materials Science and Engineering from Ohio State University. His graduate studies focused on materials degradation and weld metallurgy, specifically on the preferential corrosion of pipeline seam welds. His research contributed significantly to the understanding of selective seam weld corrosion (SSWC) of pipelines.

Areas of Specialization

Failure Analysis
Materials Technology, Characterization, and Selection
Pipelines and Pressure Vessels
Welding Metallurgy
Fractography
Laboratory Services
Manufacturing
Corrosion
Mechanical Properties and Testing

Education

M.S., Materials Science and Engineering, Ohio State University, 2020
B.S., Materials Science and Engineering, Ohio State University, 2014

Licensed Professional Engineer (P.E.)
State of Ohio..... License No. PE.87550

Professional Affiliations/Honors

Failure Analysis Society, an affiliate society of ASM International

Founding Member, 2016–present

ASM International

Member
Columbus, Ohio Chapter Treasurer (2015-2016)

Positions Held

ESi - Engineering Systems Inc., Seattle, Washington

Senior Staff Consultant, 2023–present

DNV, Dublin, Ohio

Senior Engineer, 2014-2023

Selected Project Experience

Weld Cracking on Fuel Storage Tank Bottom

Several cracks were identified on the floor of a recently constructed tank in bunker fuel and No. 2 fuel oil service. An investigation was performed to determine the cause of the cracks. Nondestructive examination identified interlinking cracks adjacent to floor plate welds oriented both parallel and transverse to the welds. A fractographic examination of the crack surfaces using a scanning electron microscope revealed intergranular fracture features. The analysis determined the overall morphology of the cracks was consistent with environmentally assisted cracking. The environment responsible for the cracking was not identified, but methanol, which is used as a drying agent, and ethanol, which is commonly blended with fuels, can produce intergranular cracking of carbon steels.

Welding Procedure Qualification

Material testing was performed of girth welds as part of the qualification of a new shielded metal arc weld (SMAW) procedure to determine the extent of heat affected zone (HAZ) softening. Hardness mapping was performed on weld samples to characterize the relative differences in hardness across the weld metal, HAZ, and line pipe (base metal) materials determining the presence of HAZ softening. Additional analysis of the hardness data was performed to demonstrate the expected strengthening effect of the weld reinforcements.

Well Casing Failure During Construction

A well casing failed at a collar while in wet-sour natural gas service at an underground storage facility during the installation of a drip at the wellhead. The failure occurred at tapered threads on the well casing where the thickness of the casing was reduced. A material analysis determined the casing failed as a result of ductile overload from an applied bending force or longitudinal force. A finite element analysis was performed that showed the amount of force used to align the piping at the tie-in location induced adequate stress at the failure origin to cause the piping to fail. A review of the casing collar design was performed, and welding of the casing collar to the casing of the other wells at the facility was recommended as possible mitigation.

Leak on Hydrogen Pipeline

A pipeline transporting hydrogen leaked while in service. An investigation was performed to determine the cause of the failure. A through-wall feature was observed at the bond line of the longitudinal seam weld during metallographic examination. Optical and scanning electron microscope examination determined the feature consisted of a lack of fusion defect that formed during manufacturing due to insufficient heat or welding pressure. Mechanical property testing of the failed pipe section confirmed that it was consistent with the materials test report values.

Rupture on Natural Gas Gathering Line

A pipeline transporting natural gas ruptured while in service. An investigation was performed to determine the cause of the failure. Colonies of inside diameter surface-breaking cracks were observed along the bottom of the failed pipe section. The failure occurred directly downstream of an interchange used to inject chemical treatments into the product stream. A review of the geography near the failure location revealed the rupture occurred at a local low spot on the pipeline where the chemical treatments may have collected. It was determined that the rupture initiated at a colony of environmentally assisted cracks consistent with stress-corrosion cracking (SCC).

Leak on Natural Gas Liquids Pipeline

A pipeline transporting natural gas liquids (NGL) leaked while in service. An investigation was performed to determine the cause of the failure. A material analysis determined the leak occurred at a repair weld due to ductile overload of a pre-existing feature. The morphology of the feature was consistent with a weld imperfection produced at elevated temperature, and HACC of the weld heat affected zone.

Damage of Underwater Pipeline Support

A pipeline located along the bottom of a lake sustained damage to a support anchoring the pipeline to the lakebed. Examination of witness marks indicated the support had been struck by a wire anchor cable of a passing boat. A scanning electron microscope (SEM) was utilized to determine the directionality of the witness marks. The direction of the witness marks in conjunction with boat GPS data was used to determine the boat responsible for the damage.

Gasoline Leak After Pipeline Repair

A pipeline in gasoline service leaked shortly after the installation of a non-pressure containing repair sleeve. The repair sleeve was installed over a dent and girth weld. A failure analysis was performed to determine the cause of the leak. A material analysis determined the leak feature initiated as HACC that formed during the construction of the pipeline and transitioned to overload failure after the installation of the sleeve. The investigation determined that the repair sleeve imparted a bending stress on the girth weld at the location of the HACC resulting in overload failure.

Tank Header Elbow Leak

An austenitic stainless steel pipe elbow leaked while in cryogenic propane service. A materials failure analysis performed on the steel elbow determined a fatigue crack initiated at a notch on the inside diameter surface at the root of the longitudinal seam weld and propagated through-wall.

Heat Exchanger Failure

A tube from a heat exchanger failed while in sour gas service. A materials failure analysis determined the failure occurred as a result of fatigue cracking that initiated at the inside diameter surface of the tube at the root of a fin.

Pig Trap Failure

A pig trap leaked while in ethane service. A pressure test determined the leak was located at the seal between the end closure and the body of the pig trap assembly. Further analysis determined the leak occurred due to an O-ring failure. Optical and microscopic examination determined the O-ring failed as a result of mechanical damage from pinching that occurred during installation.

Hydrotest Leak at Girth Weld

A girth weld leaked during hydrostatic pressure testing of a pipeline. A materials failure analysis was performed to determine the cause of the leak. An inside diameter surface-breaking crack was observed in the girth weld metal. Metallographic analysis and energy dispersive spectroscopy using a scanning electron microscope determined the crack was consistent with liquation cracking due to copper contamination of the weld metal. The remaining ligament of the girth weld metal failed due to ductile overload.

Floating Roof Pontoon Corrosion

Corrosion was observed on aluminum alloy pontoons removed from a floating roof cone of an ethanol storage tank. A materials analysis determined the corrosion consisted of pitting on the bottom of the pontoons.

Publications/Presentations

"Ice Ice or Under Pressure? Mothballed Pipeline Failure," P. Ritchie, G. Quickel, *ASM Journal of Failure Analysis and Prevention, Volume 19,* (August 2019)

"Frozen? Mothballs on Ice," P.R. Ritchie, presented at Materials Science & Technology 2017, October 9-12, 2017, Pittsburgh, Pennsylvania

"Welder's Regret: Failure Analysis of Cracks Under a Fillet Weld," P.R. Ritchie, presented at Materials Science & Technology 2016, October 24-26, 2016, Salt Lake City, Utah

Master's Thesis: Susceptibility of ERW Line Pipe to Selective Seam Weld Corrosion (SSWC), May 2020