A Materials Technology Institute Publication

MTI CONNECT

2022, ISSUE 2

GLOBAL CHALLENGES / TRUSTED SOLUTIONS

PFA Sheets Used to Reduce Refinery Maintenance Costs

Page 22

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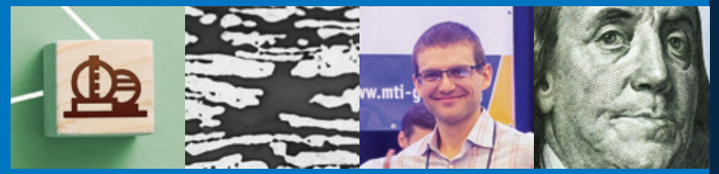
CONNECT

Inside This Issue



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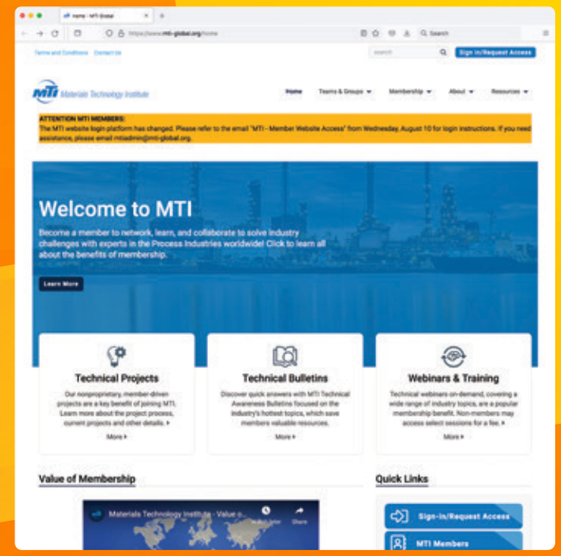
CALENDAR OF EVENTS:

AsiaTAC & Reactive Metals Training
September 19-20, 2022

AmeriTAC 139 & Ceramics Training
October 24-26, 2022

EuroTAC & FRP/Dual Laminate Training
November 14-18, 2022

MTI WEBSITE UPGRADES



MTI is pleased to announce the new login platform migration is complete. As you probably saw this summer, there were some periods of downtime while we updated the website navigation, look and login system. Thank you for your patience during this process!

Please take some time to log-in to the new system and familiarize yourself with the new navigation and member dashboard!

Member Login

Please sign-in to the new login system following the steps outlined to the right to ensure you have access to the member website. Be advised that your username may have changed due to requirements of the new login platform. If you need assistance retrieving your username, please email mtiadmin@mti-global.org.
IMPORTANT! You will need to set a new password the first time you login.

Review Your Profile Information

After signing-in, please review your profile to ensure your most recent data has been retained from the migration. Follow these steps:

1. From the member home page, click the "Profile" button under the Quick Links menu.
2. Under your profile image or avatar, click the "pencil" icon next to Contact Details.
3. On the Individual Profile page, review your contact information. If you wish to update any information, click the "Edit" buttons.
4. Click "confirm" at the bottom of the page to save your edits.

Note: Changes may take up to 30 minutes to refresh on your website profile page.

Member Dashboard

The member dashboard provides a more personalized MTI member website experience. On your dashboard, you can see and register for upcoming events, view/pay invoices, update your communication preferences and other features.

Follow these steps to view your member dashboard:

1. From the member home page, click the "Profile" button under the Quick Links menu.
2. Below your name and under the Dashboard heading, click the "Access My Dashboard" button.

Website Login Instructions

1. Visit mti-global.org and click the Sign-in/Request Access button.
2. On the Sign-in page, enter your username and click "Continue".
3. On the "Enter Password" page, click the "Forgot Password?" link.
4. On the "Self Service Portal" page, enter your email address associated with your company.
5. On the next page, confirm your email address by clicking "submit".
6. You will receive an email with instructions to set your password—click the link.
7. Set your new password and confirm in the fields provided.
8. Once your password is set, click the "Login Page" link to login.
9. Enter your username provided above in the "Enter Your Username" field and click "Continue"
10. Enter your password and click "Sign-in"

> CONTINUED ON PAGE 29

MTI BOARD APPROVES $480,000 TOWARD PROJECTS IN JUNE

EXEMPLIFIES COLLABORATIVE MTI PROCESS

The MTI Board of Directors (BOD) approved four projects following the AmeriTAC 138 meeting in Kansas City, Mo. this summer. The projects total $480,000 and will address issues of knowledge management improvement, composite repairs, High Temperature Hydrogen Attack (HTHA), and Duplex Stainless Steel (DSS) Welds.

Each project was presented to the TAC before proceeding to the BOD for financial approval. Member-driven projects are a key benefit of membership. Thanks to the efforts of the Project Champions and teams, MTI is continuing to provide trusted solutions.

Project 369 – Business Cases for Knowledge Management Continuous Improvement

Champions: Chuck Young, Tricor; Jay Schickling, Chemours

Amount Approved: $99,500

Scope: The case studies will be 2500 to 4500 words and address the main elements of KM as defined by ISO30401:2018, namely: Understanding the organization and its context; KM outcomes (planned & actual performance outcomes, success or failure); KM stakeholders; KM System; Knowledge search and retrieval; KM governance; KM culture; KM implementation; Lessons learned from the above.

Project 382 – Composite Repair Surface Preparation Study

Champions: Dale Heffner, ElectroChemical (A Knight Materials Company); Enxhi Marika, Chemours

Amount Approved: $93,000

Scope: Phase 1 – Understanding the impact of surface preparation on bonding ability and long-term performance of composite repair patches on flat samples; evaluate various surface finishes ranging from near white metal blast to no surface preparation; evaluate effects of surface prep on different materials of construction (CS, SS).

> CONTINUED ON PAGE 6

MTI BOARD APPROVES $480,000 TOWARD PROJECTS IN JUNE

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Project 390 – HTHA Atlas of NDE Images and Corresponding Microstructures

Champions: Nina Young, Chevron Phillips Chemical Company

Amount Approved: $253,000

Scope: It is envisioned this publication will complement API 586, Section2, which recommends the inspection ultrasonic techniques and provides limited HTHA imaging examples. The Guidance will focus on systematization and presentation of case histories (studies) for HTHA damage detected, imaged, characterized, sized with FMC/TFM, PAUT, TOFD and validated with metallographic/SEM imaging. The relevant case histories (studies) will be obtained from MTI #305-355-362 project reports, open literature publications, and other Joint Industry Projects.

Project 391 – Duplex Stainless Steel Welds at Elevated Temperatures

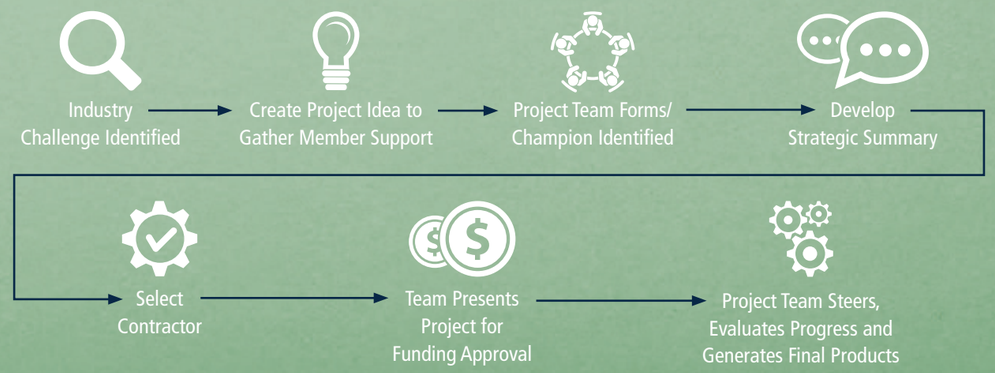
Champions: Anette Hansson, Topsoe; John Houben, ExxonMobil; Jennifer Larimore, Chemours

Amount Approved: $34,500

Scope: Heat treatments of welded SS2205 samples shall be conducted. The exposed samples shall be examined by impact testing at -40°C/°F, hardness measurements at room temperature in base metal, HAZ and weld material, and tensile testing at room temperature and at elevated temperature. Corrosion testing of weldments according to ASTM A923 Method C shall also be conducted to determine if there is significant precipitation of detrimental phases. The contractor shall perform all welding operations with MTI approved ASME IX WPS supported by PQR's and qualified welders. It is allowed to use preliminary WPS's and use the project test results to qualify the WPS/PQR's.

MTI'S PROJECT PROCESS

Many projects begin their journey as ideas through MTI resources such as the Forum, Knowledge Roundtables and the global Technical Advisory Council (TAC) meetings. When a Champion(s) has volunteered to lead the team, these projects typically move out of the Project Development Committees (PDCs) and are designated as Potential Projects. The research conducted is a collaborative process vetted through the PDCs, typically within each regional TAC. The goal is for the projects to be presented and approved for funding, then completed to develop products and/or resources that will benefit MTI members. ▪



NEW MTI SUPPLIER MEMBER AGRU EAGER TO PARTICIPATE

PLANS TO SHARE EXISTING KNOWLEDGE AND PROJECT IDEAS

Suppliers are a valuable piece of the unique MTI member-driven organization. In the first quarter of this year, MTI welcomed new supplier member AGRU, who initially began participating in MTI by exhibiting at the Global Solutions Symposium in 2020 and 2022. AGRU brings more than 60 years of experience in producing thermoplastic materials. According to Michael Krauss, the company's Designated Representative (DR), AGRU hopes to provide guidance for existing problems with their experience and knowledge of lining and piping systems with polyolefins and fluoropolymer.

AGRU's facility in Bad Hall, Austria (top) and Georgetown, South Carolina, USA (right).

"We decided to join because several of our key partners (RL Industries, Edlon — part of Pfaudler, and Electro Chemical Engineering & Manufacturing Co. — now part of Knight Materials) are members, and we solve corrosion problems in the Chemical Process Industry," Krauss explains. "We see value for both AGRU and end users."

Founded in 1948, the company has evolved from a locksmith and anodizing business with the decision to begin plastic pipe production in 1961. The focus since the late 90s has been concentrating on expanding and optimizing plastic production. These products include AGRULINE Piping Systems, AGRUCHEM Industrial Piping Systems, geosynthetic lining systems, concrete protection, infrared welding systems, and others. The business serves industries worldwide — Chemical/Heavy Industries, Semi-Conductor/Life Sciences, and Mining, to name a few.

"AGRU is based in Austria, but over 95 percent of our products are exported globally to six continents and more than 100 Countries," Krauss notes. "Outside of Austria, we have a Joint Production facility AGRU-Fank in Germany, a site in Poland, and Taicang AGRU Plastics in China. We also have Production in the United States with the headquarters in Georgetown, SC, two plants in Andrews, SC, a production site in Charleston, SC, and a Production site in Fernley, NV."

With several months of membership under their belt, Krauss remarks that AGRU is enthusiastic about participating in MTI.

"We have discovered a setting where we can collaborate with existing fabricators and end users to work on problems together rather than as adversaries," he describes. "It is really nice to be in an environment where teamwork across company boundaries is fostered."

He adds that networking and the MTI Technical Resource Library are valuable member benefits. After speaking with members, reviewing what resources MTI has available and internal discussions at AGRU, Krauss hints that they expect to propose some project ideas at MTI.

"We have ideas on projects involving thermoplastic welding conditions, H2 permeation through thermoplastics, and possibly looking at a project involving concrete protective liners," he concludes.

MTI is pleased to welcome AGRU and looks forward to a future of participation, project ideas, and continuing to solve industry challenges in a collaborative setting!

For more information about AGRU, please contact Michael Krauss through the MTI member directory or visit https://www.agru.at/. ▪

Hardness Conversion of DUPLEX STAINLESS STEEL Between the ROCKWELL C and VICKERS SCALES

BY YONG-JOO KIM
WEBCO INDUSTRIES, USA

I. Introduction

Hardness conversions between the Rockwell C and Vickers scales are different for duplex stainless steels as compared to carbon or other low-alloy steels. A proper conversion is an important consideration when hardness value limits from industry standards in Rockwell C are applied for weld qualifications or production testing, which may be conducted using Vickers macro-hardness value. The need to find the accurate correlation and development of a proper conversion table has been recognized from various organizations including ASTM, but not available yet.

This study was to evaluate and document the correlation between the Rockwell C and various Vickers scales. Tests were performed using UNS S32101, S32205 duplex and S32760 super-duplex stainless steel with various amounts of cold worked material in strip form. Different testing method options were evaluated to define the proper methodology and improve the reliability. Results documented in this experiment are summarized by the Rockwell C scale to the Vickers scale.

II. Study Summary

1. Material

Three different types of duplex grades were selected as a product form of hot rolled and solution annealed strip with chemical compositions and ferrite volume as shown in Table 1.

A section of the strip for each grade was further processed by cold rolling to increase the hardness by work hardening. The target amounts of cold working were 0% (as hot rolled & solution annealed), 5%, 10% and 15% to generate four groups of hardness for each grade. After cold rolling, samples were cut from the middle of the strip to eliminate any inconsistency from the edges.

As a reference, a microstructure of the sample material was evaluated as shown in Figure 1.

UNS Grade	Chemical Composition %											Ferrite %
	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cu	W	
S32101	0.018	5.02	0.024	0.001	0.66	1.6	21.4	0.3	0.23	0.36	-	45%
S32205	0.016	1.34	0.028	0.001	0.35	5.8	22.2	3.2	0.17	-	-	45%
S32760	0.017	0.66	0.024	0.001	0.30	6.8	25.4	3.5	0.29	0.55	0.63	43%

Table 1 Chemical compositions and ferrite % of samples

2. Measurement Methodology

Indentation Size or Volume Factor

A smaller impact will be more sensitive to the position of the impact in relation to the microstructure; this Vickers scale is illustrated in the figures on page 10 (mild etching in acid oxalic). At HV0.5, the impact varies depending on the location of the indenter, if in the austenite or ferrite grain, while at HV20 the impact covers several lamellas. Relative volume ratio between HV0.5, HV3, HV20 and HRC is 1 to 20 to 354 to 21,500, respectively. Differences are illustrated in Figure 2 (see top of page 10).

It is noted that the volume factor is dependent on the homogeneity of the microstructure. A short analysis of the data is reflected

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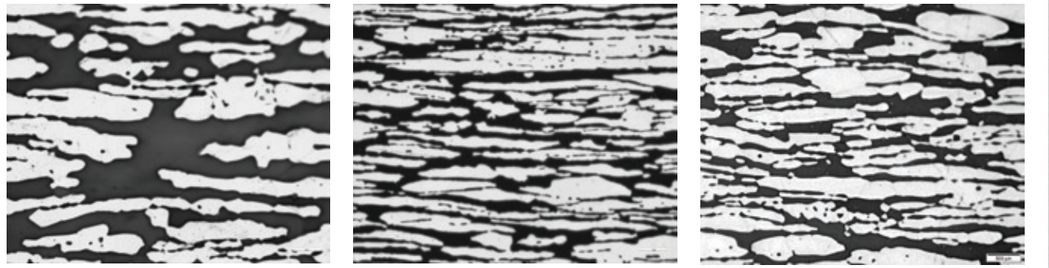

Figure 1 Example of microstructure at the cross section: Left (S32101), Middle (S32205), Right (S32760)

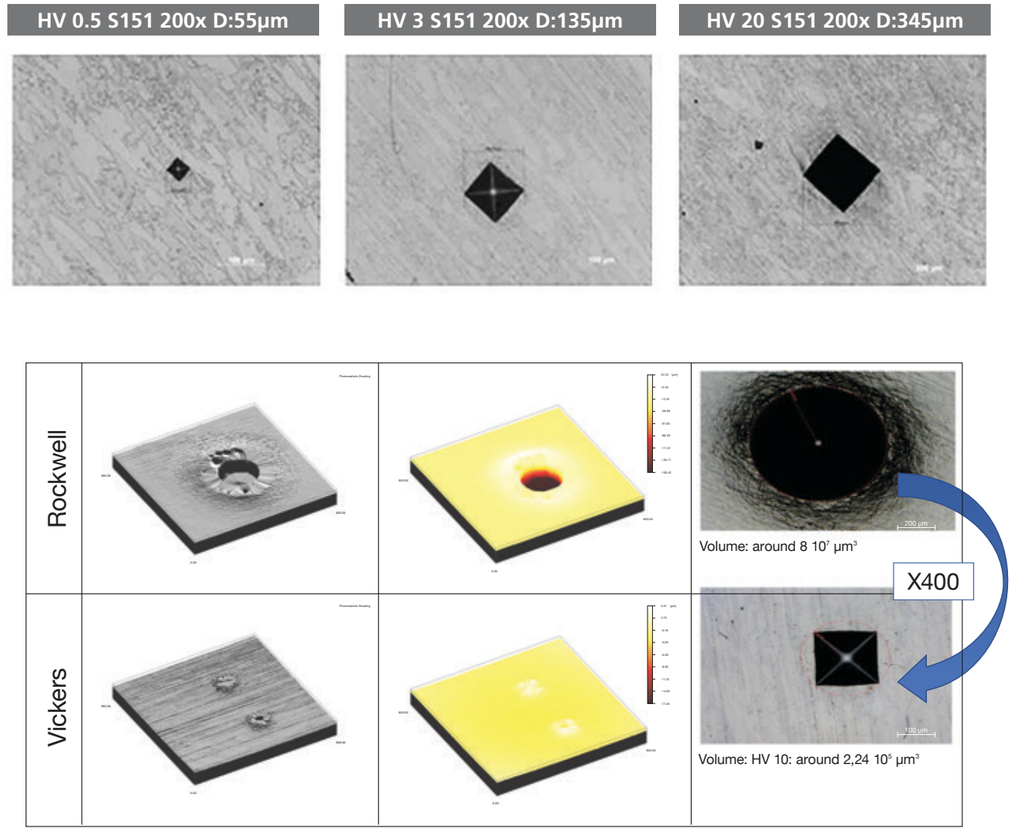

Figure 2 Impact scale example by the Vickers and Rockwell scales

Mean HV of all samples			
HV 0.5	HV 1	HV 3	HV 5
299.2	301.7	300.4	298.6

Table 3 Mean hardness difference of the Vickers scales

in Table 3, resulting in a mean hardness difference of the Vickers scales. The difference was only 3.1 HV and samples have homogeneous microstructure with minimum volume effect for the study.

Surface Hardening Factor

In the polishing process of the mounted sample for the Vickers testing, work hardening may occur at the thin surface layer depth. For the Rockwell C testing, either "as-is condition coupon" or "mounted and polished" options were considered. For the selection of the sample preparation for Rockwell C, an experimental test has been performed. The result indicated that a "mounted and Polished" condition has a work hardening effect of 0.9 HRC compared to the "as-is condition coupon."

As the cold working of the sample is initiated on the material, work hardening will occur at the first micrometers depth and will deepen as cold working amounts increase. Therefore, low weight measurements could probably be more influenced by the hardening of the surface due to the mechanical history, while a deeper impact on the surface will be less.

To eliminate surface hardening from the effect of the cold rolling operation, all samples were mounted revealing the cross section and Vickers hardness is measured at 10% of the surface depth (approximately 0.50 mm) location.

Magnification Factor

For the indentation measurement of the Vickers hardness by the light microscope, ASTM E92 recommends objective magnification size based on the diagonal length. For the selection of the magnification, 20X objective for HV0.5 scale, 50X objective for others was considered. To review the differences, a study was performed, and the result indicated that the mean HV0.5 hardness by "50X objective" was 8 HV higher than the "20X objective". To minimize the possible magnification variation, "20X objective" is selected to test all Vickers scales.

3. Sample Preparation

The original sample coupon size was 70 mm by 70 mm and cut to four sections using a cold saw to prevent any heat during cutting. Each sample was marked with location and the direction of rolling.

For consistency of the sample preparation, all samples were prepared at one laboratory using the same procedure, lab equipment and technician. All samples were cut to the same size as a flat specimen shape and mounted in epoxy then grounded and polished with three-micron diamond paste. After polishing, the samples were not etched, and the finished specimen surface was examined for any imperfections.

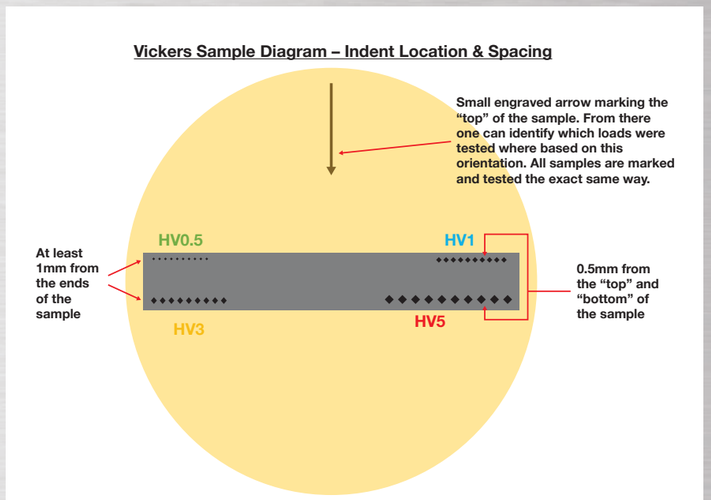

Figure 3 Vickers micro-hardness location

Rockwell C samples were 30 mm by 30 mm and were mounted and polished from the top surface, while Vickers hardness samples were 30 mm by 5 mm in size and were mounted and polished from the cross-section surface to reveal a rolling direction cross sectional view.

4. Testing Procedure

The testing instrument was calibrated and verified using a reference test block prior to testing.

Rockwell C Hardness Testing

For sample testing, the guideline from ASTM E18 was followed. From the mounted samples, hardness was checked from the center of the section and evenly spaced between the indentations.

Vickers Hardness Testing Procedure

For sample testing, the guideline from ASTM E92 and ISO 6507-1 was followed.

Hardness was checked from a polished surface and divided into four segments. Each segment is used as shown in Figure 3. The indentation is placed 0.5 mm below the surface and a minimum 1 mm away from the edge.

5. Evaluation Methods

Data was collected using four laboratories representing three duplex alloys and four hardness ranges per grade. Each individual sample had ten indentation data of Rockwell C and Vickers with load of 0.5 kg, 1 kg, 3 kg, and 5 kg.

The margin of error was reviewed with a 95% confidence interval by material grade, testing laboratory, and amount of cold working. For this test, the desired margin of error was chosen as less than 2%.

The conversion between Rockwell C versus Vickers is reviewed using the average of all indentations by the Vickers scale compared to Rockwell C values. Linearity between Vickers scales against Rockwell C was compared and the overall average linearity formula was recommended.

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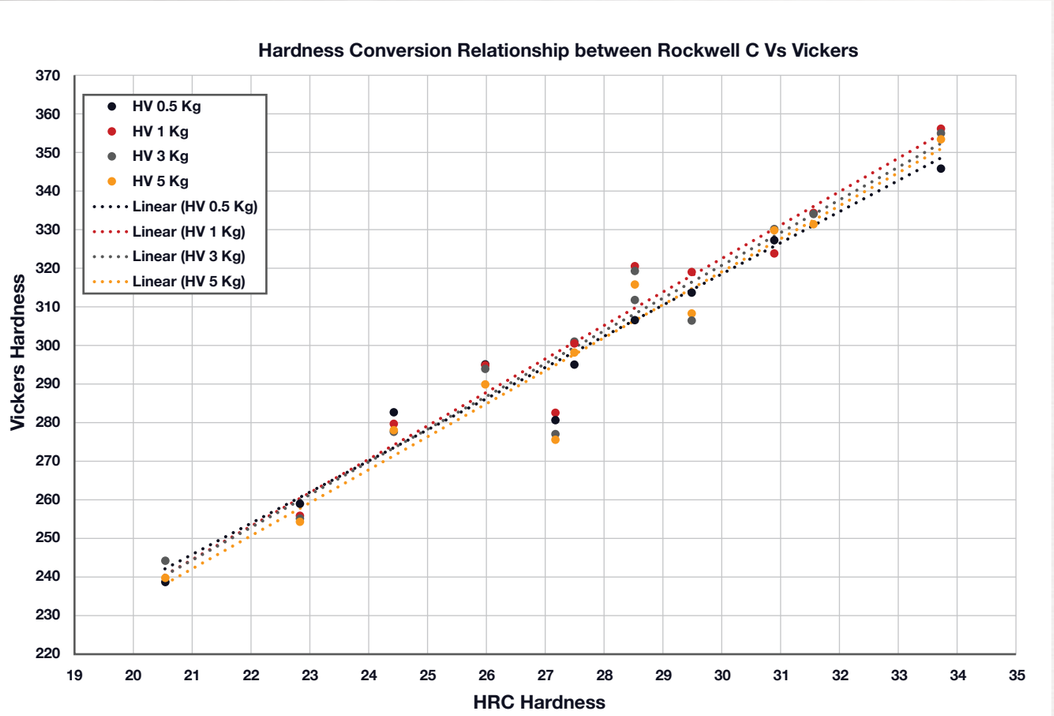

Figure 4 Hardness conversion relation between Rockwell C versus Vickers

III. Results and Discussion

1. Relative Accuracy of the Data

The overall average "Relative Accuracy percentage with 95% Confidence" (% RA) was 1.3% and by Vickers load scale was ranged 1.0% to 1.6%. The % RA by the grades was ranged 0.8% to 1.9%. There was no significant difference by the cold reduction amounts as 1.55% to 1.6%. The overall average differences by the testing laboratories varied at 1.1%, 1.3%, 1.8% and 2.1%.

2. Variation between Vickers Load Scales

Figure 4 shows the hardness conversion relationship between Rockwell C versus Vickers with load scales of 0.5 kg, 1 kg, 3 kg, and 5 kg and a linear trendline of each scale shows very similar results.

IV. Conclusion

In this research study, the correlation between the Rockwell C and various Vickers scales were evaluated and documented using UNS S32101, S32205 duplex and S32760 super-duplex stainless steel.

Results in this experiment are summarized by the following formula:

HV = (8.444 x HRC) + 67.0

where HV = Vickers hardness

or

HRC = (HV x 0.1184) – 7.9

HRC = Rockwell C hardness

The proposed formula can be used for majority of duplex grades and give a valuable correlation for hardness within the range 20 to 35 HRC and 250 to 350 Hv. It is considered that duplex stainless steel contains 40% to 60% of ferrite. The present work does not deal with hardness relevance to properties but only Rockwell/Vickers conversions.

Acknowledgements

The author would like to acknowledge the team at Webco Industries TechCenter laboratory for performing the hardness measurements and analysis of the samples. Similarly, we would like to thank Outokumpu R&D team for facilitating the acquisition of the samples used in this study as well as performing the hardness measurements. Lastly, we would like thank ExxonMobil Metallurgical Laboratory for performing the hardness measurements. ▪

ASIATAC UPDATE

PARTICIPANTS FROM 19 COUNTRIES ATTEND SPRING VIRTUAL MEETING

If attendance figures are a good indicator of an organization's health, then MTI's AsiaTAC group is alive and well. Over 100 people registered and most attended the Spring 2022 Virtual Meeting, April 7-8. In all, 32 member companies were represented, spanning 19 countries. In addition, AsiaTAC welcomed 9 guests, including potential producer members Chinese Petroleum Corporation, Formosa Chemicals and Fiber Corporation, International Flavors and Fragrances, and Wanhua Chemical. The meeting also included 23 first-time attendees and the election of one new Vice Chair: Mr. Jan Li of Outokumpu was unanimously voted into his new leadership role by his fellow members.

"I think it was quite a successful meeting because the discussion was much better than I expected for a virtual meeting," reports T.P. Cheng, AsiaTAC Chair. "Most of the attendees were Materials Engineers, so we had a lot of case studies on failures. We got very high attention from the audience, and there were a lot of questions and answers."

Associate Director Paul Liu added that the virtual format allowed more people to participate. "We did get a broader audience compared to the face-to-face meeting," he says. "The interest was high. People called in and stayed for the whole morning. This way we were also able to invite global speakers., which was also a big plus." The Spring AsiaTAC agenda included presentations from Asia, Europe, and North America.

After opening remarks from Cheng, Heather Allain discussed staff changes at MTI, including her new role as Executive Director. Allain provided her background and mentioned that her links to AsiaTAC include attending one meeting and working with former Chair Henry Ye. She also reported that MTI has two new producer members: Marathon Petroleum and Phillips 66. Allain encouraged the AsiaTAC community to reach out to anyone they know at these companies, who are based in Asia, and invite them to future meetings.

MTI Chair David Barber then presented a Distinguished Service Award to Masao Nakahara, of former member Asahi Kasei. Barber highlighted some of Dr. Nakahara's many efforts on behalf of MTI. His dedication to the betterment of the industry as a whole was also noted. He was congratulated by

> CONTINUED ON PAGE 28

EUROTAC DELIVERS SUCCESSFUL SPRING MEETING

CONCENTRATES ON SRC ROUNDTABLE AND PROJECT DEVELOPMENT

BY PATRICE HOULLE, MTI ASSOCIATE DIRECTOR

Participants at the Spring 2022 EuroTAC Meeting in Mannheim-Viernheim, Germany

Thanks to the continual efforts of the EuroTAC leadership committee, the Spring 2022 Meeting (May 18-22) in Mannheim-Viernheim, Germany was a success. Although EuroTAC is still rebounding from the effects of COVID-19, ten MTI member companies from eight different countries participated in the meeting.

Attendees were welcomed by the EuroTAC Chair – Anette Hansson (Topsoe), and new MTI Executive Director Heather Allain opened the meeting with a presentation covering the overall status of MTI. The presentation included the introduction of the new European Associate Director, Rolf Kirchheiner, other staff changes, MTI member company updates, active projects, and recent project approvals.

One full day of the meeting was dedicated to a Stress Relaxation Cracking (SRC) Roundtable, organized by Jan-Willem Rensman (Fluor). The roundtable included six presentations – two online – made by Professor Bo Chen (Leicester University) and Mike Spindler (EDF UK), who also participated in the discussions throughout the day. All the key factors to avoid stress relaxation cracking were described and discussed. At the conclusion, Rensman focused on specific details important for a testing method to evaluate the SRC sensitivity of materials that could be developed in a future MTI project.

The EuroTAC meeting provided the opportunity to deliver updates on a few pending projects. Hansson presented a summary of the different results from Project 364 – Properties of Duplex Stainless Steels after Exposure at High Temperature, and the newly funded project P391 that will especially study welded material. Nicolas Nourrit (Institut de Soudure) presented a comprehensive summary of the results of the three projects developed to optimize US testing to identify High Temperature Hydrogen Attack (HTHA) of Carbon Steels.

Technical presentations were also given by Edgar Vidal (NobelClad), Edson Santos (Zeiss) and Jonas Höwing (Sandvik).

The project development brainstorm session was led by Jader Furtado (Air Liquide) with a discussion aimed at developing new project ideas using a grid plotting damage mechanisms versus types of materials, equipment/component type, function, load type, process environment and industry. A few new topics were identified:

- Downstream tools for predicting corrosion of carbon steel in "water with CO2 and H2S" are generally used for predicting corrosion of carbon steel in biorefineries. How does that presence of HCl and NH3 impact the adequacy of the programs?
- Considering that Hydrogen will be used in many new processes as a fuel and feedstock, can hydrogen be safely handled in the existing facilities without embrittlement or other impact on mechanical properties?
- Prediction of downstream or low temperature corrosion due to bio-oils

After a long day of discussion, the group gathered at the Heidelberg Castle for dinner to resume a long-standing EuroTAC tradition.

EuroTAC will meet again November 16-18, 2022, in Amsterdam, preceded by the FRP and Dual Laminate Training session November 14-16. ■

Coming to EuroTAC in 2022

FRP & DUAL LAMINATE TRAINING COURSE





COURSE HIGHLIGHTS

Overview • MOC / Materials Selection • Design of Vessels, Piping and Flanges
Fabrication of Vessels and Piping • Laminating / Welding / Joining • Installation • Qualifying a Fabricator
Testing Techniques and Tools • Inspection of New Equipment • Evaluation of In-Service Equipment
Repair / Alteration • Case Histories • Summary / Evaluation Test

14 – 16 November, 2022 • NH Hotel Barbizon Palace • Amsterdam

Held in conjunction with the EuroTAC Fall Meeting • Register: www.mti-global.org

MTI Materials Technology Institute

PROJECT CHAMPIONS SPOTLIGHT

MTI RECOGNIZES MEMBERS FOR LEADERSHIP

Top Left: Bob Hurst (Becht) and Jennifer Larimore (Chemours); Top Right: Curtis Huddle (Eastman); Middle Left: Nate Sutton (Equity Engineering); Middle Right: Meghan Oaks (BASF) and Chuck Young (Tricor); Bottom Left: Anette Hansson (Topsoe); Bottom Middle: Oliver Durst (Air Liquide); Bottom Right: Jader Furtado (Air Liquide)

MTI recognized six Champions at the June AmeriTAC 138 meeting, in Kansas City, Mo., and three Champions at the EuroTAC Spring 2022 Meeting in Germany. MTI projects are the heartbeat of the organization, and member Champions who step up to lead these projects keep them moving forward. The dedication and guidance of these individuals led to the completion of six projects:

PROJECT 291

Stress Relaxation Mitigation Strategy

Champions: Anette Hansson (Topsoe) and Oliver Durst (Air Liquide)

The project aimed at qualifying the bending test method for the evaluation of stress relaxation cracking of welded joints. Two materials, 800h and 347H, were employed in the screening. While from 800H two workshop welds (an unrestraint and a fully restraint) were prepared, the 347H specimens were extracted from a feed pipe weld, which prematurely failed in service. The 800H materials selected turned out to be less sensitive to SRC, because of moderate Al+Ti contents (0.63% and 0.57%), while the 347H welds extracted from the feed pipe prove to be highly susceptible to SRC.

PROJECT 336

CPI Equipment, Materials and Corrosion Learning Modules

Champions: Bob Hurst (Becht) and Jennifer Larimore (Chemours)

The project produced a set of learning modules to supplement on-the-job training. The modules, created as editable PowerPoint slides, are intended for new engineers to CPI, not just new materials engineers. This is not a self-learning course and is meant to be instructor led. However, the instructor is expected to have a level of knowledge of the material. Some modules also contain YouTube videos. These are supplemental and not necessary to learning objective but do provide useful information. Final modules are available to members in the Technical Resource Library.

PROJECT 353

PSA Structural Integrity Assessment

Champion: Jader Furtado (Air Liquide)

The objective of this project was to perform a literature review covering aspects of fatigue crack initiation and propagation in pressure swing adsorber (PSA) vessels. The purpose of the review was to provide a basis for outlining a materials testing program to support structural integrity analyses of PSAs. The literature review focused on three high-level topic areas: fatigue crack initiation and propagation from notches, effects of hydrogen gas on fatigue in steels and their welds, and practices for fatigue-related fitness-for-service (FFS) assessments of pressure vessels.

PROJECT 363

e-Library Implementation

Champion: Curtis Huddle (Eastman)

The new Technical Resource Library is a replacement for the former system due to the vendor no longer providing hosting services. TIND (new vendor system) is robust and provides single sign-on from the MTI website, advanced search functions, and watermarking. Members can access the Technical Resource Library under the "Resources" menu at www.mti-global.org.

PROJECT 366

Global Solutions Symposium 2022

Champions: Meghan Oaks (BASF) and Chuck Young (Tricor)

The second in these series of events, the Symposium was held March 1-3, 2022, in Orlando, Fla. More than 170 attendees participated, eight of which were non-member producers and 15 first time members. The planning and direction of the co-Champions were vital to the success of the event, which featured two keynotes, 29 technical and knowledge management-related presentations, and 36 vendors to visit in the Global Solutions Marketplace.

PROJECT 385

Knowledge Roundtable: Renewable Diesel

Champion: Nate Sutton (Equity Engineering)

The Renewable Diesel Roundtable was an event held in conjunction with AmeriTAC 138. The intent was to bring awareness and understand how MTI could potentially help members facing renewable fuels issues through project work. Approximately 50 members and invited guests attended the Roundtable.

Congratulations and thank you for your commitment!

WORKING WITH AND WITHOUT SUBJECT MATTER EXPERTS

Knowledge Management in the Age of the Great Resignation

MTI is supporting projects on knowledge management and the value of training. One of these projects is Best Practices for Working with SMEs (Project 368) focused on gathering knowledge from experts to continue safe and productive operations after they have left the building. The assumption of the Working with SMEs model is that experts are available to be interviewed and that they will be cooperative by spending time and sharing materials so those who follow in their footsteps have breadcrumbs along the path to where they have been.

But what happens when they aren't available? And, more importantly, what do you do when some of the external systems that support the organization are breaking down? These are legitimate questions in the current environment where people are leaving organizations mid-career, and the supports around the organization such as vendors and materials may not be in place, either.

The project team is putting together materials to answer some of these questions. The goal is to assist new colleagues and those left behind to find the information they need to maintain equipment, make repairs, order materials and even design and build new plants and equipment based on lessons learned both inside and outside the organization. Some of the materials the team is generating will include templates for interviewing experts and systems for finding information when no experts or experienced colleagues are available to fill-in knowledge gaps.

This project also will look at the role MTI plays for materials engineers who are involved in solving problems within their organizations. A partial list of the content of this program includes:

1. Questions and themes to explore with experts in the form of an interview plan
2. Standard information sources generally available
3. Looking inside the organization for product- and process-specific answers
4. Looking outside the organization for material-specific information
5. Creating a plan for gathering specific types of documents

And more…

The Working with SMEs project is expected to last through the end of this year and conclude in early 2023. The project will generate a report on best practices to build a knowledge management program that preserves the intelligence, skills and even relationships (think vendors) that are critical to continuing operations.

If you would like to know more about this project and participate on the project team, scan the QR code and sign-in to "Join" the Project Team. You can also contact Kirk Richardson at krichardson@mti-global.org for additional information about the project and how to make it more valuable for your company. ▪

MTI HIRES GANSCHOW AND KIRCHHEINER AS ASSOCIATE DIRECTORS

DEDICATED TO PROJECT DEVELOPMENT AND LEADERSHIP

MTI is delighted to welcome Kevin Ganschow as a new Associate Director (AD) and Rolf Kirchheiner as the new European AD who will replace Patrice Houlle (retiring Fall 2022). Both have previous experience with MTI through prior membership participation and anticipate spending time and effort on technical projects and supporting membership activities to continue the strong MTI legacy. Congratulations!

Kevin Ganschow

Kevin Ganschow

Ganschow recently retired after 34 years from Chevron, an MTI member company, where he spent the majority of his time working in the materials and reliability world. He holds a B.S in mechanical engineering and is a materials engineer by training. At Chevron's Richmond Refinery, he was initially hired as a designs engineer and in his third year recalls being asked to work as the sole materials engineer, to which he nervously agreed.

"I greatly worried my lack of university training would hinder me," Ganschow explains. "That first year as the only materials engineer for a 250k barrel/day refinery was a combination of sheer terror and joy. I supported three different turnarounds and saw lots of corrosion and cracking."

However, Ganschow admits it turned out to be his favorite job with the company. He compares it to an old American football lineman drill called "Bull in the Ring" where one person is at the center of ring made up of teammates. The coach calls out someone's name and they charge trying to push the person out of the ring. At any moment, the coach can call another name or two from any direction.

"Being the sole materials engineer felt like this drill with people coming at me continuously and from different directions with questions or challenges – all of which were massive learning experiences," he says. "The technical growth was exponential, and I loved it!"

His longest stint was 13 years as a materials specialist, and during that time he began participating in MTI, where he quickly joined in as project champion, designated representative and served on the Board of Directors (BOD). It was only a six-year involvement due to a big move. He transitioned to a rotational assignment as a reliability advisor/expert role at the Tengiz oil field in Kazakhstan during his last four years with Chevron.

Ganschow's vast technical experience and knowledge of MTI will no doubt translate to his role as AD where he will manage the Integrity PDC (Project Development Committee) and technical projects as assigned by the Executive Director.

"Even though my years of experience with MTI is relatively low, I learned much with my involvement and marveled at how the organization functioned and thrived," Ganschow describes. "The involvement with the BOD gave me the most insight to see how the MTI organization functions and see close-up the difficulties of maintaining membership and continuing the quality and quantity of work. That experience and insight will help me as an AD to continue the MTI legacy."

Ganschow plans to concentrate significant energy on his PDC. He believes the PDC's are the "nursery" of MTI where good ideas mature and become great ideas, which eventually turn into successful and value-adding projects. He also finds it fortuitous to be assigned to manage the Integrity PDC after his reliability role at Chevron just ended. He hopes to operate the PDC to help prioritize ideas and make sure only those that have true value produce projects.

"I am also lucky to have two great PDC leaders in Srini [Kesavan, FMC] and Jeremy [Nelson, Koch Industries] and I have much to learn from watching them," he notes.

"I am cognizant that time is a resource all of us have very little of, particularly our members who have full time jobs. Finding a happy medium to stimulate innovation while not being overly risky is tricky and I have no secrets to success on that front, just awareness."

When he isn't focused on MTI project work, Ganschow has various projects and hobbies that otherwise keep him occupied. You might find him in a winding river, working under the hood of a car, or repairing or updating something in his home.

"I am a self-taught fly-fisherman. My in-laws own a cabin on the Weber River in Utah. I literally go out the backdoor, down a flight of steps and I am on a river with native Cutthroat Trout. I love the challenge of presenting a fake fly to the fish and trying to convince them to take it," he describes.

"I also love to tinker and fix things. I started my own car repair business when I was 13 years old. I still fix and maintain my own cars today and would love to have a project car to restore. Home projects are another pastime. My father was a general contractor and my brothers and I helped with construction work as boys and teenagers. In 2018, we built a new home. I had the contractor leave some bathrooms and laundry room unfinished to give me some projects."

Following some time after returning from his final rotation in Kazakhstan, Ganschow officially started with MTI in June and is excited to work with the organization in a different capacity and ready for new challenges ahead.

"It feels great to be back at MTI and associating regularly with such fine and technically competent people. I was welcomed warmly at the recent AmeriTAC 138 meeting and almost felt like I never left. MTI is really about the people and the reason why I wanted to return in a staff role. The quality of people who invest their time in MTI clearly shows in their commitment to the organization and the value it brings," he concludes.

Rolf Kirchheiner

Rolf Kirchheiner

Kirchheiner, based in the Rhine-Ruhr area of the western part of Germany, comes to MTI with an extensive industry background and previous participation in the organization. After attaining a chemical engineering degree, he worked for KRUPP-VDM and was responsible for the development of metallic High-Performance Alloys for the CPI, Oil and Gas and Energy sectors for 20 years. He furthered his knowledge of forged, cast and centricast Super Alloys while at Schmidt & Clemens, where he was responsible for managing the Central R&D Department for nearly 12 years. In addition, he worked for a period at Vallourec-Mannesemann with a focus on the development and qualification of Nickel-Alloys.

"All the time during my career I was in close contact to the CPI (Bayer, BASF, Hoechst, DSM, Linde, Air Products and many others) working on solutions in the field of materials and corrosion," he explains. "Alongside, I expanded my network including all European organizations for pressure vessel surveillance and inspection. For the power suppliers, I was also involved in cooperation projects with the big European enterprises RWE, EnBW, Vattenfall and EDF."

His background connections will allow him to seek potential partnerships and new members within Europe to broaden the EuroTAC reach. Kirchheiner's experience of meeting planning and organization during a five-year stint at a research institute for materials will also come in handy. He was responsible for the implementation of training courses for engineers and organizing conferences on materials and applications, and leans on this experience to help plan valuable EuroTAC conferences and training sessions.

However, Kirchheiner is quite familiar with how MTI operates projects. He participated in MTI as a delegate for VDM in the 1980s and was a strong proponent for Schmidt + Clemens to join membership while employed there. He attributes much of his valuable knowledge of MTI processes to the Fellows he had the opportunity to engage.

"Learning about effective project management and international team cooperation and leadership was triggered by MTI Fellows Galen Hodge, Bert Krisher, Sheldon Dean, Sandy Sharp, and many others," remarks Kirchheiner. "That was a major experience and a push-forward for my career development. A prominent place in my bookshelf is reserved for the MTI book series on materials.

> CONTINUED ON PAGE 27

PFA Sheets Used to Reduce Refinery Maintenance Costs

Corrosion of the WSA condensers at the OMV refinery in Schwechat made them less economical in the long-term due to constant maintenance. A new condenser design engineered by OMV and INWA AG using PFA sheets reduced the maintenance costs in half while increasing both maintenance intervals and overall safety. A total of three condensers have already been rebuilt and lined by INWA AG.

> CONTINUED ON PAGE 24

As the largest industrial company in Austria, OMV refines fuel products and petrochemicals at its site in Schwechat, Austria. In the refining process, crude oil and natural gas are processed into high-quality fuels, oils and other special products such as paraffin, heating oil, bitumen, sulphur and sulphuric acid. The aim of all these processing steps is to achieve a high added value from the raw materials to work economically as a company while operating to sustainably protect the dwindling resources and the environment. In the end, all the residual products from the processes are being fed into a combined heat power plant to produce steam, electricity, district heating and other products through combustion energy. A downstream flue gas cleaning system (SNOx) cleans the flue gases and allows the burning of high-sulphur fuels in the power plant. Due to the high sulphur content in the fuels SO_2 is produced during combustion, which is then used for the production of concentrated sulphuric acid. Sulphuric acid is the most commonly used acid in the world, and there is a global interest in this product. In conclusion, a contaminated flue gas is turned into clean exhaust air and a sellable industrial product, which is used in a variety of applications.

In the flue gas cleaning system dust is filtered via electrostatic precipitators in the first step. Afterwards the NOx is removed in a catalytic process in a second step. The remaining SO_2 gases are then oxidised via converters to SO_3. In the last step of the converter, the majority of the SO_3 reacts with H_2O to form H_2SO_4 vapour. The vapour is transported to the heat exchanger, in which the gaseous sulphuric acid is condensed to liquid H_2SO_4 with a concentration >94%. The condensing droplets of sulphuric acid are formed on the surfaces of the heat exchangers (acid condenser) and the surrounding equipment. The dew point of the flue gases is reached, if the gas temperature drops below approx. 240 °C - 260 °C, which depends on the exact combustion gas composition. The condensation of the acid droplets on metal surfaces would lead to the so called "dew point" corrosion, in which regular steels and stainless steels are destroyed quickly. In order to achieve sufficient resistance to the highly aggressive application conditions, a multi-layer structure is often used, which consists of the following materials: chemical stone lining, foam glass layer, non-welded PTFE plates, chemical protection layer and a carbon steel tank.

This lining system was also used at OMV; however, due to the significant increase in maintenance work and the associated operational downtimes and repair costs incurred, the economic efficiency of the SNOx plant decreased a lot over time. During the repair work, it became apparent that the multi-layer structure did not create a long-term leakproof lining system, which caused corrosion of the carbon steel tank by the condensing sulphuric acid. As a result, it was necessary to remove the lining system, which was already soaked with acid, at great safety expense and to refurbish the steel structure and lining in a further step.

Due to the apparent downtimes and the increasing repair costs, OMV decided to fundamentally redesign the condenser area, whereby the objectives were defined as follows:

- At least an equal production quantity and product quality compared to the current system
- Increase in reliability or rather availability and safety
- Extension of maintenance intervals
- Reduction of maintenance costs due to easier possibilities of repair

In the course of the design work, detailed solutions were worked out, that make it possible to shut-off a certain part of the SNOx plant, so that the plant can also be operated under partial load during its maintenance. In addition, a two-layer structure already patented by OMV was developed so, that the process can be permanently checked for leaks via a monitoring system. The main focus of the development, however, was the selection of a lining system that will withstand the harsh operating conditions and meet the specified project objectives. In the selection process, eight different lining systems were evaluated and analysed. Due to experience in the field of PFA linings for sulphuric acid condensers INWA AG was already able to rely on a combination of their experience and on their long-term references that demonstrate the functionality of this lining system. In addition AGRU commissioned a Swedish testing institute to carry out an exposure test, in which AGRU PFA sheets were exposed for one year at temperatures and concentrations, that exceeded the operation conditions (260 °C, 98% sulphuric acid) without any significant changes to the product properties. Based on the available long-term references and the investigation carried out, the PFA fixed-point lining system was specified as the optimal lining system. INWA AG was commissioned to start with the first refurbishment of four plant sections in 2018. Figure 1 shows the new tank design, which consists of a double layered steel tank, both layers lined with PFA.

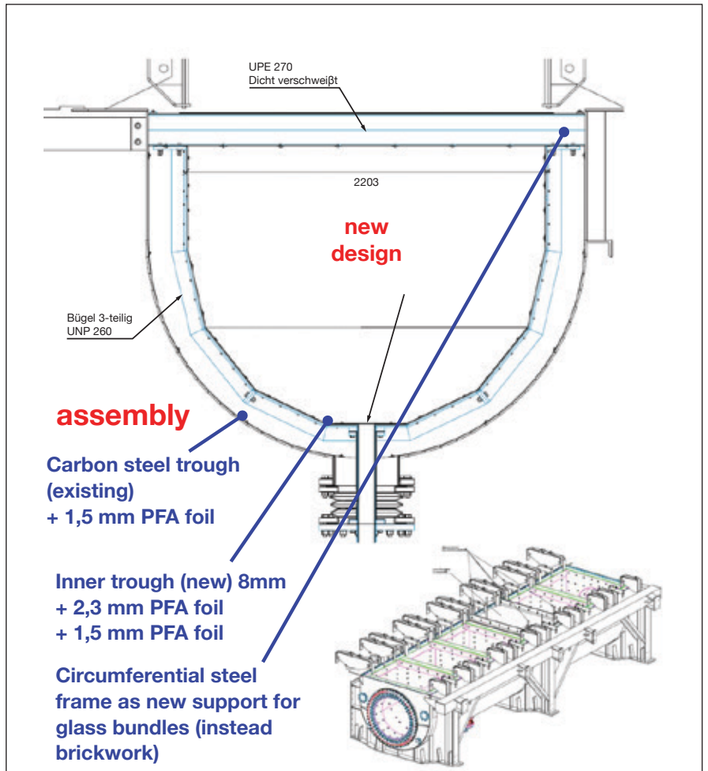

Figure 1: Detail view on new condenser design [Source: OMV]

Figure 2: PFA lining and welding work in the sump area [Source: OMV]

Compared to the old design, the chemical protection layer now consists of two PFA sheets located on top of each other, whereby the PFA sheet at the bottom was simply installed for additional operational safety. The steel tank at the bottom, which is not in contact with the medium during normal operation, was additionally lined with a PFA sheet in order to achieve a comprehensive corrosion protection even in the event of leakages.

The PFA fixed-point lining offers simple repair options since the sheet can be welded again after proper preparation in the case of damages. In the future time-consuming special repair work with dissimilar materials will no longer be necessary reducing downtime.

Figure 2 shows the installation and welding work of the AGRU PFA sheets in the sump area. Figure 3 shows the final lined condenser, before put into operation.

PFA Fixed Point Lining

With the PFA fixed point lining, a PFA sheet is fixed to a steel structure by a mechanical fastening using bolts or screws. This system is mainly used in flue gas applications and desulphurisation plants up to 260 °C, see Figure 4.

In order to be able to seal the multi-layer PFA sheet structure, a thermoformed PFA covering cap was developed in cooperation between INWA AG and AGRU, see Figure 5. It was successfully used for all refurbishment steps.

Due to the great success of the project, three plant sections were already relined through 2021. As a system supplier, AGRU was able to produce all the required PFA

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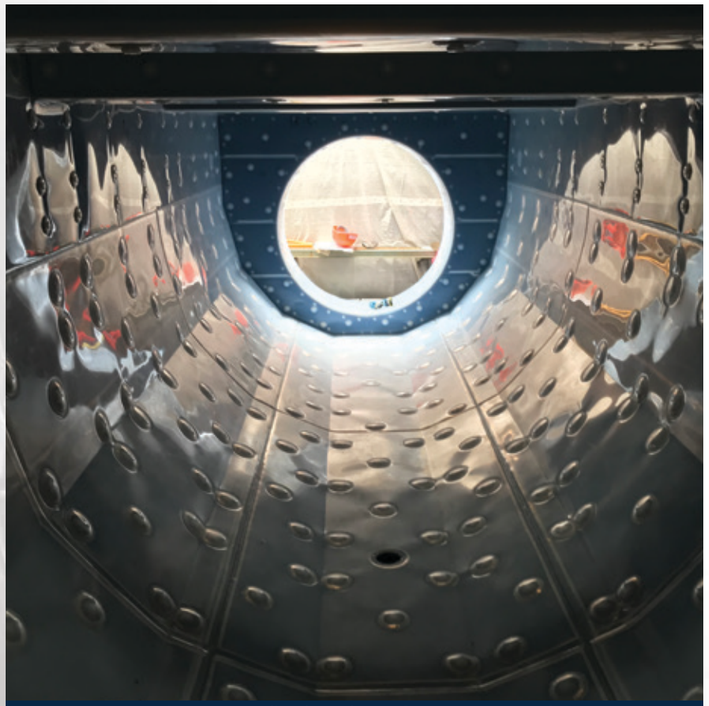


Figure 3: PFA-lined condenser [Source: INWA Ag]

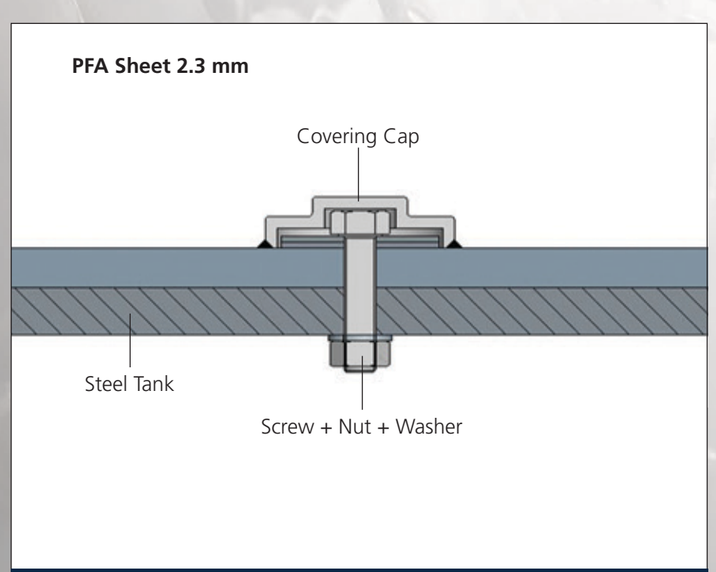


Figure 4: Sketch of mechanically fixed PFA sheet and injection moulded cover cap

products and thus made an important contribution to the realisation of this project. Since the PFA products are used under very aggressive operation conditions, the PFA production was inspected and controlled by INWA AG and OMV through regular audits. Due to the good experience during the past 3 years, also last part of the SNOx condensers will be renovated using PFA fix point lining. It is currently in the planning stage and the installation is scheduled for spring and summer 2022.

Conclusion

In the course of a routine inspection carried out in 2021, no damages or abnormalities were detected on the PFA lining installed in 2018. As the person responsible for the project on the OMV side, Mr. Ronald Hoffer, DI (FH) Dipl.-Ing., concluded after the inspection of the plant area: "Despite the highly aggressive application conditions, the PFA lining shows no noteworthy damage or changes after an operating period of three years. It seems that sheet has just been installed".

Thanks to the successful development and the performed reconstruction, OMV and INWA AG were able to apply for a patent for this lining system. In addition, the specified project goals were achieved:

- Increase in reliability, availability and safety
- Halving of maintenance costs
- Reduction of downtimes by 75%
- Patented leakage monitoring system enables permanent control of the plant components
- Increased operational safety due to an additionally installed tight lining system ▪

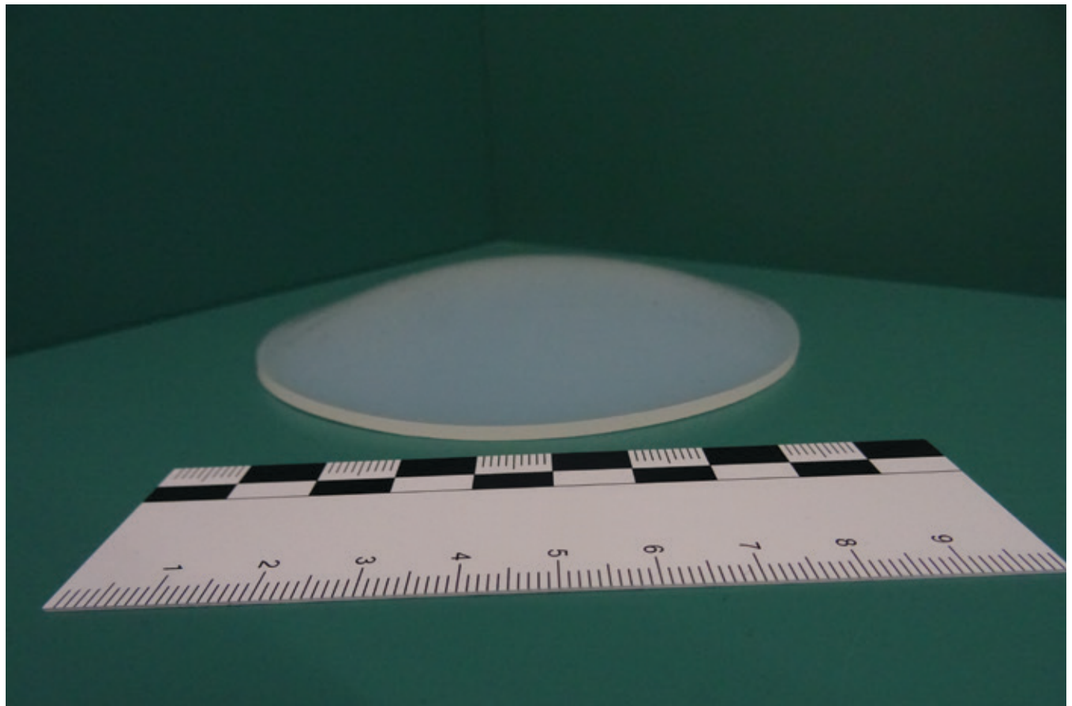


Figure 5: Thermoformed cover cap

MTI HIRES GANSCHOW AND KIRCHHEINER AS ASSOCIATE DIRECTORS

> CONTINUED FROM PAGE 21

I use them up to now as daily advisors in my engineering office."

When not focused on MTI work or his consultancy business of more than five years, Kirchheiner finds time for many other activities. He has practiced martial arts for more than 20 years and received a Black Belt from the Japan Karate Association. Always eager to learn, he switched to Tai Chi, reads regularly and participates in the Carl Gustav Jung Society in Germany to learn about the "subconscious mind."

Additionally, Kirchheiner says he appreciates creativity and hopes to channel that into his technical work.

"I am a reasonably good photographer and video creator. If time permits, one of my future projects is a little YouTube clip highlighting "High Performance Alloys," he notes.

Both technical background and his hobbies make him well-equipped to tackle MTI responsibilities. As he prepares for the new challenges ahead, he closes with a note on his drive to succeed.

"I am motivated to manage projects with challenging targets, especially in teams across the borderline of companies, enterprises, and research institutes. I would like to dive into the strength and capabilities of MTI US and EU first and then layout a plan for future development. My 'verve' goes to the practical application of modern innovation management principles," concludes Kirchheiner. ▪

ASIATAC UPDATE

> CONTINUED FROM PAGE 13

the AsiaTAC leadership team and participants for the achievement, then immediately added to his long list of contributions by seamlessly transitioning from acceptance of his latest honor to the meeting's first technical presentation.

In "Changes and Challenges of Material Engineering in Evolving Japanese Chemical Industries," Dr. Nakahara discussed the economic boom of chemical industries and change of failure rates in ethylene production in Japan since the mid-1960s. He went on to cover cases of pitting, stress corrosion cracking, and MIC. Dr. Nakahara concluded his speech by discussing measures taken in Japan to meet the many challenges faced by the Chemical Industries. His full presentation is available to members at www.mti-global.org, along with the other presentations mentioned in this article.

Next, CY Tsai, ITRI and Gary Coates of the Nickel Institute provided an update on MTI Project 367, "Corrosion Data Collection, Nickel Alloys, Phase II" Tsai discussed the project background and needs. He described corrosion test procedure used at ITRI's lab, including the test apparatus and the results for Parts 1 and 2 of the project. Coates covered how to use this report and why MTI conducted Phases I & II. He reviewed all of the alloys tested and provided details on Alloy C-276, Alloys 600 and 800, and Alloys B-2 and B-3. Coates added that information on how to properly use the data generated from the project will appear in the ITRI Report that will be Phase II. For more information on the project, including a potential Phase III, visit the Project Team page on the MTI website. Coates encourages interested members to join the team and contribute.

Former AsiaTAC Chair Henry Ye, Chemours, followed the Corrosion Data Collection presentation with a series of case histories on the "Failure Analysis of Duplex Stainless Steels in HCl Service." Ye showed a comparison of normal stainless steels and duplex stainless steels, then shared a failure case for corroded 2205 pipe that was used in anhydrous HCl service. His final case reviewed corrosion of 2205 in a reboiler bottom head where there were large concentrations of NaCl salts. Ye concluded, adding that there were many other cases of failures of duplex stainless steels in concentrated HCl and saturated chloride processes.

Other valuable presentations provided during the two-day meeting included:

- Bing Li of BASF discussed "Quality Control of Various Materials Including Explosion Cladded Plates and Duplex Stainless Steels." Li covered a nozzle leakage case and reviewed the background of the nozzles (manufacturing etc.) and testing of the failed parts. He also shared images showing inclusions and cracks that led to the failures. Li then provided countermeasures for manufacturing.
- Jan Li of Outokumpu provided a presentation on "High Performance Austenitic Stainless Steels Used in Chemical Industry." Li's presentation covered sulfuric acid, phosphoric acid, azoedicarbonamide (ADC), polypropylene, MEK, acrylic fiber, urea, melamine, and the coal chemical industry, including their service conditions and some of the materials of construction for equipment in these services.
- Coates spoke a second time at AsiaTAC, this presentation on "Emerging Carbon Capture and Storage Technologies and Material Corrosion. He discussed carbon capture, utilization, and storage. His presentation covered a coal-fired power plant, noting that a solvent process is used to remove the CO2. Coates also talked about the Northern Lights Project in Norway, which will take CO2 from several sources, compress and transport them permanently offshore in a subsea storage area.
- Huayu Zhang of Arkema shared information on a "Molten Salt/Steam Heat Exchanger Failure Analysis." Zang provided details on three leaks in an economizer, including the materials of construction. He discussed the conditions in the economizer and presented images showing corrosion pitting in the majority of the tube bundle. Zhang reviewed the process used for identifying the leakage and talked about the impact of the corrosion and provided a hypothesis of the failure mechanism.
- Roger Zhang, a guest speaker from Wanhua Chemical, presented a case study on High Temperature Low Concentration Alkali SCC. Zhang provided the operating conditions then discussed what happened to the preheater, including a tube joint crack. The preliminary conclusion was the cause was alkali SCC. Further research included an SSRT stress corrosion test of the five materials.

The information-packed AsiaTAC Spring Session technical talks concluded with "Establishing Integrity Operating Windows (IOWs) for Biofuels HDO Units" by Jignesh Desai and Cathleen Shargay of Fluor. Desai opened, discussing the growing global demand for biofuels. He reported that China and Singapore are building renewable diesel and biojet to supply to export markets. Desai went on to provide feed and process descriptions, then introduced IOWs, which are limits on operating parameters for each "circuit" of equipment and piping seeing similar process conditions. Shargay shared Fluor's format for IOW tables and provided a comprehensive list of damage mechanisms. She concluded that IOWs have proven to be a very helpful tool in many types of processing plants and seem to be especially well-suited to biofuels processing, which is a relatively new process technology. Before handing the Zoom controls back to Cheng to adjourn the virtual AsiaTAC Meeting, Shargay wrapped up the week's technical presentations by encouraging members to participate in Project 357, Corrosion in Bio-Oils.

The AsiaTAC Meeting was also time for farewells and looking forward to new opportunities in the future. MTI Fellow Pradip Khaladkar, who supported AsiaTAC before retiring as an Associate Director in December 2021, gave a special talk on the beginnings of MTI, the people who formed it, as well as his observations of the early days and the organization's challenges. He went on to discuss his role in recruiting Henry Yi (Chemours) to be involved in MTI and helping to form SinoTAC in 2008, which later became AsiaTAC. Pradip took the opportunity to encourage members to become Project Champions, which he said, "will elevate your technical abilities and leadership abilities." Khaladkar said his goodbyes and closed by wishing the AsiaTAC group a bright future.

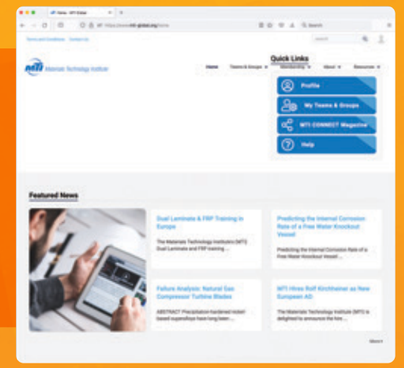
Speaking of the future, the next AsiaTAC Meeting is just around the corner. The Fall 2022 session is scheduled for September 19-20, in Shanghai, China. Cheng reports that this will be a hybrid meeting, with locals attending face-to-face, and worldwide members and speakers able to participate virtually. Visit www.mti-global.org for details and registration information. ▪

MTI WEBSITE UPGRADES

> CONTINUED FROM PAGE 3

3. On your dashboard, choose from any of the links under the left menu and click to view, edit, pay, etc.
   i. For example, click "Communication Preferences" to opt-in or out of specific MTI email communication types.
   ii. Note: there are no past invoices or events from the old system. New items will be available as you participate using the new platform.
4. On the right side of the Dashboard, you will see your message history report. This shows you all email communications from the system that have been sent to you.

The Member home page features quick links to your teams and groups, popular resources, and more.



Technical Resource Library

With the new login system, this offers an improved experience to access the Technical Resource Library. Once you've logged in to the member website, you can navigate to the Technical Resource Library and have access to available member resources. You might have to click "Login" on the library landing page on your first visit of the day, but you will no longer be required to enter credentials!

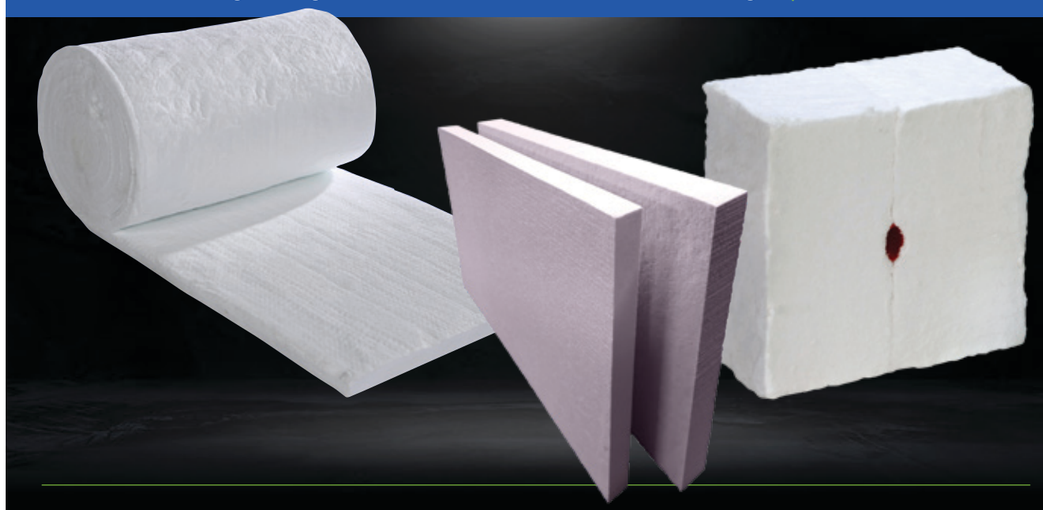
Thank You!

Again, thank you for your patience and we hope this new user experience will be a valuable member asset. If you encounter any issues or need assistance, please contact us at +1 314.567.4111 or email mtiadmin@mti-global.org. ▪

Materials Technology Institute Presents

REFRACTORY CERAMIC FIBER TRAINING

In Conjunction with AmeriTAC 139 | October 24, 2022 | 7:00 AM - 7:00 PM* CDT
Stress Engineering Services Labs, 13610 Westland East Blvd., Bldg. 2 | Houston, TX



This one-day course will utilize experts from within MTI and from the RCF Industry, including Morgan Thermal Ceramics and Harbison Walker International Refractory Products, to present state of the art information on RCF. The training will be a "deep dive" equipping the participants with the knowledge to more effectively manage RCF at their facilities.

TRAINING TOPICS

- Refractory Ceramic Fiber Fundamentals
- Pros and Cons of Different Types of RCF Modules
- RCF Design Guidelines
- Installation
- Advanced RCF Fundamentals
- Health and Safety Considerations for Use and Handling of RCF
- Inspection and Maintenance of Aging Linings
- Product Demonstrations

Register at www.mti-global.org

Members: Included with TAC Registration
Non-members: $300

mtiadmin@mti-global.org
1-314-567-4111

MTI Materials Technology Institute

**Timeframe includes travel, tour of labs and a reception.*

Photos courtesy of Morgan Advanced Materials Thermal Ceramics.

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

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MTI 2023 SCHOLARSHIP OPEN FOR APPLICATIONS

TWO $5,000 AWARDS AVAILABLE

Students pursuing a career related to Materials Engineering in the Process Industries are encouraged to apply for MTI's annual scholarship. The 2023 Bert Krisher Memorial Scholarship will be awarded to two applicants selected by the MTI Scholarship Committee.

The recipients will be awarded $5,000 each to help cover educational expenses. An added benefit of the scholarship is the unique opportunity to network with MTI members and build relationships with potential employers in the industry. Both students will receive an invite to attend one of MTI's Technical Advisory Council meetings in 2023. 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 to submit an application:

- Completed Application
- Academic Transcript
- Résumé
- Three (3) Recommendation Forms from educators or employers familiar with applicant's background
- Supplemental Essay

Scan the QR code to apply, or visit www.mti-global.org/about/scholarships for details. All required paperwork must be received no later than January 4, 2023. ▪