

A Materials Technology Institute Publication



CONNECT

2024, ISSUE 2

GLOBAL CHALLENGES / TRUSTED SOLUTIONS

EVALUATION AND PREVENTION OF HAZ GRAIN BOUNDARY LIQUATION CRACKING IN ALLOY 800H FORGINGS

Page 10

CONNECT

Inside This Issue



- 3** MTI Classic Giveaway
- 4** Nominate or Apply for MTI 2024 Honors
- 5** Leadership Perspective
- 6** MTI Gains Three Supplier Members
- 10** Evaluation and Prevention of HAZ Grain Boundary Liquefaction Cracking in Alloy 800H Forgings
- 17** AsiaTAC/JSCE Joint Meeting a Success
- 18** EuroTAC Spring Meeting Highlights Technical Collaboration
- 20** MTI Visits the "Mile High City" for June AmeriTAC, Roundtable
- 22** Corrosion Data Collection – Nickel Alloys, Phase II
- 24** MTI eLearning Course
- 26** Sanicro® 35 – A Super Austenitic Material Solution for Petroleum Refining, Chemical Process Industry, and Renewable Diesel Production
- 33** HTHA Project Series Produces Final Reports and Guideline
- 34** Project Champions Spotlight
- 40** Applications for the 2025 MTI Scholarships Open September 1

ABOUT THIS PUBLICATION:

MTI CONNECT is published by the Materials Technology Institute, Inc. (MTI). MTI is a unique, cooperative research and development organization representing private industry. Its objective is to conduct generic, non-proprietary studies of a practical nature on the selection, design, fabrication, testing, inspection, and performance of materials and equipment used in the process industries.

The contents of articles and any opinions expressed therein are those of the authors and do not represent those of MTI. Any products and/or services advertised in this publication carry no real or implied endorsement or recommendation by MTI.

Copyright © 2024 Materials Technology Institute, Inc. All rights reserved.

CONTACT MTI:

1001 Craig Road, Suite 490
St. Louis, MO 63146
T: +1 314.567.4111
mtiadmin@mti-global.org
www.mti-global.org

MTI CONNECT EDITORIAL BOARD:

Heather Allain, MTI
Mike Anderson, Suncor
David Barber, Dow
Kevin Ganschow, MTI
Curtis Huddle, Eastman Chemical
Byron Keelin, MTI
Michael Krauss, Agru
Maria Jose Landeira Oestergaard, Topsoe
Daniel Rasmussen, MTI
Kirk Richardson, MTI
Maurice Wadley, DuPont
Editor: Lindsey Skinner, MTI

SUBSCRIPTIONS:

For a free subscription, visit
www.mti-global.org/about/connect-magazine.

CALENDAR OF EVENTS:

AsiaTAC Fall Meeting Corrosion Testing/Monitoring Training

September 23–25, 2024
Hangzhou, China

AmeriTAC 145 Heat Exchanger Fabrication Roundtable

October 21–23, 2024
Tulsa, OK

EuroTAC Fall Meeting

November 18–20, 2024
Amsterdam, The Netherlands

MTI CLASSIC SWEEPSTAKES

MTI publications are valuable processing industry resources. In this issue of CONNECT, we are excited to offer a chance to win a copy of *Reliability Guidelines for Flexible Hoses*!

The *Reliability Guidelines for Flexible Hoses* describes the life cycle best practices for maintaining and improving the reliability and safety of flexible chemical process hose applications. The focus of these Guidelines is on a hose management program that encompasses Mechanical Integrity and Quality Assurance (MIQA) principles for hose applications, such as establishing and documenting the design basis for a hose, procurement practices including auditing of suppliers, tagging and labelling, inspection/replacement decision making, in-service inspection and testing, and common failure modes, to name a few examples.

While references relevant to design, fabrication, installation and

handling exist in supplier catalogs, ensuring reliable hose purchasing and applications is difficult with the lack of consensus industry standards available. This guideline references some of the available codes and documents, and attempts to provide a comprehensive overview for hose procurement, installation and maintenance.

The extent of implementation of these principles should be defined by the user based on the criticality of the hose application. Experience has demonstrated that a uniform implementation of these best practices in an operating facility for all hose applications results in an effective hose management program, and less chance for omitting an important program element. Examples of such applications are loading/unloading and transfer hoses, jumper hoses

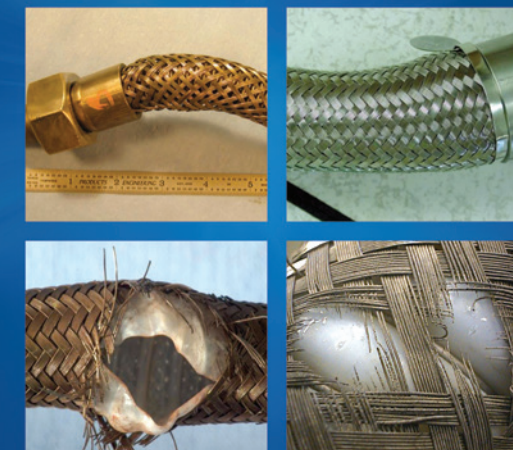
in process installations, laboratory and bottle hoses, hoses used as permanent installations that are not considered expansion joints, and to some extent, utility hoses.

Scan the QR code or use the link (<https://forms.office.com/r/kV8RbUjhnz>) to enter to win this issue's sweepstakes. The form is open through October 25. One winner will be selected at random from those entered and notified by October 31. ■



MTI Materials Technology Institute

Reliability Guidelines for Flexible Hoses



Steven P. Springer

NOMINATE OR APPLY FOR MTI 2024 HONORS

ONLINE AWARD FORMS DUE SEPTEMBER 20

MTI annually recognizes member companies and individuals who demonstrate accomplished leadership, participation and industry expertise within our membership through the MTI Awards. Please consider submitting award nominations to recognize others and/or a value award application to be recognized with these prestigious honors at the 2024 MTI Awards Banquet!

THE DISTINGUISHED SERVICE AWARD

This award recognizes distinguished service by members with more than five years' service at MTI. Examples of the types of service that warrant nomination include:

- Significant ongoing contributions to the success of a PDC or project.
- Significant ongoing contributions to a BOD Committee.
- Significant activity and support of MTI member resources, such as ongoing contributions to the TAC forum, TAC Meetings or project teams.
- Successful academic outreach, such as ongoing work on MTI-university projects.
- Authorship or involvement in publishing several MTI books, guides, or other works.
- Overall lifetime service/contributions to the organization.
- Other significant activities that have delivered value for several members.

Requirements

- Candidates must have made significant ongoing contributions to MTI.
- Candidates' activity must cover at least five years of service at MTI. (For example, the nominee for a January 1, 2019 submission shall have been a member of MTI since at least January 1, 2014).
- Candidates must be from a current member company of MTI. Exceptions will be allowed for posthumous nominations.
- Candidates may be nominated by members or staff from within MTI only. Self-nomination is not permitted.

THE CHAIR'S LEADERSHIP AWARD

This award recognizes exemplary service. Examples of the types of service that warrant nomination include:

- Revitalizing a dormant activity, such as a stalled project.
- Significant contributions to the success of a PDC, such as developing an MTI workshop.
- Significant contributions to a Board of Directors (BOD) Committee.
- Contributions key to successful completion of an MTI Project, such as noteworthy involvement editing and reviewing an MTI book.
- Leading an MTI Roundtable or other event, from its inception to successful completion.
- Successful academic outreach, such as working as a mentor on an MTI-sponsored university project.

Requirements

- Candidates must have made significant, noteworthy and exceptional contributions to the MTI.
- Candidates' are eligible after one year of activity with an MTI member company.
- Candidates must work with a current MTI member company.
- Candidates may be nominated by members or staff from within MTI only. Self-nomination is not permitted.

> CONTINUED ON PAGE 37

LEADERSHIP PERSPECTIVE

AVERY BOYER SHARES A YOUNG ENGINEER'S EXPERIENCE IN MTI

Avery Boyer, a Materials Engineer who joined Chemours in June of 2022, has quickly embraced leadership roles through corporate MTI membership and encouragement from Debra McCauley (MTI Chair), his mentor at Chemours. It didn't take long for McCauley to introduce her new colleague to the Materials Technology Institute at his first AmeriTAC Meeting in October 2022.

Since then, he has come up to speed quickly and moved into the fast lane, already taking on two Project Champion roles and recently agreeing to lead the Polymers Project Development Committee (PDC). In our interview, Boyer talks about his interests in materials engineering and growing role as a leader in the MTI technical community. He also takes a break to discuss his passion for a certain team sport that is loved 'round the world.

CONNECT: Avery, please describe your role at Chemours.



Avery Boyer, Chemours

Boyer: I work in the capacity of a non-metallic materials engineer for our leveraged engineering technology group, which means I support all of our business units.

Basically, what that means is we're responsible for all the non-metallic equipment at our manufacturing sites. That might be polymer or elastomer, that might be glass, or that might be fiberglass reinforced plastic. Those are the types of materials I'll work with. We work on the

project side for new equipment and new manufacturing applications, but then also the failure analysis side, including lab work to evaluate how those pieces of equipment did in service.

CONNECT: What opportunities for growth has MTI offered you so far?

Boyer: Very early on, there were many opportunities to get involved and to grow.

> CONTINUED ON PAGE 36

MTI GAINS THREE SUPPLIER MEMBERS

MTI is excited to share news of three new additions to the list of member companies—Crane, Apex Engineered Products and Andronaco Industries. Each new member brings unique capabilities, which adds to the broad expertise of the entire membership. This allows MTI to be more effective in its project development and execution, meetings, and overall collaborative nature. Please help us welcome these new members!

CRANE HIGHLIGHTS EXPERTISE AND PLANS TO GAIN KNOWLEDGE

Crane, originally R.T. Crane Brass and Bell Foundry, was established in 1855 as a producer of valves, fittings, and specialty castings to serve the growing industry in America. However, the company has grown and changed many times over the years. Today, Crane employees 7,300 people in 21 countries. The diversified business is now segmented into three divisions: Aerospace & Electronics, Engineered Materials, and Process Flow Technologies.

Crane's Aerospace & Electronics (A&E) segment provides mission critical systems that require high reliability and accuracy, such as pressure sensors for aircraft engine control, aircraft anti-skid braking systems for commercial and military jets, power conversion solutions for spacecraft and lubrication systems for the harshest and most hazardous environmental conditions. The Engineered Materials segment manufactures fiberglass-reinforced plastic (FRP) panels and coils, primarily for use in the manufacturing of recreational vehicles (RVs), and in commercial and industrial buildings applications. Crane Process Flow Technologies primarily serves the chemical, water and wastewater, pharmaceutical, and general industrial end markets. This division

CRANE

provides industrial fluid control products, including valves, pumps, lined pipe, and instrumentation, and will be the primary participant in MTI.

"The business excels in critical performance and severe service applications that require the highest reliability, with a strong and lengthy track record of innovation in all areas related to the flow of fluids," explains Daniel Lapp, Engineering Manager and MTI Vice Designated Representative for Crane. "We manufacture valves, instrumentation, pumps and piping and thus have significant knowledge of design, production and application of these products. We expect to provide leadership and guidance to help drive MTI project teams to successful outcomes."

When it comes to contributing at MTI, the company is no stranger to solving industry challenges and looks forward to offering their expertise, especially on topics that include improving reliability in abrasive services, harsh chemistries, high

temperatures and pressures, and ultra-pure process streams.

"We expect to participate actively in several current and potential project teams. Specifically, we expect to join the PTFE Bellows Expansion Joint Integrity project and we anticipate benefits for our newer engineers from Introduction to Plastics and Elastomers potential project," Lapp notes. "Extractables in Polymers also has promise to benefit Crane."

The Vice DR is also eager for Crane to gain knowledge through other MTI membership benefits, including attending meetings and relevant training programs, networking and participating in the MTI forum. Sustaining and strengthening knowledge in metallurgy, polymers and ceramics—three of the primary materials areas MTI focuses—is a perceived need at Crane as the company constantly seeks education and growth for employees, Lapp says.

ANDRONACO SHARES EXPERTISE AND ENERGY TO COLLABORATE

Andronaco Industries is a turnkey, total systems provider for demanding fluid management applications. The Kentwood, Michigan-headquartered company is a designer and manufacturer of high-performance specialty polymer and composite-engineered products for corrosive environments.

"We are unique in that we provide field services as well as offer multiple materials of construction in our broad product line," points out Ellen Turner, Director of Marketing and Business Development. "Our products include lined steel and non-metallic piping and fittings, valves, expansion joints, piping accessories, hoses, hose accessories, pumps, and non-metallic vessels/tanks."

Andronaco is a growing and evolving company that started as a family business but accelerated its growth through a transition to private equity ownership. "As Andronaco celebrates its 30th anniversary this year, we are proud of our solid business that has been built through organic growth and product innovations supplemented with a collection of acquired products and brands," says Tammy Trivette, Vice President of Marketing.



Andronaco Industries recently added a field services offering and expanded its fiberglass vessel/tank and piping capabilities and capacities through acquisition of Diamond Fiberglass Systems and Services in Victoria, Texas.

With its most recent acquisition of Diamond Fiberglass Systems and Services, Andronaco is continuing to strengthen its portfolio with more vessel/tank capacity plus the addition of a field services offering. The company also maintains manufacturing facilities in Kentwood, MI, Pearland, TX, Victoria, TX, and France.

A former member of MTI, Andronaco kept in contact with the organization by sending team members to its biennial Symposium.

Turner and Trivette exhibited at the recent Baton Rouge event and came away impressed with the technical presentations and interaction at the subsequent AmeriTAC meeting. What sold them on applying for membership was MTI's focus on scientific data, the number of respected member companies, the collaborative nature of the sponsored projects, and the active communication mechanisms that members leverage.

> CONTINUED BOTTOM OF PAGE 8

"We have greatly enjoyed recent symposiums and TAC meetings. Information about tightening purity requirements in the semiconductor industry and legislative trends related to PFAS have been particularly helpful. Networking has been very helpful, providing contacts

with useful knowledge among our customers and suppliers," he observes. "MTI is a great one-stop shop for expertise in virtually any aspect of material science and products for the process industry. It provides multiple viewpoints for common and uncommon problems.

This has been the most useful aspect of membership so far."

Crane is ready to become more involved and is happy to be an MTI member. To learn more about this new member, please visit the company website www.cranecpe.com. ■

APEX AIMS TO CONTRIBUTE EXPERTISE AND LEARN

Apex Engineered Products, established in 2001 in Northwestern Pennsylvania, with satellite manufacturing facilities in Tampa, FL and India, joined MTI in early 2024. The company specializes in the fabrication of corrosion resistant process equipment serving producers around the world in sulfuric acid, hydrogen, phosphoric acid, nitric acid, general chemical, petrochemical, and many other process industries.



"APEX provides complete design and fabrication solutions for chemical producers worldwide and offers one of the largest range of materials of construction in the industry, with hundreds of weld procedures,"

explains Mark Grasso, President. "We use the latest advances in automated fabrication technologies, software modeling, and thermal analysis tools to provide reliable and repeatable solutions on-time and

on-budget." This includes the design and fabrication of heat exchangers, pressure vessels, tanks, reactors, coolers, condensers, gas heaters, gas reheaters, evaporators, vaporizers, coils, columns and custom fabrications."

In addition, APEX is an exclusive representative of Graphite India for North America and offers complete graphite solutions, such as shell and tube heat exchangers & HCL synthesis systems. APEX also offers spare graphite blocks, tubes, and subsystems, as well as on-site support.

The company's broad range of industry work reinforces the knowledge it brings to MTI. For instance, a recent APEX project involved a major petrochemical company needing to resolve caustic cracking mitigation behind the tube sheet of a large vertically mounted shell and tube condenser. Experience in the ammonia industry, along with proprietary shell venting designs that met ASME and TEMA standards, allowed APEX to provide a raw materials savings with a stepwise improvement to mitigate shell side steam caustic cracking in the vapor space of the multi-million dollar heat exchanger.

Apex Engineered Products also emphasizes the value of developing strategic partnerships, and membership in MTI is similar. Over its 23-year existence, APEX has conducted materials performance testing that parallels MTI's research; examples include, corrosion coupon testing to collect data on corrosion rates in specific applications, and the installation of similar metallurgy tubes to gather comparable corrosion, erosion, and fouling-resistance data in heat exchangers.



Apex Engineered Product provides multi-stage reactor fabrication consisting of Hastelloy C-276 vessel and internals and 316 SS water jacket.

ANDRONACO SHARES EXPERTISE AND ENERGY TO COLLABORATE

> CONTINUED FROM PAGE 7



The company is already looking for opportunities to contribute its expertise in solving the CPI's materials engineering challenges. "As new members, we are in the process of adding our engineers to the online forum so that they can begin participating and help other members solve problems."

Turner and her colleagues have also expressed an interest in many MTI projects and Project Development Committees (PDCs), including projects focused on high purity and corrosion resistance of fluoropolymer lined steel and fiber reinforced polymers in particular. "We see non-metals as an underrepresented space in the general market, and we would like to build awareness and knowledge of how these materials can be best used," she says. "We desire to help with both lined metallic and non-metallic standards and guides as well."

"Our overall goal is twofold," continues Turner, "Firstly, we want to enable safer, more reliable plants where existing unit operations' maintenance is becoming too costly. Secondly, we are excited to leverage new equipment technology and materials to solve emerging problems like super high purity for semiconductor, solar, or markets that utilize electrolysis like green hydrogen. Sometimes the need is corrosion resistance, but other times, it is all about removing metals and other impurities to achieve very high purity to protect membranes and improve efficiencies. With all the capabilities we have in molding and fabricating non-metals, we can create something totally new to solve a serious issue in the market. There are currently a couple of projects related to high purity polymers and equipment, and we are getting involved there, for sure. We are

excited to solve problems together with MTI."

Turner believes that being part of a materials engineering network of experts is going to benefit Andronaco's technical team as well. "We envision that other members will be able to help us by providing feedback on areas of improvement within our product/service offering or to meet evolving needs of our customers from the perspective of engineers," she says. "Because change can come with risks in the markets we serve, innovation in process equipment (piping, tanks, valves, etc.) can be slow. We think that the collaborative nature of MTI could accelerate innovation. Our company is growing and changing, and we want to be flexible enough to create new products, when we prove, through MTI project work, that a better solution is valid."

Andronaco Industries and its newly acquired business, Diamond Fiberglass Systems and Services, are thankful to be a part of MTI and are ready to engage with MTI members. To learn more about this new member, please visit the company website www.andronaco.com ■



"Just like 'No Man Is an Island,' no company operates in a vacuum," Grasso states. "MTI has always been at the forefront of the latest trends, developments and inventions affecting our industry. In this context, we look forward to both learning from and contributing to MTI."

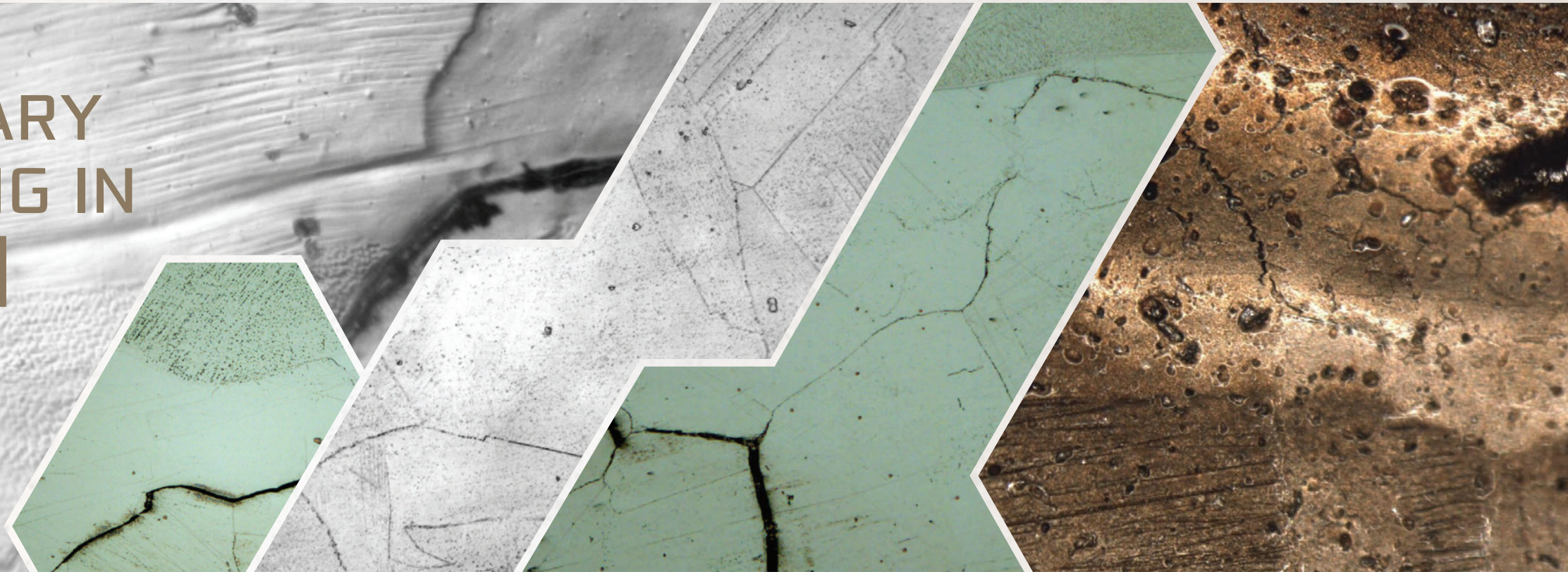
APEX joined only at the beginning of the year, but in this short time the new member has displayed the motivation to collaborate and participate in the organization by attending the 2024 Global Solutions Symposium, contributing to technical presentations on acid lance designs for severe service conditions, and accessing the Technical Resource Library to explore publications and presentations to further improve its pressure vessel designs for high and low temperature corrosive applications. More recently noted, the company tapped into MTI resources and member knowledge to assist a client replacing a FRP caustic intermediate storage tank.

"Apex Engineered Products has now been a member of MTI for approximately six months, so our current TAC project activities have been limited to date," shares Grasso. "However, we are very interested in participating in the active projects on Duplex Stainless Steel Welds at High Temperatures, Navigating Material Selection for Abrasion and Corrosion Challenges Roundtable, Corrosion Data Collection, Nickel Alloys – Phase II, and New Testing Methods for Titanium Hydriding."

Looking to the near future, he says the company plans to send attendees to AmeriTAC 145 for the Heat Exchanger Fabrication Roundtable, continue using MTI references, and networking to develop relationships with other members.

APEX is excited to be part of MTI and ready to become more involved. To learn more about Apex Engineered Products, please visit www.apexep.com. ■

EVALUATION AND PREVENTION OF HAZ GRAIN BOUNDARY LIQUATION CRACKING IN ALLOY 800H FORGINGS



Executive Summary

Alloy 800H is a high-performance, nickel-iron-chromium alloy that is specifically designed for high-temperature service. Its composition and properties make it suitable for a range of demanding applications, including pressure vessels, heat exchangers, and other process components. However, 800H has an inherent susceptibility to solidification cracking during fabrication due to its larger grain structure and alloying additions. In this case study, Alloy 800H (UNS N08810) forgings were welded with NiCr-3 filler metal. Microfissures were observed with dye penetrant inspection adjacent to the fusion line in the HAZ of the Alloy 800H base material. Experimentation was performed by varying weld processes, metal transfer, heat input, and shielding gas. Evaluation of the as-received and HAZ base

material revealed large grain size and intergranular cracking, respectively. Minimal cracks were found with the SMAW, GTAW, and FCAW processes at low heat input, and cracks were eliminated only at extremely low weld heat inputs. The mill test reports for the forgings were analyzed to determine changes in chemistry, thermal history, and grain size, as compared to the previous heats. Silicon (Si) and titanium (Ti) had elevated readings but were still within specification. A sample containing a crack was removed and evaluated using scanning electron microscopy/ energy dispersive X-ray spectroscopy (SEM/EDS) technology and optical microscopy to examine the microstructure and to determine specific elements on the internal crack surface. After completion of this testing, along with other evaluations, research, and consultation,

it was concluded that the microfissures were a result of a HAZ grain boundary liquation cracking mechanism caused by large grain size and elevated Si and Ti contents in the 800H forging base material.

Introduction

The weldability of Alloy 800H forgings was assessed due to concern of dye penetrant inspection indications adjacent to the fusion boundary of welds made with NiCr-3 filler metal. Alloy 800H is a crucial component material used in pressure vessels. The weldability was examined by performing several test welds varying weld processes, metal transfer, heat input, weld location, filler metal, base metal thermal history, and shielding gas. In addition, replications were applied to the base material, along with the weldment, to evaluate the microstructure and

cracking through optical microscopy. A sample containing microfissures in the 800H HAZ was obtained and analyzed using microscopy and SEM/EDS technology to determine elemental composition on the crack surface.

Alloy 800H Forging Material

The Alloy 800H (UNS N08810, ASME SB564, P-No. 45) forging material and NiCr-3 (UNS N06082, ASME Section IX F-No. 43) filler metal nominal compositions are

listed in Table 1. The material has a nickel-rich face-centered cubic (fcc) austenitic microstructure, which is solid-solution strengthened with alloying additions. Alloy 800H is typically solution annealed between 1950°F to 2150°F (1066°C to 1177 °C) to assure that alloying additions are dissolved in the austenite matrix and to eliminate any embrittling phases. The forgings supplied were heated at 1800°F (982°C) for six hours and water quenched by the manufacturer. In the ASME SB564

specification for nickel alloy forgings, the average grain size requirement is an ASTM No. 5 or coarser.

In the 800H heat affected zone, several metallurgical reactions can occur, including grain growth, grain boundary segregation, and grain boundary liquation. Alloying additions, such as Ti and Si, and impurity elements like S and P, can segregate to grain boundaries upon heating. This segregation can form low melting point eutectic

> CONTINUED ON PAGE 12

Alloy/AWS Class	UNS No.	Material	Cr	Ni	Fe	Cu	Ti	Al	C	Mn	S	Si	Nb
800H	N08810	Forging	19-23	30-35	39.5 min	0.75 max	0.15 - 0.60	0.15 - 0.60	0.05- 0.10	1.5 max	0.015 max	1.0 max	---
ERNiCr-3	N06082	Filler	18-22	67 min	3.0 max	0.50 max	0.75 max	---	0.10 max	2.5 - 3.5	0.015 max	0.50 max	2.0- 3.0

Table 1. Base Metal/Filler Metal Composition

constituents along the grain boundaries. For example, during welding, the base metal just adjacent to the fusion zone will experience a range of temperatures, which are between the liquidus and the effective solidus temperature of the 800H alloy. In this region, partial melting, or liquation, will occur at the grain boundaries forming low melting point eutectic films. Liquation cracks will form if the locally melted region cannot sustain the applied strain due to welding.

Experimentation and Results

There have been several attempts to eliminate the cracking indications in the 800H forging material. First action was to reduce weld heat input and HAZ base metal strain. This was attempted by adjusting weld parameters and by experimenting with different welding processes. Table 2 lists the testing that was performed along with the results. Six different welding processes were used, which included, SMAW, FCAW, GTAW, GTAW-P, GMAW, GMAW-P. In addition, welding parameters were varied to increase and decrease heat input. Changing of filler metals between NiCr-3, NiCrFe-3, NiCrMo-3, NiCrMo-4 and autogenous welding (no filler) were tested along with shielding gas changes between 99.997 Ar, 75/25 Ar/CO₂, 75/25 Ar/He, 90/10 Ar/He, and 95/5 Ar/He. The results revealed that using the GTAW, SMAW, or FCAW process at low weld heat input dye penetrant indications were minimized or eliminated.

The next possible solution was to heat treat the material. By solution annealing the 800H forging, the plan was to dissolve carbides, which could cause cracking. This test was performed by heat treating two scrap discs (≈0.200 in. or ≈0.508 cm) obtained from the machining of the 800H forgings. The discs were held at 1950°F (1065°C) for

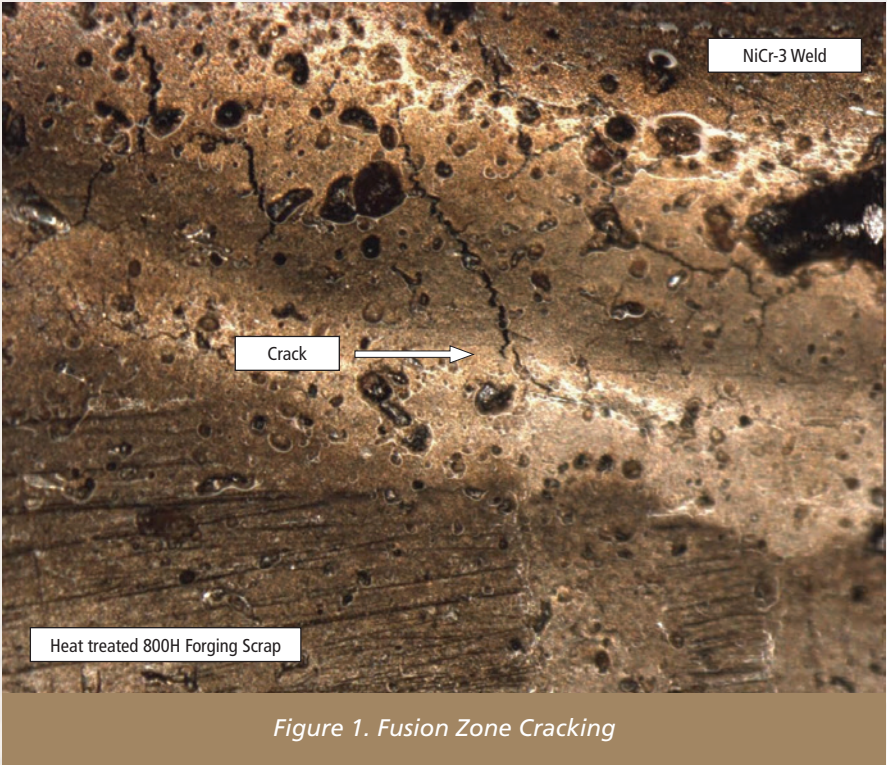


Figure 1. Fusion Zone Cracking

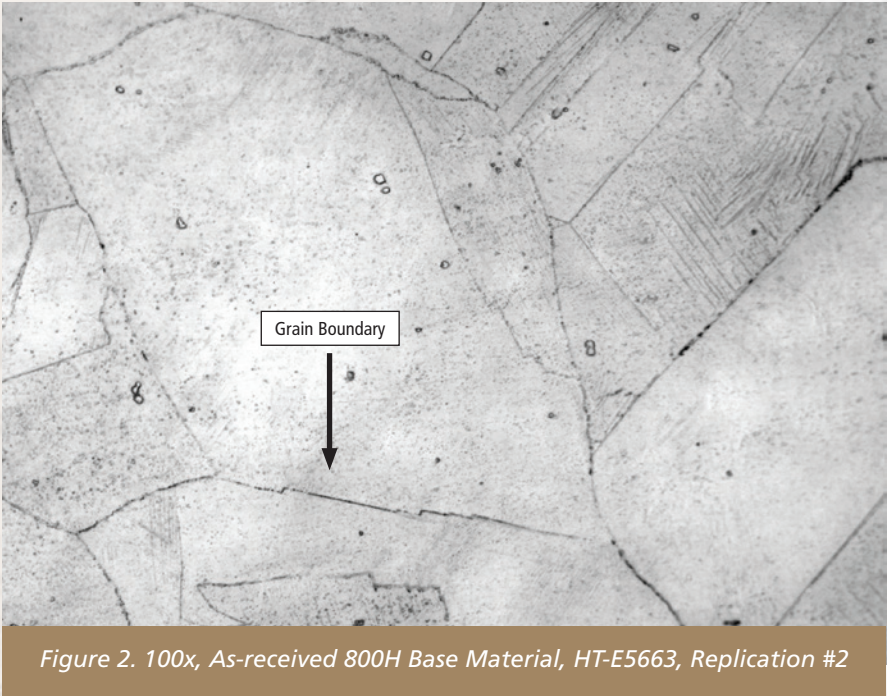


Figure 2. 100x, As-received 800H Base Material, HT-E5663, Replication #2

30 minutes then water quenched. GMAW-P fillet welds were made on the heat-treated disks. Dye penetrant inspection and stereo-microscopic examinations were performed on the weldments. Indications were observed by penetrant inspection and the stereo-microscopic images displayed cracks along the fusion zone as displayed in Figure 1.

Analysis and Discussion

By analyzing the results from the testing, preliminary conclusions could be drawn to develop future investigation. Because the indications were detected directly after welding and because of the inherent characteristics of the material, it was determined that a type of

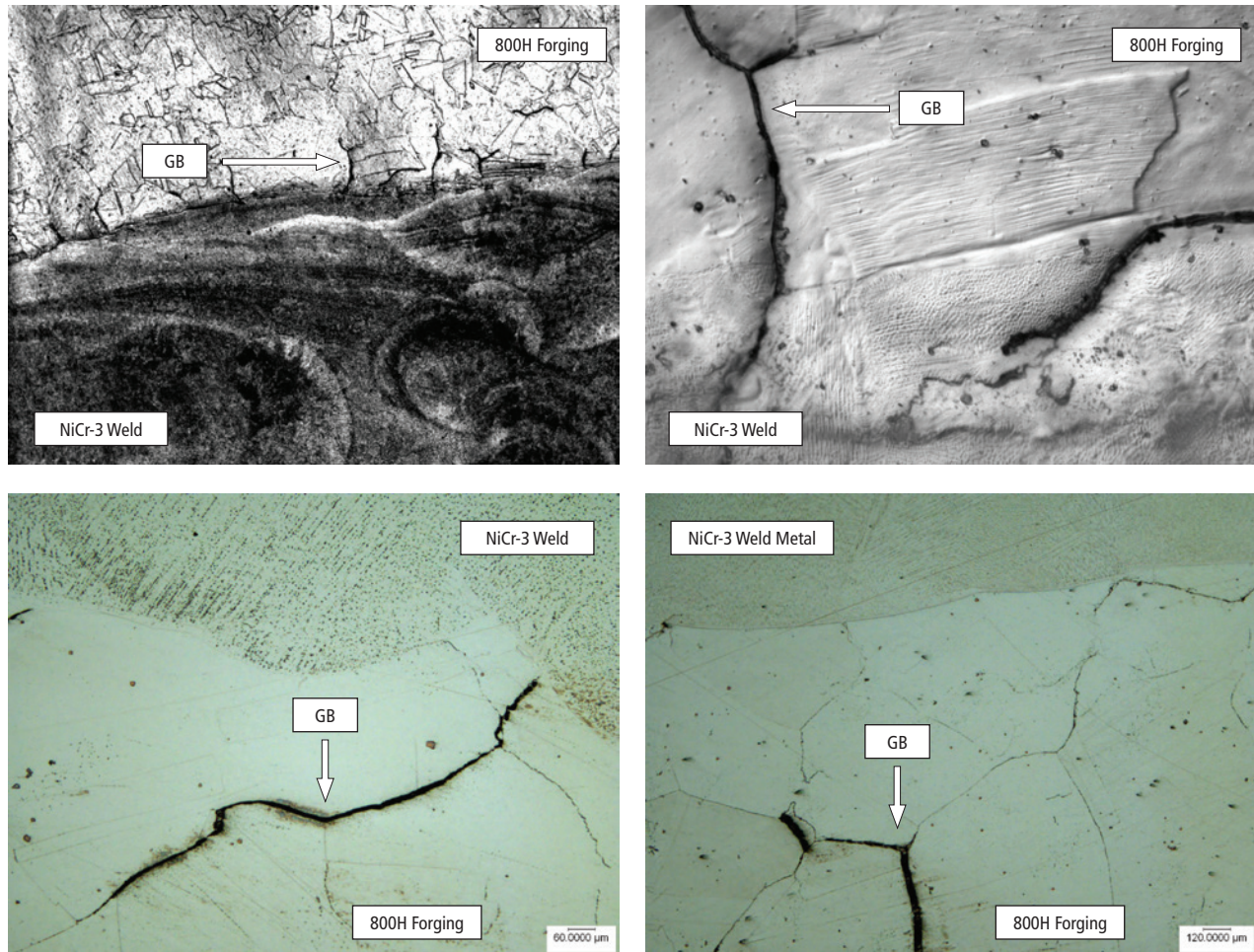
> CONTINUED ON PAGE 14

Alloy 800H Weld Tests

Weld #	Base Pos.	Process	Current(A)	WFS(ipm)	Voltage(V)	Filler	Shield Gas	Indications
1	top side	GTAW	200	N/R	N/R	No Wire	100Ar	no
A	side	GTAW	200	N/R	N/R	No Wire	100Ar	no
2	top side	GTAW	200	N/R	N/R	No Wire	100Ar	no
B	side	GTAW	200	N/R	N/R	No Wire	100Ar	no
3	top side	Pulse GTAW	200	N/R	N/R	No Wire	100Ar	yes
C	side	Pulse GTAW	200	N/R	N/R	No Wire	100Ar	yes
4	top side	Pulse GTAW	200	N/R	N/R	ERNiCr-3	100Ar	some
D	side	Pulse GTAW	200	N/R	N/R	ERNiCr-3	100Ar	some
5	top side	Pulse GTAW	N/R	N/R	N/R	ERNiCr-3	100Ar	some
E	side	Pulse GTAW	N/R	N/R	N/R	ERNiCr-3	100Ar	some
6	top side	GTAW	N/R	N/R	N/R	ERNiCr-3	100Ar	no
F	side	GTAW	N/R	N/R	N/R	ERNiCr-3	100Ar	no
7	top side	SMAW	110	N/R	N/R	ENiCrFe-3	N/A	no
G	side	SMAW	110	N/R	N/R	ENiCrFe-3	N/A	some
8	top side	Pulse GMAW	N/R	N/R	N/R	ERNiCr-3	75Ar/25He	some
H	side	Pulse GMAW	N/R	N/R	N/R	ERNiCr-3	75Ar/25He	some
9	top side	Spray GMAW	N/R	N/R	N/R	ERNiCr-3	100Ar	some
I	side	Spray GMAW	N/R	N/R	N/R	ERNiCr-3	100Ar	some
10	top side	FCAW	170	355	25.6	ENiCr-3	75Ar/25CO2	no
J	side	FCAW	170	355	25.6	ENiCr-3	75Ar/25CO2	no
11	top side	FCAW	170	355	25.6	ENiCrMo-3	75Ar/25CO2	no
K	side	FCAW	170	355	25.6	ENiCrMo-3	75Ar/25CO2	no
12	top side	Spray GMAW	204	275	27	ERNiCrMo-3	100Ar	yes
L	side	Spray GMAW	204	275	27	ERNiCrMo-3	100% Ar	yes
13	top side	Pulse GMAW	N/R	355	N/R	ERNiCrMo-3	75Ar/25He	yes
M	side	Pulse GMAW	N/R	355	N/R	ERNiCrMo-3	75Ar/25He	yes
N	side	Pulse GMAW	N/R	355	N/R	ERNiCrMo-3	75Ar/25He	yes
O	side	Pulse GMAw	N/R	355	N/R	ERNiCr-3	95Ar/5He	yes
P	side	Pulse GMAW	N/R	355	N/R	ERNiCr-3	90Ar/10He	yes
Q	side	Pulse GMAW	197	355	25.6	ERNiCr-3	100Ar	yes
R	side	Pulse GMAW	N/R	355	N/R	ERNiCrMo-4	75Ar/25He	yes
S*	side	Pulse GMAW	216	355	26.5	ERNiCr-3	100Ar	yes
T	side	Spray GMAW	165	275	24	ERNiCr-3	100Ar	yes
U	side	Spray GMAW	167	N/R	26	ERNiCr-3	90Ar/10He	yes
V	side	Spray GMAW	155	N/R	25.5	ERNiCr-3	95Ar/5He	yes
W	side	Spray GMAW	167	N/R	26	ERNiCr-3	95Ar/5He	yes
X*	side	Spray GMAW	275	N/R	29	ERNiCr-3	100Ar	yes
Y	side	FCAW	160	N/R	25.3	ENiCrMo-3	75Ar/25CO2	no
Z	side	FCAW	160	N/R	25.3	ENiCr-3	75Ar/25CO2	no

N/R = not recorded *Performed with Thermal Arc Welder

Table 2. Weld Testing



Top Left: Figure 3. HAZ Solidification Cracking, HT-E5198, Replication #4
 Top Right: Figure 4. 100x, HAZ Solidification Crack, HT-E5198, Replication #4
 Bottom Left: Figure 5. HAZ Solidification Crack, HT-47980
 Bottom Right: Figure 6. HAZ Solidification Crack, HT-47980

solidification cracking was the issue. In addition, the results proved that low weld heat input minimized or even eliminated the indications. By lowering heat input in welds, this increases the cooling rate and reduces strain on the 800H material and permits less time for low melting point segregates to migrate to the grain boundaries, thus minimizing grain boundary liquation.

After considering the results from the testing, an investigation of the solidification cracking was performed by analyzing the 800H forging material and examining the HAZ of the weldments. This investigation included base metal grain size detec-

tion, stereo and optical microscopy, and SEM/EDS analysis. In addition, a comparison of the compositions of each heat was graphed to detect any trends in crack susceptibility with elevations in specific elements.

The grain size detection was performed by evaluating replications created from the as-received base metal. The evaluation was completed with an optical microscope by the comparison method. The ASTM nominal grain size number was found to be 2 to 0, with 0 being the largest. This is a coarse grain size but it's still within specification (ASME SB564). Figure 2 (see page 12) displays one of the

micrographs of the replication from which the grain size was identified. Although this is within ASME code, this could cause weldability issues. As the grains of a material increase, the grain boundary area decreases, thus increasing the applied strain on each grain boundary during welding. Also, the decrease in grain boundary area will increase the concentration of impurity and low melting point segregates at the grain boundaries on heating, making the material more susceptible to HAZ liquation cracking.

Replications were also created from the HAZ of a weld made on the 800H forging. They were examined

with optical microscopy. Figures 3 and 4 reveal the HAZ solidification cracking directly adjacent to the fusion line. Through these micrographs, it was evident that the microfissures were located in grain boundaries of the heat affected zone, and more specifically, in the partially melted zone (PMZ). The PMZ is the area immediately adjacent to the weld metal where liquation of the grain boundaries in the base metal can occur during welding. Because the replications only copy the topography of the surface, SEM/EDS analysis could not be performed. Consequently, a sample containing the actual HAZ of the 800H material needed to be removed so thorough examination of the microfissures could be conducted.

A small sample from the HAZ of a FCAW fillet weld made on the 800H forging was removed for evaluation. The sample was mounted, polished, and etched to reveal the microstructure and microfissures. Figures 5 and 6 display the micrographs captured with optical microscopy. In addition, scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM/EDS) analysis was utilized for further examination. Figure 7 displays the SEM image and the EDS analysis of the composition found in one of the HAZ microfissures. This analysis proved that Si, an element that forms a low melting eutectic constituent, was present in the crack.

The heat of 800H forging material that was used for the SEM/EDS analysis produced more microfissure indications than any other heat of the forging material. Due to this consideration, a comparison of the compositions of each heat was graphed to detect a trend in crack susceptibility and elevations in specific elements. This graphical analysis is displayed in Figure 8 (see page 16) and the number of base

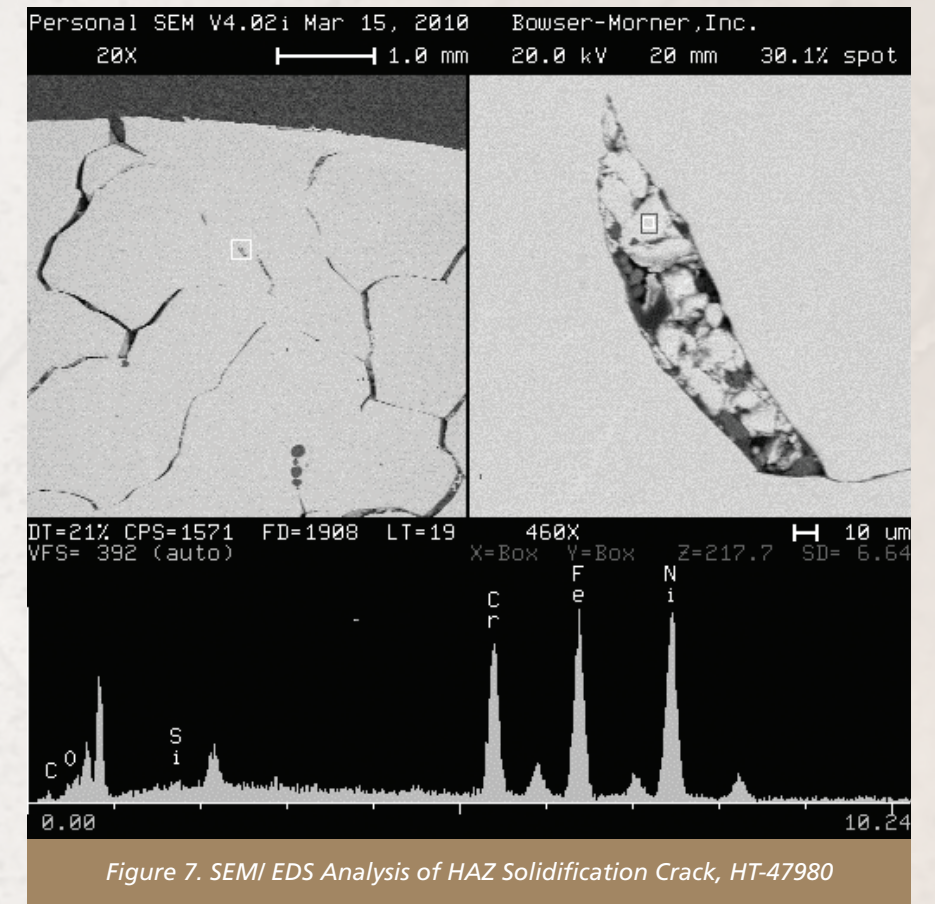


Figure 7. SEM/EDS Analysis of HAZ Solidification Crack, HT-47980

plates produced from each heat is listed in Table 3. By comparing the data, it is evident that the Si content, 0.70 wt %, in heat 47980 is higher than any other heat. In addition, the Ti content, 0.57 wt %, is relatively elevated as compared to the other heats. Si and Ti are two of several elements that form low melting point eutectic constituents. During welding, these elements can segregate to the grain boundaries and form liquid films in the PMZ. If sufficient stress is present and the grain boundary cannot sustain the applied strain because of the liquid film, grain boundary liquation cracking will occur.

Conclusion

After experimentation and analysis, it is determined that the mechanism responsible for causing the microfissures is a type of solidification cracking known as grain boundary HAZ liquation cracking. This is

Heat #	Qty
#47980	6
#48079	3
#48221	3
#48007	6
#48208	4
#48151	2
#E5635	4
#E5198	4
#E5613	4
#E5369	4
#E5663	4
#E5685	4
#E5822	4

Table 3.

a direct result of the alloy 800H forging material. The forging material has an inherent susceptibility

> CONTINUED ON PAGE 16

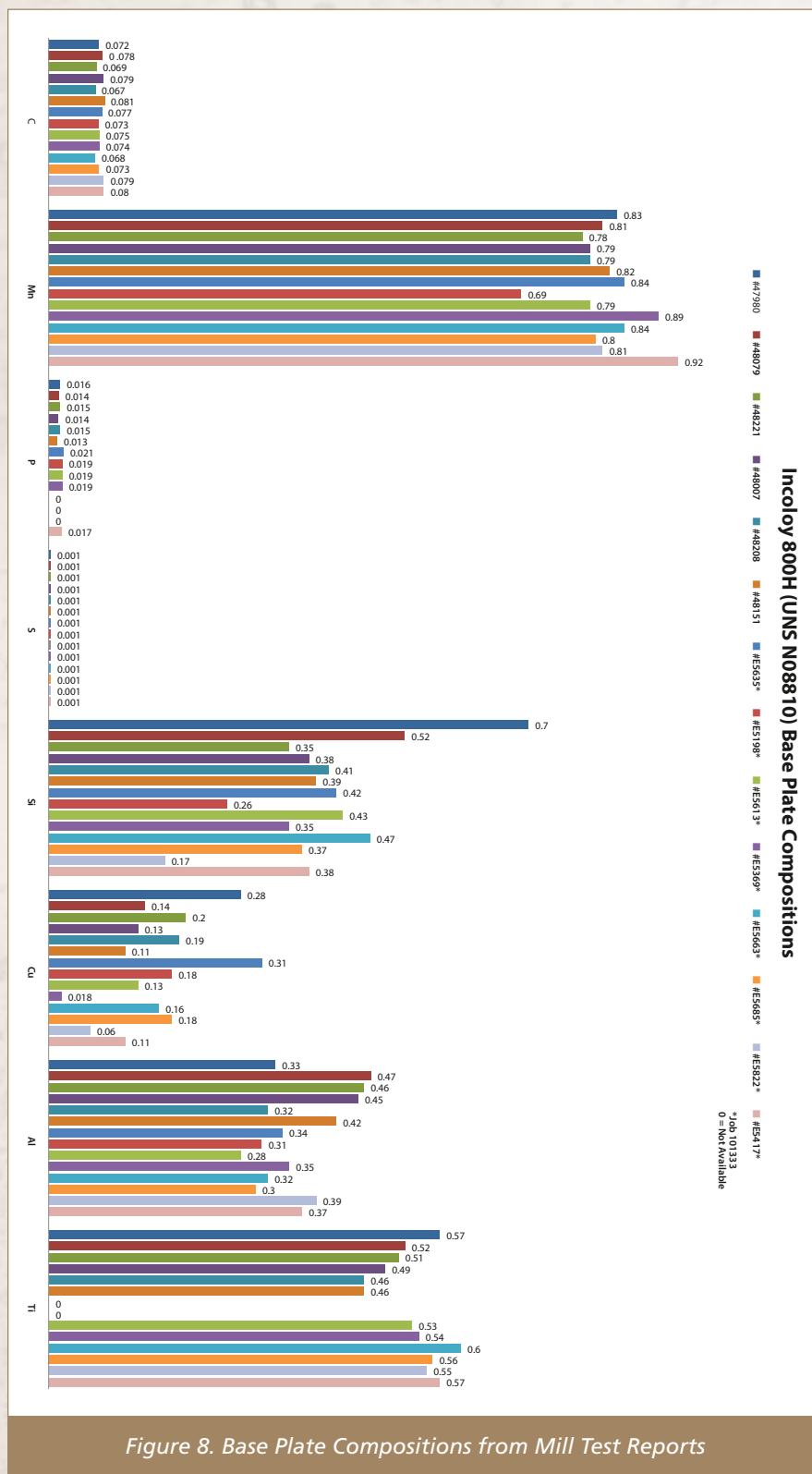


Figure 8. Base Plate Compositions from Mill Test Reports

to solidification cracking, especially when coupled with its large grains and alloying additions.

Specific heats of the base plates have relatively high amounts of elements, particularly Si and Ti, which can form low melting point

eutectic constituents. During welding, these constituents form liquid films at the grain boundaries of the base metal directly adjacent to the fusion zone, specifically in the partially melted zone. Liquation cracking occurs when the grain

boundary cannot sustain the applied strain and microfissures form. Because liquation cracking susceptibility is affected both by alloying composition and the condition of the base metal, it is even more evident that liquation cracking is the mechanism because of the coarse grain size of the forging. Due to the large grains, the grain boundary area decreases and the applied strain on each grain boundary increases. Also, the decrease in grain boundary area increases the concentration of impurity and low melting point segregates at the grain boundaries, making the material even more susceptible to HAZ liquation cracking.

Because of the alloy 800H forging susceptibility to grain boundary HAZ liquation cracking, the following recommendations are offered:

- Reduce the amount of Si and Ti contents by introducing a lower maximum limit while staying within specification.
- Restrict the grains to a finer grain size to increase grain boundary area while still complying with ASME SB564.
- Develop and initiate an inspection plan for vessels containing base plates with higher wt % of Si and Ti.

References

- Kuo, Sindo, Welding Metallurgy, Second Edition, John Wiley & Sons, Inc. (2003)
- DuPont, John N., Lippold, John C., Kiser, Samuel D., Welding Metallurgy and Weldability of Nickel-Base Alloys, John Wiley & Sons, Inc. (2003)
- Lippold, John C., Kotecki, Damian J., Welding Metallurgy and Weldability of Stainless Steels, John Wiley & Sons, Inc. (2005)
- ASME 2023 Section II, Part B, SB 564, "Specification for Nickel Alloy Forgings" ■



MTI held a Summer 2024 AsiaTAC meeting in conjunction with the Japan Society of Corrosion Engineering in Sonic City (Saitama), Japan, June 3–6. It was the second joint meeting between MTI and JSCE since 2015, and members expressed interest in meeting on a more frequent basis. "Our members were excited to come to Japan once again, after a series of successful 2017–2019 spring AsiaTAC meetings in Thailand, Singapore, and India, then a sudden stop by a chaotic COVID pandemic and last year's unexpected cancellation in Vietnam," reports T. P. Cheng (ITRI), AsiaTAC Chair. Cheng and 14 members of the AsiaTAC group were back in action again this June, taking in and delivering two full days of technical content. Activities included a special JSCE-hosted welcome reception, where the MTI guests were honored, as well as an AsiaTAC members dinner.

MTI/AsiaTAC member presentations included: An Introduction of MTI and its Materials Engineering Projects by Kirk Richardson and Paul Liu (MTI); Case Study of 2205 Duplex Stainless Steel Weld Failure by Tzu-Ping Cheng and Cheng-Chang Liu (ITRI); Advanced Austenitic Alloy UNS N08935—Properties and Fabrication by Dragon Hao (Alleima); Study on Clad Plate of New NiCrMo Alloy by Dior Chen (Haynes International); Corrosion Performance of 316L, 2205, 904L, and C276 Alloys in HCI-Related Chemical Process by Henry Ye (Chemours); and Case Studies of High Velocity Thermal Spray Application in Refineries and Petrochemical Plants by Rajaram Chidambaram (ExxonMobil Asia Pacific Pte) and Kiran Chandran (ExxonMobil Chemicals Operation PTE).

"Many other presentations were provided by the JSCE, and our members participated in lively

question and answer discussions with professionals from chemical companies like Asahi Kasai, Mitsui, Sumitomo, and Mitsubishi," shares Kirk Richardson, MTI Associate Director. "It was a great opportunity to reconnect with and learn from our peers in Japan, and we hope to do it again in the near future."

After the AsiaTAC–JSCE Meeting concluded, the leadership team and MTI staff toured Nippon Steel's Kimitsu plant in Chiba, Japan, which graciously hosted lunch and provided technical presentations on some of their latest advancements in metallurgy. "I was impressed by the great achievements of upgraded material performance," Cheng notes. In addition, Nippon Steel was invited to give a Special Speech at the upcoming 2024 Fall AsiaTAC meeting to be held in Hangzhou, China, September 23–25.

> CONTINUED ON PAGE 38

EuroTAC SPRING MEETING HIGHLIGHTS

TECHNICAL COLLABORATION

ATTENDEES FOCUS ON PROJECT PROGRESS AND BRAINSTORMING

EuroTAC held its Spring 2024 Meeting May 22-24 at member company Victaulic's facilities, in Nazareth, Belgium—30 minutes from the beautiful city of Ghent, where MTI arranged accommodations and a bus transfer to the meeting site.

The planning committee is very pleased that the meeting attracted 31 attendees from 15 European and American producer and supplier companies.

"Eleven of the registrants were first-time attendees to an MTI meeting, which is very satisfying," remarks Asger Sturlason, MTI Associate Director—Europe. "This indicates that member companies are 'spreading the word' internally!"

The planning team, including EuroTAC Chair Anette Hansson (Topose), Vice Chair Lars Rose (DuPont), MTI staff, meeting hosts Guillaume Chonet and Paul Herman (Victaulic), and project champions John Houben (ExxonMobil), Jan-Willem Rensman (FLUOR), and Jader Furtado (Air Liquide), worked in cooperation to develop the technical program, which was instrumental to the success of the meeting.

The excellent agenda kept participants eager to hear and discuss the latest on projects championed by EuroTAC members, new developments shared by MTI members, and five guest speakers from Belgian and Dutch companies. The funded and potential MTI projects reported at this meeting include:

- #379: PSA (Pressure swing adsorption pressure vessel) Structural Integrity; Fatigue

Testing Program—Kevin Nibur (Hy-Performance Testing)

- #390: HTHA Atlas of NDE Images and Corresponding Microstructures—Mark Lozev (Becht)
- #405: Reheat/Relaxation Cracking Susceptibility Mapping for High Temperature—Jan-Willem Rensman (FLUOR)
- #406: Guideline for Preservation of New Equipment and Piping During Plant Construction, Commissioning and Maintenance Replacements—John Houben (ExxonMobil)
- #407: Surface Modification Guide—John Houben (ExxonMobil)
- #417: Extruder Alloys for Processing Recycled Materials—John Houben (ExxonMobil)

In addition, MTI members Angela Philipp (Alleima) and Claes Tigerstrand (Outokumpu) provided insights into two topics: 1) corrosion resistance in relation to highly acidic conditions and hydrogen applications and 2) the carbon footprint of various super duplex stainless steels compared to super-austenitic alloys and more conventional austenitic grades.

The guest speakers also covered a variety of interesting subjects for the group. Stijn Clijsters (LCV-SKF) and Arnaud Massant (LaserCo) touched on laser cladding as a tool for high-alloy product optimization and component refurbishment. Joachim Antonissen (Guaranteed) spoke about large scale wire-arc additive manufacturing, and Professor Tom Depover (University

of Ghent) offered a comprehensive presentation of the characteristics of hydrogen assisted degradation of metals. "On behalf of the EuroTAC leadership and meeting participants, I want to express appreciation for the contributions of these guest speakers," Sturlason shares. "Victaulic also deserves our thanks for graciously hosting the meeting."

As part of the meeting, the hosts provided a presentation about Victaulic with a focus on their main product of compact and easily applicable flexible pipe joints characterized by the joint housing fixed by two bolts only and kept in place by rolled or machined grooves at pipe ends. The assembly methods and product testing were demonstrated during a group tour of the facilities led by Victaulic's staff.

Additionally, a brainstorming session resulted in seven new projects ideas. These now await the formulation of a strategic project summaries by the interested members for further development as MTI projects. An Open Forum on the final day of the meeting featured discussions on ammonia cracking of steels used for hydrogen storage and transport equipment, shrinkage prediction by numerical simulation as a design tool for high quality castings and in castings, and of the importance of correct grain size verification, especially of thin-walled components.

The meeting was also characterized by lively discussions both during and between the sessions, and "after business hours" when participants could relax and socialize in the beautiful and vibrant old town. MTI

hosted a group dinner at Restaurant De Graslei, a historic building from the 16th century located directly by the river flowing through the city.

Upon the conclusion of the meeting, Hansson announced that the EuroTAC Fall Meeting—with the support of Jan-Willem Rensman—will be held at FLUOR in Amsterdam, November 18–20. The planning committee welcomes any members interested in developing the fall meeting to contact Asger Sturlason. Be sure to look for future registration email announcements and check www.mti-global.org/about/events/eurotac-meeting as details are added. ■



31
TOTAL
ATTENDEES

15
COMPANIES
REPRESENTED

11
FIRST-TIME
ATTENDEES

EuroTAC host Victaulic invited attendees on a tour and demonstration of the facilities.

MTI VISITS THE “MILE HIGH CITY” FOR JUNE AmeriTAC, ROUNDTABLE

MEETING AND PROJECTS UPDATE

MTI members and guests convened June 24-26, 2024, in Aurora-Denver, CO, for three days of technical learning and discussion, project development and more at AmeriTAC 144. Day one consisted of the MTI Roundtable: Navigating Abrasion and Corrosion Challenges in the Process Industries. Co-Champions Murray Pearson (Hatch), Gary Coates (Nickel Institute) and Stephen Clarke (MTI Designated Professional), assembled a comprehensive program of nine presentations for the Roundtable and a panel discussion:

- Advancements in Materials and Thermal Spray Coatings for Severe Service Wear-Resistant Applications—Murray Pearson (Hatch)
- Abrasion Challenges in Operational Areas in the Mining World and Secondary Containment for Aggressive Chemical Environments—Surojit Mukherjee (AkzoNobel)
- Case Studies of High-Temperature Corrosion and Wear—Kranthee Peddeti (FL Smidth)

- Selection and Application of Various Engineered Ceramics for Various Wear Applications in Mineral Processing and Hydrometallurgical Plants—Tim Connors (Blasch Precision Ceramics)
- Kolsterising: Surface Hardening of Stainless Steels and the Benefits of the Process—Scott Roberts (Bodycote)
- Amorphous Fe-Based Alloy Coating for High Performance in Severe Industrial Applications—Enrique Maya-Visuet (Liquid Metal and Coating Solutions)
- Case Study of Ultimet™ Alloy for Corrosive and Abrasive Services—Javier Guerrero (Haynes International)
- Study of Wear Resistance of High-Performance Stainless Steel/Nickel Alloy(s) in Hydrometallurgical Applications—Claes Tigerstrand (Outokumpu)
- Using FRP in Hydrometallurgical Mineral Process Design—Kevin Lambrych (INEOS)

In addition, attendees had the opportunity to visit Hazen Research facilities the following morning, which ran concurrently with MTI project meetings. Approximately 15 attendees joined the tour, and a report summarizing the tour was given on Wednesday at the AmeriTAC meeting.

The AmeriTAC meeting agenda for Tuesday and Wednesday was full, including 10 project team and five Project Development Committee (PDC) meetings, a presentation on Valve Design Considerations for Abrasive Services by David Ashwill (MOGAS Industries), project funding requests, project completion reports, MTI Forum discussions, networking and a 5k Fun Run.

Three projects—#310, #411 and #412—were presented to TAC and approved to proceed to the Board of Directors for funding (see sidebar for details). Projects #289—eLearning for FRP Inspection Basics and #394—Summarizing Requirements of ASME PCC-2 for Composite Repair were completed

and presented to attendees. Two new projects also emerged during AmeriTAC:

- #419—Develop FRP Flange Design, Full Face and Lap Joint, Champion: Steven Cobb (Albemarle)
- #420—Field Installation Manual for Dual Laminate Pipe, Champion: Philip Hypes (Knight Materials)

Technical presentations from the week are available in the Technical Resource Library and the Executive Summary, including funding and other TAC reports, is available in the AmeriTAC library at www.mti-global.org.

The AmeriTAC leaders have quickly transitioned to planning TAC 145, October 21–23, 2024, in Tulsa, OK. The team notes another packed agenda in the early development stages of the program, including a Heat Exchanger Fabrication Roundtable on Monday, a reception hosted by Webco Industries, the Annual Membership Meeting, and the Annual Awards Banquet.

Please be sure to watch for registration announcements or check

www.mti-global.org/about/events/ameritac-meeting ■

FUNDED PROJECTS

#310 – New Test Method for Titanium Hydriding (Phase II)

Project Scope: Search for established method to non-destructively detect titanium hydriding in the field.

Champion: Curtis Huddle (Eastman Chemical Company)

Amount Requested: \$16,000 (Phase I approved at TAC 140 for \$12,000)

improvements to eliminate as much foreign material as possible to this point.

Champions: Michael Kraus (AGRU) and Jenell McCall (Chemours)

Amount Requested: \$68,500

#412 – AI for Knowledge Management

Project Scope: This MTI project will explore using Artificial Intelligence (AI) as a search function “behind the firewall,” only within the MTI website, to assist members with accessing content more rapidly pertinent to their query.

Champions: Maria Jose Oestergaard (Topsoe) and Andrew Rentsch (Huntsman)

Amount Requested: \$117,358



CORROSION DATA COLLECTION – NICKEL ALLOYS, PHASE II

MTI PROJECT 367 DELIVERS FINAL REPORT

Nickel alloys are used by chemical processing industries to handle highly corrosive chemicals in extreme conditions and to meet the challenging environmental requirements. The previous Materials Technology Institute (MTI) Project 269, completed in 2017, had built up a corrosion rate database for five grades of the most commonly used nickel alloys inclusive of Alloy 276 (N10276), Alloy 22 (N06022), Alloy 625 (N06625), Alloy 825 (N08825), and Alloy 600 (N06600). The documentation from Project 269 has proved to be extremely useful to many MTI members, and a successive phase 2 project, MTI Project 367, was thereby initiated to extend the database for more grades of nickel alloys. The main goal of Project 367 is to collect and build up a corrosion rate database for 10 grades of commercially available nickel alloys, including Alloy 2000 (N06200), Alloy 59 (N06059), Alloy 686 (N06686), Alloy 2120 (N06058), Alloy 690 (N06690), Alloy G-30 (N06030), Alloy 800 (N08800), Alloy 825CTP (N08827), Alloy B-2 (N10665), and Alloy B-3 (N10675). Project 367 consisted of two parts; Part 1 is to collect the readily available corrosion rate data and to analyze the data statistically, and Part 2 is to acquire test mate-

rials from world-renowned material producers and to conduct corrosion tests accordingly.

Existing corrosion rate data for nickel alloys tested by ASTM G28A and G28B, ASTM A262C, and DuPont SW800M standards had been collected comprehensively from research papers, publications, data sheets, and internal test data shared by material producers. In total, 1,629 data points were collected for wrought and welded coupons.

The readers should be aware that corrosion rate data are not suitable for a direct comparison among nickel alloys and the actual service conditions may be very much different from the corrosion test solutions described in this report. The corrosion tests in many cases do not correlate to fitness for use in the intended service.

ITRI had acquired wrought and welded plates/sheets, base metal coupons and welded coupons, and weld filler rods from four world-reputed material producers. The as-received plates/sheets were in a mill-annealed condition, and the as-welded coupons were not subject to further heat treatment. All of these coupons were ready for testing after cutting, grinding, and surface preparation. Alloy sheets and filler

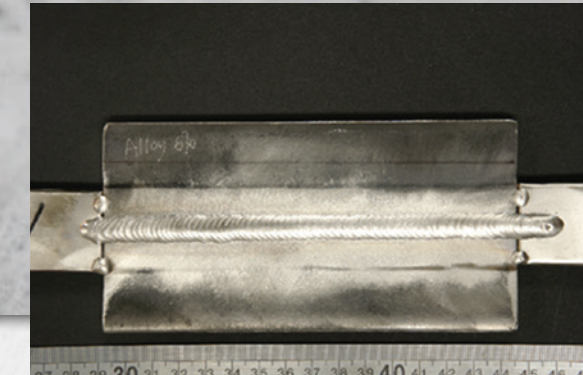
rods were also used to fabricate some tungsten inert gas (TIG)–welded bead-on-plate test coupons, to which the generally accepted welding procedure was applied. The heat input of manual welding was calculated as 1–1.2 kJ/mm.

Part 2 laboratory corrosion test results showed a similar ranking of corrosion rates to Part 1 collected data. Additionally, laboratory test data showed slightly lower corrosion rates and a smaller scattering of test data than the collected database, which were retrieved from numerous production heats. Except for Alloy 800's test data, all nickel alloys irrespective of material producer demonstrated similar ranges of corrosion rates tested by a specific test method. Welded coupons did suffer slightly greater weight losses than their wrought counterparts because of the weld's microstructural features and redistribution of alloying elements. Alloy 800 is a dual-purpose nickel alloy suitable for corrosion applications and high-temperature services. The corrosion rates of wrought Alloy 800 plates per ASTM G28A varied with C content. It would be more severely attacked if the C content were higher. A similar finding was obtained from the TIG-welded Alloy 800 coupons with a high C content,

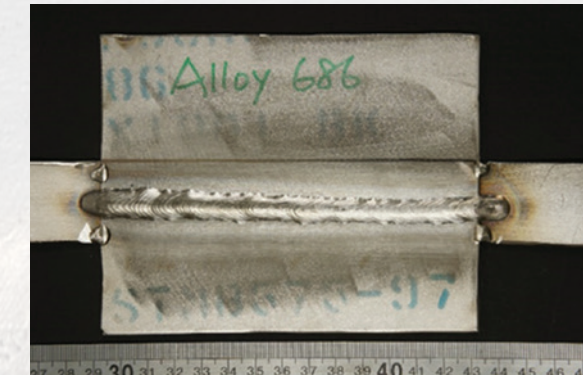
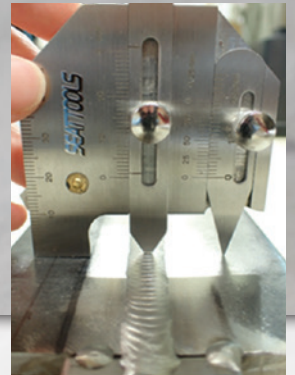
which exhibited a severe weld decay at the heat-affected zone.

The specified testing time for ASTM G28A test is 24 or 120 h, depending on alloy grade. The feasibility to assess the low- or no-Mo nickel Alloys G30, 800, 825CTP, and 690 by a shorter 24-h testing was explored. The modified tests showed the corrosion rates were in the same order of magnitude as those data assessed by standard-specified 120-h testing, if uniform corrosion dominated the corrosion morphology. However, it could be very misleading if subject to intergranular corrosion. So, adopting a shorter 24-h testing time is possible for the purpose of fast screening or simple comparison, but the user should pay careful attention to interpreting the test results. For instance, a careful examination of corrosion morphology at higher magnification is strongly suggested after testing. To determine whether the nickel alloy components are properly processed, it is still recommended to use the standard-specified testing time for performing the G28A test.

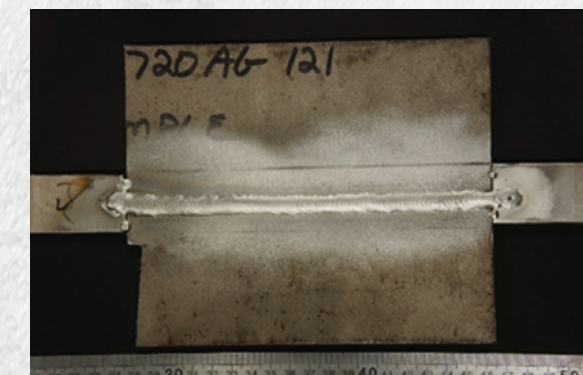
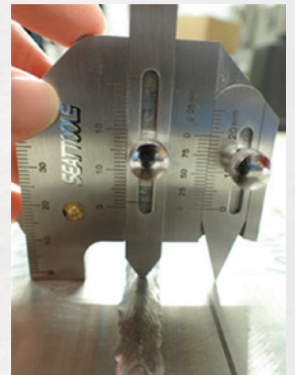
The final report was released in late June 2024 and is available exclusively to MTI members in the Technical Resource Library. ■



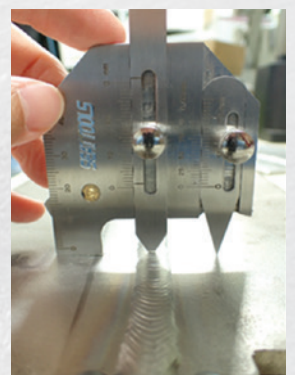
Alloy 690 with filler metal 52



Alloy 686 with filler metal 686CPT



Alloy 800 with filler metal 82



As-welded plates of Alloys 690 (top), 686 (middle), and 800 (bottom) with appropriate filler metals. The filler metals for Alloys 690 and 686 are matched to the base metal. The filler metal for Alloy 800 has a much higher Ni content. The weld reinforcement was checked with weld gauge.



MTI

eLearning Course

ONLINE INTRODUCTORY FRP INSPECTION PROGRAM FILLS PROCESSING INDUSTRY VOID

The MTI team “eLearning Course for FRP (Fiber Reinforced Plastics) Inspection Basics” (project 289) announced the completion of the project during the AmeriTAC 144 meeting this past June. As part of the project completion report, MTI Associate Director Dale Keeler provided a short demo of how to access the eLearning, costs and overview of the course, which is hosted by Oregon State University’s online platform—Professional and Continuing Education (PACE).

The purpose of the course is to assist end users in developing a basic understanding and competence in FRP. The online program may also benefit MTI member companies by being able to:

- Require contractors used for FRP inspection and repair to complete and pass this eLearning course to ensure basic understanding of personnel
- Require internal personnel responsible for FRP equipment to complete and pass this eLearning course so that they

may oversee inspections or repairs to their FRP equipment.

- Use test results for determining personnel qualifications / competency
- Require personnel take this as a refresher to maintain qualifications

Nonmember companies could also benefit from this course to better their marketability in the field of inspection and repair of FRP.

The course consists of nine training modules, including:

1. Materials
2. Design
3. Fabrication
4. Inspection Philosophy
5. Inspection Tools
6. External Inspection
7. Internal Inspection
8. Visual Inspection
9. Repair and Alterations

Each module requires between 30–45 minutes, with a total of eight hours of coursework to be completed. The \$100 member registration fee is solely for administrative and hosting costs to provide the

course as a benefit of membership. The course is available at a higher rate of \$1,000 to nonmembers. Upon successful completion of the training program, a course completion certificate will be awarded.

“This project has been a labor of love by project co-champions Ed Naylor (Nouryon) and Hardin Wells (Albemarle), with the help of multiple team members and three MTI ADs, especially Dale Keeler in the last few years, to guide this over the finish line,” explains Heather Allain, MTI Executive Director. “We appreciate the team’s hard work to develop this great online offering, which is not available anywhere else in the processing industries.”

Course sign up is now available! Scan the QR code or visit www.mti-global.org/participate/education/frp-training-equipment-design-inspection to learn more and get started. ■



eLearning Course for FRP (Fiber Reinforced Plastics) Inspection Basics

Course Description

Online introductory Fiberglass Reinforced Plastic (FRP) training for use in chemical processing industries. The FRP training course covers materials used to construct FRP equipment (vessels, tanks, and piping), basic design and fabrication, inspection tools and philosophy, what to look for during internal and external visual inspection, and a brief overview of the repair and alteration of FRP.

Exclusive! This is currently the only training available that addresses the inspection of FRP equipment.

This Flexible Online Program Provides:

- Foundational Information on the Material (FRP)
- Damage Mechanisms to be Aware of and Causes
- Inspection Techniques That Work Best for FRP Inspections
- Assessment of Repair/Alteration and Planning for These Repairs/Alterations
- Acceptance Criteria for Repairs/Alterations

Additional Information

Intended for plant, engineering or materials personnel and inspectors seeking to improve their knowledge and understanding with respect to in-service FRP inspections.



Online, On Demand Delivery Format



8 Hours of Coursework



MTI Members: \$100
Nonmembers: \$1,000



SANICRO[®] 35

A SUPER AUSTENITIC MATERIAL SOLUTION
FOR PETROLEUM REFINING, CHEMICAL
PROCESS INDUSTRY, AND RENEWABLE
DIESEL PRODUCTION

KAREN PICKER, M.SC. – TECHNICAL MARKETING MANAGER
KAREN.PICKER@ALLEIMA.COM

LUIZA ESTEVES, PHD – TECHNICAL MARKETING ENGINEER
LUIZA.ESTEVES@ALLEIMA.COM

RODRIGO SIGNORELLI – LEAD TECHNICAL MANAGER –
MARINE & ENERGY
RODRIGO.SIGNORELLI@OUTOKUMPU.COM

CLAES TIGERSTRAND, M.SC. – GLOBAL
TECHNICAL MANAGER, HEAVY INDUSTRY
CLAES.TIGERSTRAND@OUTOKUMPU.COM

Abstract

When making metallurgical upgrades in the petroleum refining and chemical process industries, there are many alloy options to choose from. Striking a good balance between corrosion performance and project economics is vital in material selection. Traditionally, when 300 series austenitic grades are no longer an option, users then have the option to use duplex stainless steel (DSS) grades, provided the operating temperature of the process is within the acceptable limits for this family of alloys, or to use super austenitic grades. However, in severely corrosive environments, the available alloy options become limited, and the solution is typically found in traditional and costly nickel alloys like Alloy 625 and Alloy C-276. Sanicro® 35 is a 27% Cr, 35% Ni, 6.5% Mo recently developed high-performance austenitic stainless steel with a pitting resistance equivalent number (PRE) of 52 that approaches nickel-based alloy performance in certain environments. This article explores the alloy's performance in comparison to austenitic and nickel-based alloys in various process environments by using standardized testing methods such as ASTM G48, modified ASTM G150, ammonium chloride (NH₄Cl), ammonium bisulfide (NH₄HS), as well as its pitting and stress corrosion cracking resistance in renewables lipids feedstock pre-treatment conditions.

Introduction

Sanicro® 35 is structurally stable, offers localized corrosion resistance, and outperforms conventional 6Mo grades. It also has the desirable corrosion resistance of high nickel grades in chloride-bearing environ-

Grade		C	Cr	Ni	Mo	N	Fe	Others
Type	UNS							
316L	S31603	0.04	17.2	10.1	2.1	-	Bal.	-
904L	N08904	0.01	19.8	24.2	4.3	-	Bal.	1.4Cu
254 SMO	S31254	0.01	20	18	6.1	0.2	Bal.	Cu
Sanicro®35	N08935	0.02	27.0	35.0	6.5	0.30	Bal.	Cu
6XN	N08926/ N08367	0.01	20.5	24.8	6.5	0.2	Bal.	Cu
Alloy 825	N08825	0.01	23	39	3.2	-	Bal.	Cu, Ti
2507	S32750	0.02	25.0	7.0	4.0	0.27	Bal.	-
Alloy 31	N08031	0.015	27.0	31.0	6.5	0.2	Bal.	2Mn, Cu
Alloy 625	N06625	0.03	22.0	Bal.	9.0	-	<5.0	3.5 Nb+Ta
Alloy C276	N10276	0.01	16.0	Bal.	16.0	-	5.0	3.5W, 2.5Co

Table 1 – Chemical composition of the grades

ments. The PREN is used to rank the pitting corrosion resistance based on the chemical compositions, and a commonly used formula is PRE= %Cr+3.3%Mo+16%N. Sanicro® 35 is classified as super austenitic stainless steel due to its high PREN value of approximately 52 [1]. This material was designed to bridge the gaps between duplex stainless steel or austenitic grades and nickel alloys. Sanicro® 35 is an alternative material for applications in demanding environments, such as seawater coolers [2], high chloride, and high-temperature processes. Sanicro® 35 produced in sheet, plate, bar, seamless tube, and pipe is approved by the ASME Boiler and Pressure Vessel Code, Section VIII, Division I and II, under Code Case 2982-2 up to 450°C (842°F). It provides easy fabrication when it comes to welding. Sanicro® 35 requires no pre-heating or post-weld heat treatment due to its high

structural stability and is not prone to form intermetallic phases. It also offers formability comparable to other 300 stainless steels and super-austenitic grades, which allows cold bending to a tight bending ratio.

Corrosion Properties

The combination of high contents of nickel, chromium, and molybdenum in Sanicro® 35 offers resistance to general corrosion in many common acids, such as hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid, caustic solutions, and organic acids [3].

Pitting and Crevice Corrosion

Table 1 compares the chemical composition of different austenitic and nickel alloys. When performing accelerated corrosion tests in ASTM G150 with a modified and more aggressive solution of 3M MgCl₂, it is demon-

strated that, given its highly alloyed composition and PRE number, Sanicro® 35 has superior resistance to pitting corrosion and crevice corrosion in comparison to 6Mo grades, duplexes, other types of stainless steel, or even nickel-based alloys, as shown in Figures 1, 2, and 3.

Figure 2 compares the critical pitting temperature (CPT) of Sanicro® 35 and Alloy 625. This chart shows the results from testing according to ASTM G48 Method C, which has a testing temperature limit of 85°C (185°F), “Green Death,” and modified and more aggressive 4.5M MgCl₂ ASTM G150 solution.

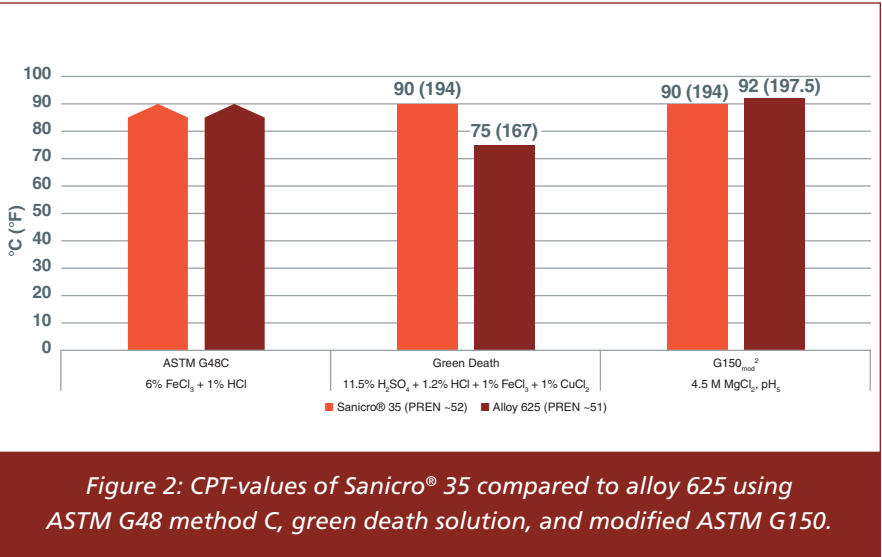
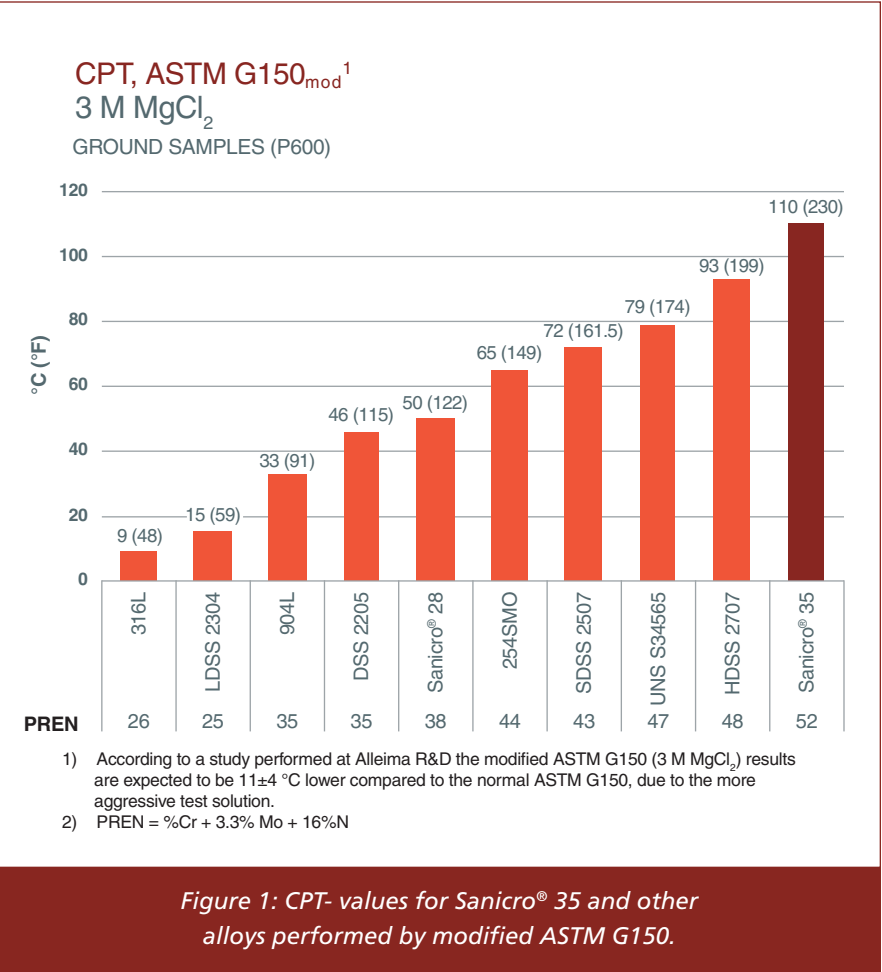
Figure 3 shows the crevice critical temperature (CCT) for Sanicro® 35 and other alloys. Sanicro® 35 can be an alternative in applications where seawater or chloride environments are present. Sanicro® 35 exhibited superior localized corrosion resistance compared to austenitic stainless steel. It also provided comparable corrosion resistance to Alloy 625 and Alloy C-276 while being a more cost-effective solution.

Figures 1, 2, and 3 prove that Sanicro® 35 is more resistant to localized corrosion than austenitic stainless steels. The data in these figures also confirms that the localized corrosion resistance of Sanicro® 35 is comparable or superior to two of the most widely used nickel alloys (Alloy 625 and Alloy C-276) in several standardized laboratory corrosion tests.

Stress Corrosion Cracking (SCC)

Standard austenitic steels of the ASTM 316 type are susceptible to chloride-induced stress corrosion cracking (SCC) in chloride-bearing solutions at temperatures above 60°C (140°F). However, SCC

> CONTINUED ON PAGE 30



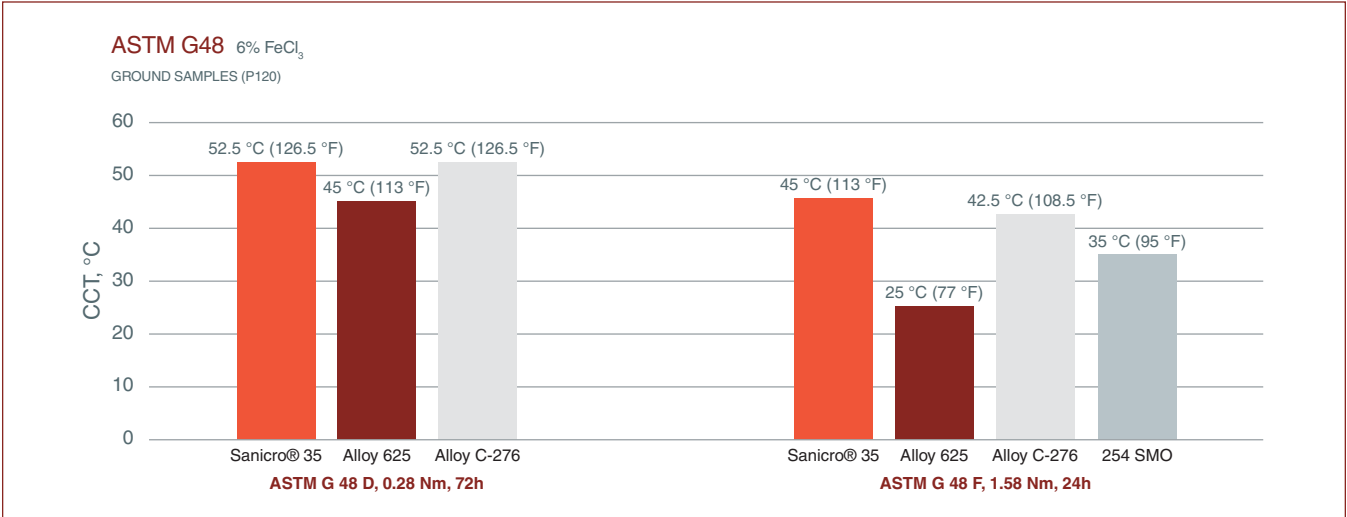


Figure 3: CCT-values for Sanicro® 35 compared to other alloys using ASTM G 48 Method D and F.

Grade	Cracked Samples
254 SMO	3/3
6XN	3/3
Sanicro® 35	1/3
Alloy 825	2/3
Alloy 31	3/3

Table 2 – Results of SCC resistance. 24h U-bend test in boiling 45% MgCl₂ at 155°C. Number of cracked specimens out of three tested.

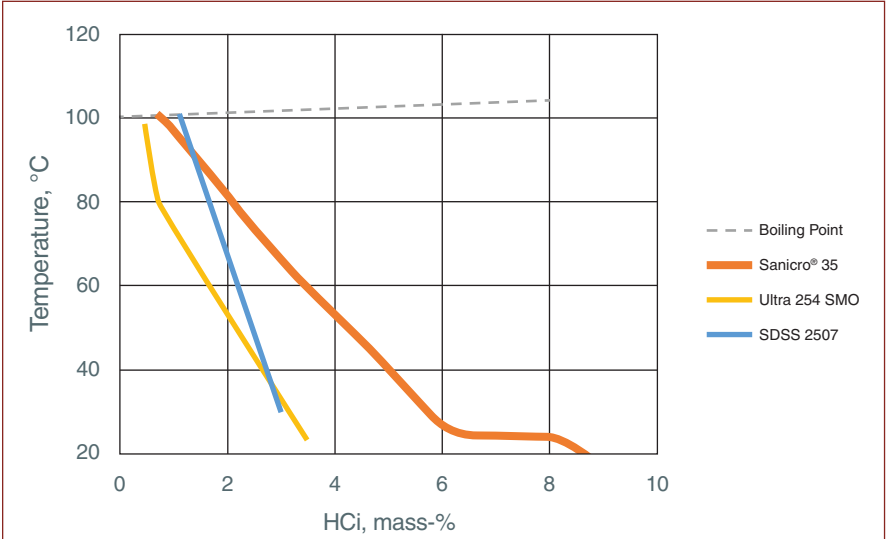


Figure 4: Iso-corrosion in hydrochloric acid. The curves represent a corrosion rate of 0.1 mm/year (4 mpy) [3].

susceptibility declines with increasing nickel content of the alloy. Additionally, a chromium content of over 20% can also be beneficial. Sanicro® 35 has excellent resistance to SCC, as seen in Table 2.

Renewable diesel feedstock contains contaminants, such as phosphorus, metals, and chlorides, that call for a feedstock pre-treatment process that involves high temperatures, pressures, and an acidic environment. In addition, these feedstocks are rich in such free fatty acids that lead to a highly corrosive environment with a high total acid number (TAN). All of these represent a challenge for the material of construction of renewable pretreatment units that require improved metallurgical solutions. Corrosion concerns include the potential for chloride stress cracking at high temperatures and high acid concentrations. Sanicro® 35 has been tested in water with pH=2 using citric acid, 500 ppm chlorides, and T=275 °C (527 °F), proving to be resistant to corrosion and cracking under these conditions.

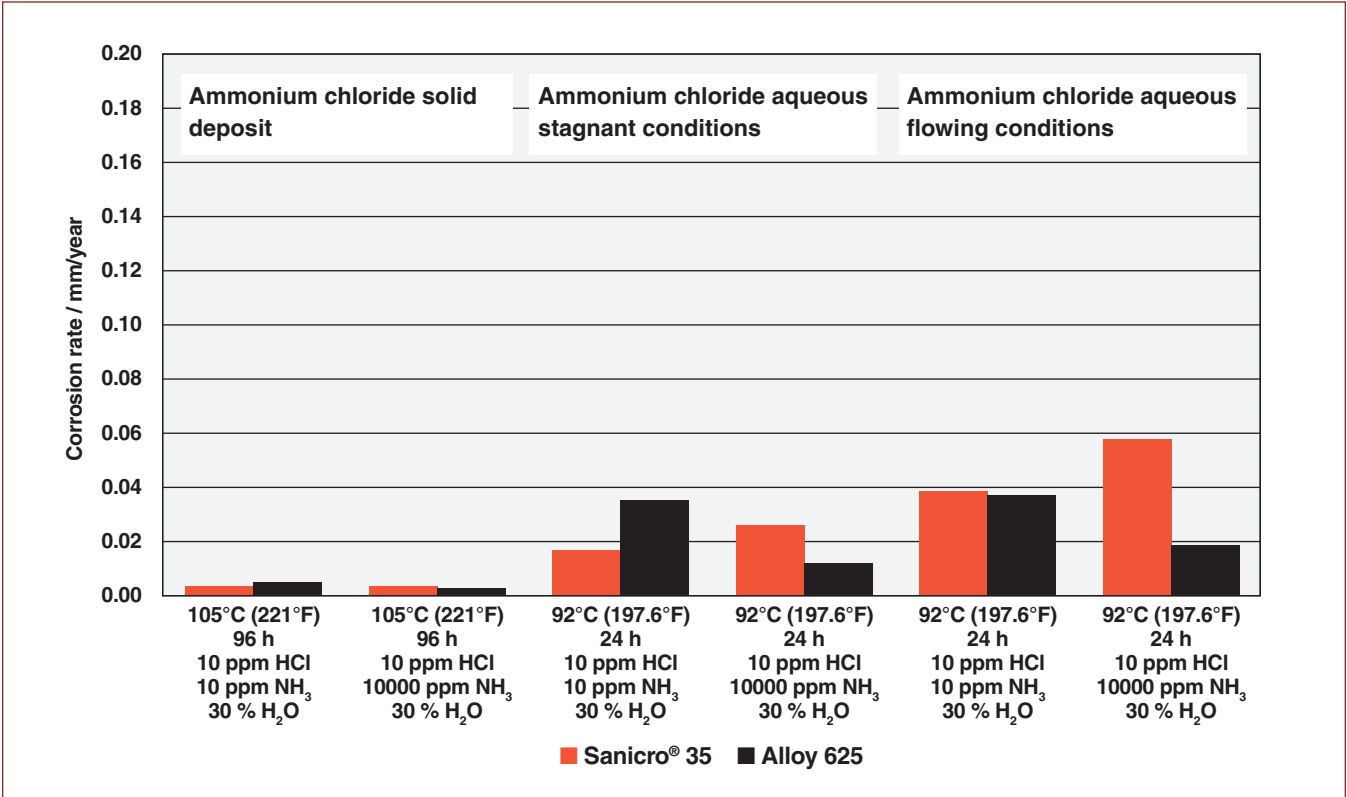


Figure 5: Corrosion rates for under-deposit and acidic aqueous corrosion performed at Honeywell, Houston, TX, USA.

Corrosion in Refineries

In refineries, the distillation tower overhead systems of the crude distillation unit can be susceptible to corrosion due to hydrochloric acid when the equipment operates at or below the water dewpoint temperatures. Sanicro® 35 performs well in hydrochloric acid and can be used in heat exchangers that may encounter dew point corrosion from condensing hydrochloric acid [4,5]. The pH level of the starting condensate is around 1 or 2, which varies based on the quantity of HCl present in the distillation tower's overheating stream [6,7]. The iso-corrosion diagram shown in Figure 4 demonstrates that Sanicro® 35 is a suitable alloy for situations where such conditions may occur.

A common cause of corrosion in refinery applications such as over-

head condensers, hydrotreater shell and tube heat exchangers, and air coolers is fouling from ammonium chloride (NH₄Cl). Ammonium chloride can cause under-deposit corrosion, pitting corrosion, and stress corrosion cracking. Sanicro® 35 has been shown in advanced laboratory testing to have the same resistance to this kind of corrosion as Alloy 625 (see Figures 5 and 6).

Figure 5 shows a simulation of the ammonium chloride under deposit corrosion in crude distillation overhead condensers, where Sanicro® 35 was shown to be a cost-efficient alternative to alloy 625 for overhead condensers in refinery applications [6]. Other challenges particularly predominant in the effluent from the hydrotreater reactor are chloride and sulfide stress corrosion cracking and pitting corrosion of

lower alloyed stainless steels due to the presence of water, hydrogen sulfide, ammonia, carbon dioxide, and chlorides. Upon cooling, an acidic water phase with chlorides is formed, which can cause cracks and leaks that potentially lead to fires or explosions if hydrocarbons are released into the atmosphere. Typical heat exchangers where corrosion is a concern are Feed/effluent heat exchangers, Reactor effluent air coolers (REACs), Water-cooled heat exchangers, and Pre-heat trains. Traditional refinery heat exchangers use carbon steel tubes, TP321/347, or Alloy 825, but these may not be suitable, particularly when processing renewable feedstock. Figure 6 shows corrosion tests similar to the ammonium bisulfide (NH₄HS) in reactor effluent air coolers (REAC)

CONTINUED ON PAGE 32

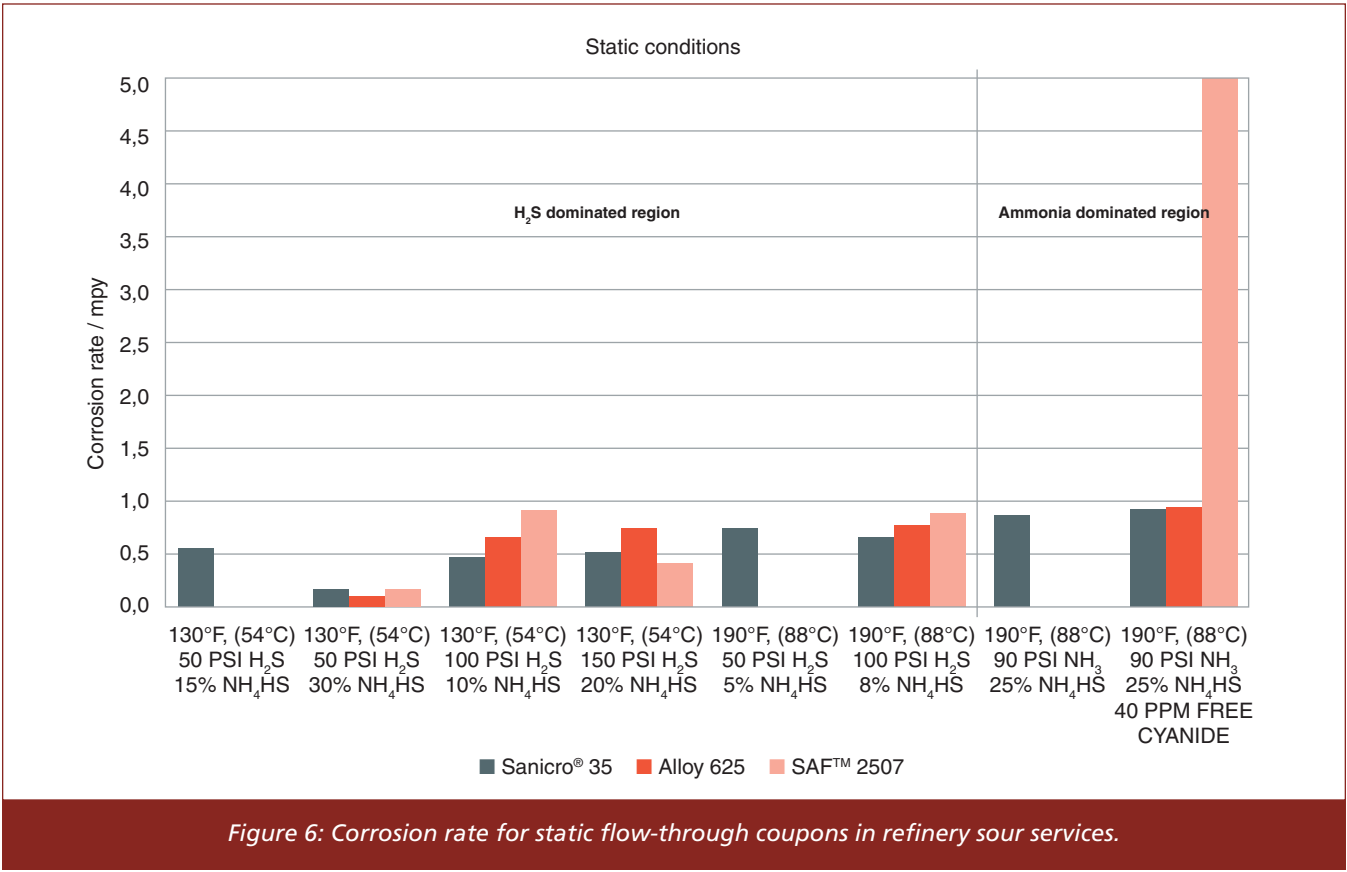


Figure 6: Corrosion rate for static flow-through coupons in refinery sour services.

service [8]. Sanicro® 35 has excellent corrosion resistance to ammonium bisulfide corrosion. In the case of chlorides, it has much better resistance toward pitting and crevice corrosion than Alloy 825. Sanicro® 35 has proven excellent corrosion resistance to both ammonium chloride and ammonium bisulfide corrosion.

Conclusions

Sanicro® 35 is an alternative material for applications in demanding environments, such as seawater coolers, high chloride, and acidic conditions. With its high yield strength, excellent pitting, crevice, and stress corrosion cracking resistance combined with good structure stability and weldability, Sanicro® 35 is suitable for the refinery and chemical industry.

References

[1] S. Li, Precipitation behavior of the super austenitic stainless steel Sanicro® 35 and the effect on impact toughness and pitting corrosion resistance, M.Sc. Thesis, School of Industrial Engineering and Management, 2022.

[2] J. Eidhagen, R.M. Öhnfeldt, U. Kivisäkk, UNS N08935-a new alloy for seawater applications, in: Corrosion 2021, Paper No. 16573, 2021.

[3] B. Helmersson, M. Almén, Uniform Corrosion Characterization of UNS N08935, in: AMPP 2023, Paper No. 19294, 2023.

[4] D. Gullberg, R.M. Öhnfeldt, A.R. Yhr, Corrosion properties of Alloy 35Mo, new PREN 52 alloy for refinery and chemical industry, in: Corrosion 2020, 2020: pp. 1–9.

[5] D. Gullberg, R. Mattsson Öhnfeldt, A.R. Yhr, Corrosion properties of Alloy 35Mo, new PREN 52 alloy for refinery and chemical industry, in: Corrosion 2020, Paper No. C2020-14769, 2020.

[6] J. Höwing, K. Picker, Corrosion Properties of UNS N08935 In Crude Distillation Unit Overhead Service Conditions, Corrosion 2021 (2021).

[7] N. International, Crude Distillation Unit — Distillation Tower Overhead System Corrosion, NACE International Publication 34109 (2009) 1–85.

[8] K. Picker, J. Höwing, Corrosion Behavior of UNS N08935 In Refinery Sour Water Services, Corrosion 2021 (2021). ■

HTHA PROJECT SERIES PRODUCES FINAL REPORTS AND GUIDELINE

MTI COMPLETES PROJECTS 305, 355 AND 362

HTHA Crack-like Damage Imaging in Weld (top; left [A] – before surface preparation, right [B] – after surface preparation) using FMC/TFM (C), FMC/PCI (D) and PWI (E) Techniques

MTI’s High Temperature Hydrogen Attack (HTHA) project series is complete! The project teams are pleased to share the results, including three final reports and a “Guideline for Optimized HTHA Nondestructive Evaluation (NDE) Performance.” The final reports and the guide were released in mid-July and are available exclusively to MTI members in the Technical Resource Library.

Project 305 “Performance of NDT, Simulation and Destructive Testing on Carbon Steel Samples Damaged by HTHA” funded in December 2017, was developed to evaluate NDE methods and to develop a simulation model of HTHA defects in carbon steels. It demonstrated the ability of the selected ultrasonic

techniques to detect and characterize the early stages of HTHA damage, limitations of these techniques in resolving specific degrees of damage and in identifying actual damage from noise or signals generated by the microstructures or inclusions of the steels. An ultrasonic simulation script for an ideal volumetric HTHA damage case was developed as a CIVA module and validated by comparison to metallographic images.

Phase 2, MTI project 355, was initiated with the main objective to refine the simulation technique for HTHA and develop and test optimal NDE probes and calibration blocks. Simulated probe designs were tested, then several iterations of actual probes were built and tested

to determine the best design for HTHA early stage damage.

The scope of project 362 applied the same simulation techniques to the critical weld area and inclusions. Statistical laws, simulation, and modeling of both synthetic inclusions and field exposed samples were used to improve discrimination and further refine the probe designs.

The resulting probes developed because of the project will be available as MTI HTHA Probes from Ekoscan. The final deliverable of the project is a succinct guideline that summarizes the optimal use of these probes and interpretation of the data to assist end users with HTHA evaluation. ■



Q&A

CAMERON MORELOCK

#409 Evaluating Equipment for High Purity Service

PROJECT CHAMPIONS

MTI is at the forefront of providing global leadership in materials technology to improve safety, reliability, sustainability, and profitability. Technical research projects play a vital part in the success of the MTI mission. While the goal and outcome of each project varies, the overarching commonality is member leadership to develop and nurture each project from inception to completion. These member leaders, dubbed MTI Project Champions, have the unique opportunity to grow leadership skills, network and create tangible solutions alongside other industry professionals.

In this issue, CONNECT spoke with Cameron Morelock to learn about his leadership experience championing project 409 — Evaluating Equipment for High Purity Service.

Q: Please describe your role at Eastman.

A: My current role at Eastman is an Engineering Technologist; however, I started at Eastman in September of 2014 as a “limited-service employee” in the Analytical Services Department. I worked swing shift for a year in that lab patiently awaiting an opportunity to get in full time with Eastman. That opportunity came in 2015 when I was offered a chance to interview with our Materials Team within Worldwide Engineering and Construction. I have been with that team ever since. My responsibilities have changed and grown over the years. When I was first hired in, I was a level 1 technician. I would come in, cut up materials for destructive failure analysis, and prepare

metallographic samples. With my background in chemistry, I was able to transfer my lab skills into growing our corrosion testing capabilities. We now have an extensive, although small, corrosion testing lab within Eastman alongside our destructive failure analysis lab. I support 35 manufacturing sites globally for Eastman using our lab. To say that we are busy is an understatement, but I still enjoy the work as well as the team I am privileged to work with.

Q: How long have you personally been a member of MTI? How have you benefited from your involvement?

A: I personally joined MTI in 2022. After much encouragement from Curtis Huddle, I created

an account and got to work digging through old forum posts and taking in information when I had time or was seeking an answer to a question that left me scratching my head. To capture the full benefit of MTI would be an undertaking far more laborious than any one person could handle. The amount of information, expertise, field experience, and lessons learned that MTI has been able to capture makes it one of the most potent and vital communities within the materials science industry. Seeing is believing when it comes to the MTI experience. We went through some difficult times with strictly online participation but when it comes to meeting in person, I have yet to attend any

other organizational meeting that holds this much experience within the walls of a building. I look forward to what the future holds for MTI as well as how I can contribute and pay it forward in the industry.

Q: Have your fellow MTI members helped you grow in your career and/or in your involvement with MTI? If so, how?

A: Everyone I have interacted with at MTI has helped me in some way and becoming a project champion has been one of the best ways to really dig into MTI and see what it’s all about. I could thank countless members. From the “deer in the headlights” task of becoming a project champion to off-the-wall transport questions about trailer materials or isotainer stability, to the mysterious behavior of titanium and zirconium, many members have helped me in one way or another.

Q: How did you become a project champion of this project?

A: During AmeriTAC 141, I spoke with Andrew Rentsch, Huntsman and Curtis Huddle, Eastman Chemical, about the need for high purity support for our site after the High Purity Roundtable. We threw some ideas around and landed on the current project. I decided to take on the role so I could solidify myself as a regular at MTI since Eastman has never sent a “tech” to MTI, only engineers. I currently have nine years of intensive testing experience within Eastman that I bring to the project team and hope to keep honing my craft through ques-

tions posed to others within the industry that have already “been there, done that” and gained insight from their learning.

Q: How was the project idea developed? Are/were the current/final stages of the project the same as the original idea? If not, how have they changed?

A: The project is a large undertaking, and we are still carving out ideas for it. It has morphed several times but still holds the image of its former self even after revision. The goal is ultimately to provide a resource to help those in the high purity industry have a quick reference for solving problems and to provide some case study information when guidelines are too vague.

Q: Tell us about the Project.

A: Project 409 is, simply put, “Evaluating Equipment for High Purity Service”, but simple is not always easy. The goal is to provide a resource for folks to reference when working with high purity applications. How do we assess our equipment? What do we do if we can’t use new equipment? What analytical tests are required to ensure we are running a properly clean product? These questions and more are what we intend to tackle with this project. It’s hotly contested how to go about evaluating this equipment. In a perfect world with free money, it should all be new, self-contained, and never opened ever again for the life of the process. I wish that could be true! It would make this project obsolete and solve my greying hair problem. Since that is not

the case, we hope to target industries working with the ever-demanding requirements of high purity products by providing this resource within MTI to direct people with questions to the proper resources and answers, whether that be the standards required for testing your equipment or studies that have shown what works and does not work. Although it is still a work in progress, I feel confident the team will land on a scope that will be sufficient to provide value to MTI as well as attract contractors to help tackle the work.

Q: Please explain what you have learned from your previous experiences on an MTI project team (or as a project champion) and how it has helped you champion this project.

A: My experience within the Knowledge Management PDC has led me to feel confident enough to tackle a Project Champion role within MTI. I have learned that we are all here for the same reason, to move the industry forward and share knowledge with others to make each other better at what we do. I have always felt comfortable speaking up and asking questions and have found that others may be thinking the same thing but don’t want to ask. MTI has a wonderful staff to help guide people who want to be a champion as well and they do much of the heavy lifting. I would recommend anyone who is thinking about getting involved as a champion to take the leap and see what you learn along the way!

> CONTINUED ON PAGE 38

One of the first being at that Houston meeting, where MTI hosted an early career panel at Rice University for the students there. I volunteered to offer a more similar experience to what those students are currently going through, as I had only graduated a few years prior. The opportunity to be the “early career person” on the panel was very nice.

I’ve also been fortunate enough to champion two projects through MTI and have been on the project team for a few more, mostly through polymers project committees. That opportunity to be involved so quickly and so early on has been really great. Basically, all the opportunities were there. I just had to put my hand up and say that I would do it.

CONNECT: Tell us more about those projects that you’re championing.

Boyer: I championed Project 394, which was a summary of ASME PCC 2 Part 4 and the corresponding ISO standard. The project summarizes the requirements of those two standards, but also explains what those composite wraps system repairs would look like. It covers non-metallic wrap repair for metallic equipment at sites, which is particularly important to me because we get asked that type of question all the time by our manufacturing sites. I think it’s very important as well for some of the more metallic-leaning folks at MTI or folks not as familiar with the composite wraps systems.

This project is going to culminate in a summary guide and also a summary-like flow chart, basically to tell you, ‘If you have a repair, start here and here’s all your options.’ A webinar has also been recorded and will be available on the MTI website. I think that the project is particularly interesting and useful as it gives another option for time-

limited circumstances like these repairs are typically used for.

My other project role was on the second dual laminate training hosted by MTI. Deb McCauley involved me very early, so I was fortunate enough to be on the team for the original Amsterdam training session project. I was able to work on those modules and basically give feedback to the team as someone who was still learning the technology. Then this go-around, I was a Champion for the dual laminate training in The Woodlands, Texas, and I was also fortunate enough to be one of the trainers for that workshop.

CONNECT: What an amazing opportunity to participate in the live training, being fairly new to your career. That had to be just tremendous to get in there mixing with all these other subject matter experts from around North America and having these discussions. What a great opportunity for a young professional!

Boyer: I keep saying that I’m very fortunate, and it’s going to be a recurring theme. But I’m grateful to have worked with Dale Keeler, Deb McCauley, Brian Linneman and Lisa Desai, who was my Co-Champion. We all were the trainers for this project. I learned so much from them in the process of setting it up and also in the process of just delivering those modules.

I was fortunate enough to get some modules that I have a little bit of background in, so I could contribute but also was able to learn and work with them, which was really a great opportunity.

CONNECT: Let’s turn our attention to the forum, a unique feature that MTI offers. How has it helped you in your young career, either from a

learning perspective or getting critical questions answered in a timely fashion?

Boyer: I get the summary email every day and I read through the posts on the technical forum. And for some context on me, my background is in chemical engineering and materials engineering with a polymers focus, so I don’t have any formal metals training.

I don’t know anything about metallic components more than just the basics of what to call them, so the forum has been really good for me.

The questions and answers posted are at a very high technical level. Seeing those from someone who doesn’t really have a background in metals, while a little overwhelming at first, has been a great way to get my feet wet or be thrown into the fire.

A lot of the questions and comments sound interesting. Many times I found that the search on the MTI website points back to old forum posts that will also give me some background. My initial interaction with the technical forum was just a sort of a deer in headlights for this high level information, but the more I’ve interfaced with it and work through it, the more knowledge I’ve gleaned. I find it incredibly useful, and I have a lot of value for the forum.

CONNECT: Now, for fun, we’d like to get to know you outside your role as an engineer and polymers expert. So, what are your hobbies, Avery?

Boyer: I really enjoy soccer. I grew up playing soccer, played all the way into college, since getting out and starting my career, I’ve transitioned more to the coaching side. I’m coaching a travel team here in Delaware, so that’s a pretty big hobby of mine. I like still being a part of the game and coaching.

I also watch it a lot. I’m an Arsenal fan, which is a team out of England. So soccer is probably my biggest interest in a hobby outside of work, especially in the sports realm.

CONNECT: Enough fun for now. Back to the business at hand. Your traveling team and the Euro Cup will have to wait. What are some of your ambitions within MTI as an active member? Are there any projects or areas that you would like to see us delve into that you think would be valuable to you?

Boyer: Right now, my main goal is immersing myself and learning as much information as I can. I’ve talked with Dale Heffner and Dale Keeler specifically about the Polymers PDC. That’s where my background is and where most of my interests lie. They’ve been really great about getting me more involved in some of the planning, and as of AmeriTAC 144, I have agreed to be the chair of the Polymers PDC.

A good example of where they were kind enough to let me help

early was with a brainstorming session held before I began participating. They had a list of topics and let me lead a group in ranking those project ideas and trying to get champions for them. One of the ideas to come out of that was Project 399, the second Dual Laminate Training. I can’t pat myself on the back too much for saying I found a champion because it was me and Lisa. But at least we got the project off the brainstorming page and into the actual funded stage.

CONNECT: Final question: Any other thoughts on MTI in what it’s meant to you as a young professional or any other thoughts that you have on MTI that you would like to share with your colleagues and peers around the world?

Boyer: I think the networking present in MTI is really unique and extremely valuable. My first few meetings going, I felt kind of like the new guy—all these folks have known each other for years. They’re all very advanced in their careers,

and I really wouldn’t have imagined if they saw any value in talking to me. It was the complete opposite. Everyone was extremely friendly and extremely happy to have earlier career people being involved. Any area I have expressed any interest in has been met with the utmost support and encouragement. Whether it’s individual over emails, over phone calls, or in person, I haven’t had an ounce of negativity towards me or any of my ambitions. It’s been really exceptional to come into this community of extremely intelligent and technical folks, which can be very egotistical or cagey in other environments, and really find a technical community that wants to work together and work towards a common goal. I know that’s the slogan of many individual organizations, but I think it’s embodied by MTI. I’m just really grateful and happy to be a part of it and looking forward to more involvement in the future! ■

NOMINATE OR APPLY FOR MTI 2024 HONORS > CONTINUED FROM PAGE 4

The Value Awards Eligibility

The Value Award recognizes members that have realized quantifiable value from successful application of knowledge gained through their MTI membership. Any current employee of a MTI member company is eligible to submit an application.

Value case examples could include, but are not limited to:

- Incorporation of training or procedures developed and delivered by MTI

- Application of technical knowledge obtained from MTI Projects or Publications
- Savings and efficiencies realized from information gained at live TAC forums, structured forum presentations, or through MTI’s online technical forum
- Solutions obtained via MTI’s network of experts and member representatives
- Producer-supplier joint projects that have delivered value to the companies or the industry. (There is no limit to how many

companies can be included on a single Value Award application that focuses on a collaborative effort benefiting more than one organization.

All award nominations and submissions are due by Friday, September 20, 2024. Please visit www.mti-global.org/membership/ awards for applications and additional information. ■



MTI AsiaTAC and Japan Society of Corrosion Engineering (JSCE) collaborated to hold a joint meeting in Sonic City, Japan in early June.

ASIATAC/JSCE JOINT MEETING A SUCCESS

> CONTINUED FROM PAGE 17

The upcoming meeting will also offer members a chance to follow up on several interesting project ideas collected at the AsiaTAC 2023 Fall meeting in Shanghai, China. Since last year's event, AsiaTAC members expressed the need for "in-field corrosion testing and monitoring" training, a special opportunity that has been

added to the Fall 2024 program. According to Cheng, three trainers will cover the technology overview, selection of corrosion monitoring points, case studies in actual refineries and chemical plants, and more. In addition, the training will be provided in Chinese, since China-based companies are the primary targeted audience. The training

materials will be prepared bilingually so that MTI's worldwide membership can participate.

Be sure to register at www.mti-global.org/about/events/asiatac-meeting and join us in one of China's most historic and beautiful cities! ■

PROJECT CHAMPION SPOTLIGHT

> CONTINUED FROM PAGE 35

Q: What are you gaining from this experience as a project champion?

A: The connections to MTI are a large factor to consider when taking on the Project Champion role. I feel more connected to MTI because of the project and because I have the opportunity to talk with others and gather insight within the team as we develop scope and talk about the different aspects of the project. I am also learning how to reach out for feedback and not be afraid of criticism. I enjoy some conflict in my life because

it makes me a better person and keeps me sharp. I'm always open to the "devil's advocate" in the room because it may reveal blind spots that I would not see otherwise. Overall, the whole experience as a PC has made me more confident in my decision making and willingness to ask questions to inquire and learn from others.

Q: What are you passionate about outside of work and MTI?

A: Outside of MTI, I have more hobbies than I have time.

I work on vehicles, play drums for a few churches locally, bow hunt, camp, hike, fish, work on watches, and collect/enjoy whiskey in my free time to name a few. I'm always up for sitting down and having conversations with people to get to know them better as well.

CONNECT thanks Cameron for his contributions. Members interested in the 409 project can learn more at www.mti-global.org. ■

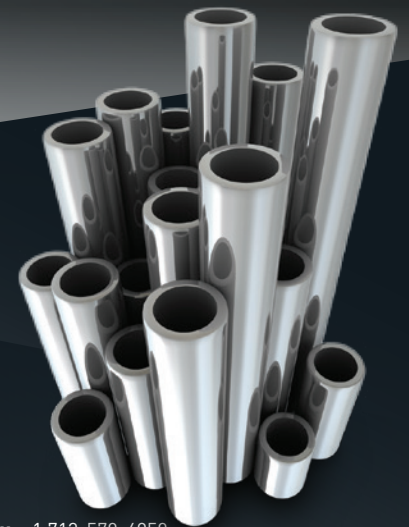
- Backorders?
- Late Deliveries?
- Inaccurate documentation?
- Specification non-conformance issues?
- Material not protected for shipment?

TIME FOR A CHANGE TO P.A. INC.

P.A. Inc. is leading the way with solutions for specialty alloy piping requirements.

PIPE, FITTINGS AND FLANGES

- | | |
|---------------------------|------------------------------|
| ▶ Alloy 20 | ▶ Alloy C-276 |
| ▶ Alloy 200 | ▶ Stainless 304H, 321H, 347H |
| ▶ Alloy 400 | ▶ 2205 Duplex |
| ▶ Alloy 600, 601, 625 | ▶ Titanium GR. 2 & 7 |
| ▶ Alloy 800H/HT, 803, 825 | |



6626 Gulf Freeway, Houston – Texas 77087 | USA Phone: (800) 460-7473 | +1 713-570-4900 | Fax: +1 713-570-4950

Email: sales@painc.com | www.PAInc.com

Where Does RMB FIT in Your Plant?



Find out if your vessel will FIT in our oven:



Equipment Fabrication

- Carbon or stainless steel materials
- ASME Section VIII certified
- Columns, reactors, scrubbers, storage tanks, and process vessels
- Expedited service available

ETFE (Tefzel™) Rotolining

- Long-lasting corrosion protection
- Exceptional chemical resistance
- Outstanding thermal stability
- Seamless bonding
- Full vacuum rating



Over 30 Years of Combating Corrosion for Major Chemical Processors

Questions? Contact us:
(719) 382-9300 ■ rmbproducts.com

APPLICATIONS FOR THE 2025 MTI SCHOLARSHIPS OPEN SEPTEMBER 1

TWO \$5,000 AWARDS AVAILABLE

The Materials Technology Institute invites college students who show an interest in pursuing a career related to Materials Engineering in the Process Industries to apply for the prestigious 2025 Bert Krisher and Robert Sinko Memorial Scholarships. Each scholarship is valued at \$5,000 and two applicants, selected by an MTI committee, will be awarded to help cover educational expenses.

Winning also offers the unique opportunity to network and build future working relationships with some of the most notable engineers in the process industries. The chance to attend one of MTI's global Technical Advisory Council (TAC) meetings is a highly regarded benefit of receiving an MTI scholarship.

Students may begin applying September 1, 2024. Qualified applications will be accepted from undergraduate students enrolled

in Materials Engineering, Materials Science, Corrosion Engineering, and other relevant programs. The following information is required for submission:

- Completed application
- Academic transcript
- Three recommendation forms from educators or employers familiar with applicant's background
- Résumé
- Supplemental essay



Applications must be received no later than January 2, 2025.

Scan the QR code for complete details or visit www.mti-global.org/about/scholarships! ■

