A Materials Technology Institute Publication

MTI CONNECT

GLOBAL CHALLENGES / TRUSTED SOLUTIONS

2020, ISSUE 3

Corrosion Control Documents Provide Foundational Element of Mechanical Integrity Programs

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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.

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CALENDAR OF EVENTS*:

AmeriTAC 134 & Additive Manufacturing Roundtable
February 22 - February 24, 2021
Virtual Event

AsiaTAC Spring Meeting
April 20-21, 2021
Danang, Vietnam

EuroTAC Spring Meeting
May 18-20, 2021
Villepinte, France

*Subject to Change

2021 MTI BOARD OF DIRECTORS CONVENES FOLLOWING VIRTUAL GLOBAL TAC AND ANNUAL MEETING

APPROVES FOUR NEW PROJECTS FOR FUNDING AND DISCUSSES FUTURE OUTLOOK

MTI held its Annual Member Meeting on Wednesday, October 28, for the first time virtually. MTI Designated Representatives voted prior to the event and the results were reported during the live session. The following slate of MTI members were elected to serve on the 2021 Board of Directors (BOD) effective following the Annual Meeting: David Barber (Chair), Dow; Debra McCauley (Vice Chair), Chemours; Bill Bieber, Webco Industries; Maria Jose Oestergaard, Haldor Topsoe; Chuck Young, Tricor; Nina Young, Chevron Phillips Chemical Company; Srini Kesavan, FMC; Dale Heffner, Electro Chemical; Eileen Chant*, Becht; George Donald, NOVA Chemicals; and Ex-Officios Jeremy Nelson (AmeriTAC Chair), Koch Industries; Andrew Rentsch (AmeriTAC Vice Chair), Huntsman; Anette Hansson (EuroTAC Chair), Haldor Topsoe; and TP Cheng (AsiaTAC Chair), ITRI.

Following the virtual meeting week, the 2021 BOD conducted its first meeting on Monday, November 2. The board welcomed newly elected AmeriTAC Vice Chair, Andrew Rentsch (Huntsman) and Jeremy Nelson (Koch Industries) as the new AmeriTAC Chair, who replaces outgoing AmeriTAC Chair Marc Cook (Dow). As the new AmeriTAC Chair, Nelson will also serve as the Chair of the MTI Conflict of Interest Committee.

The board then reviewed the completed Virtual Fall Global TAC Meeting, which featured a two-day Elastomer Training, multiple project meeting sessions, an online TAC Forum review and discussion, and a new Technical Showcase.

As part of the review, the board discussed and voted on the funding requests of four projects – three submitted during the October Global TAC Meeting and one recommended by AsiaTAC – for total funding of $140,900.

"Two of the projects were presented by our EuroTAC group, one project from our AmeriTAC group

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Anette Hansson (Haldor Topsoe)

Andrew Rentsch (Huntsman)

MTI membership approved the slate of 10 officers and four ex-officios to serve on the 2021 Board of Directors. Pictured left to right: Jeremy Nelson (Koch Industries), George Donald (NOVA Chemicals, TP Cheng (ITRI), Eileen Chant (Becht), Srini Kesavan (FMC), Debra McCauley (Chemours), David Barber (Dow), Nina Young (Chevron Phillips Chemical Company), Bill Bieber (Webco Industries), Maria Jose Oestergaard (Haldor Topsoe), Dale Heffner (Electro Chemical), and Chuck Young (Tricor).

SITECH SERVICES JOINS MTI AS SUPPLIER

SERVES THE PROCESS INDUSTRIES WITH EXPERTISE IN TECHNOLOGY, MANAGED SERVICES AND OPERATIONS

Sitech Services is the newest supplier member to join MTI in 2020. With activities primarily in the Process Industry, the new member will bring several tools and areas of expertise to MTI, including knowledge related to Industry 4.0.

According to the Sitech website, the company was founded in 2008 from DSM (Dutch State Mines) departments. Sitech is located in the The Netherlands where they primarily serve customers, along with Germany and Belgium, but also any other countries upon request.

"We serve the process industry with our main focus and decades of experience in the chemical industry based on ammonia and plastics/ rubbers," remarks Peter Janssen, Designated Representative.

"In recent years, Sitech has expanded its strategy from only working for site users on the Chemelot site (an industrial park that is a unique chemical and materials community) to also working for external parties. The increasing possibilities of digitization play an increasingly important role in this."

Sitech's services concentrate on three areas: technology, managed services and operations, he notes.

"With technology, think of services in the field of safety, sustainability and digitization. Managed services concern the daily maintenance of factories, improvement projects and turnarounds. With operations we take care of the infrastructure and water purification at the Chemelot site," Janssen adds.

"The services we provide are inextricably linked and the combination of these makes Sitech distinctive. The fact that we have such a broad in-house technology knowledge is due to the scale of our managed services, for example. Add to that the excellent support from various support departments and you know how we can perform to the maximum every day."

He also notes that Sitech strives to be a frontrunner in technology and innovations, and the company thought MTI would be a good fit to help them continue to expand their knowledge base and network.

"We joined MTI because we felt the need for more in-depth knowledge on failure mechanisms (extend our library and keep it updated), and also to have peers to share and discuss our findings with during failure investigations," Janssen explains.

Photos courtesy of Sitech Services.

Although 2020 has been different with no face-to-face meetings for member networking, the company has been taking advantage of online or virtual MTI benefits, including the e-Library, TAC Online Forum and participating in potential project meetings to name a few. They hope to continue exploring all that MTI offers to gain valuable knowledge from membership.

In exchange, Janssen says Sitech is willing to share more than 50 years of in-depth experience, especially for the chemical industry, for materials advice, failure mechanisms, asset performance management, inspection, and failure investigation.

"We are pleased to introduce Sitech Services as a new member to the MTI technical community," observes Paul Whitcraft, MTI Executive Director.

"Please be sure to reach out to Peter and other Sitech members through the online membership directory to welcome them to MTI!" ▪

2021 MTI BOARD OF DIRECTORS CONVENES FOLLOWING VIRTUAL GLOBAL TAC AND ANNUAL MEETING

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and one from our AsiaTAC group," notes David Barber (Dow), BOD Chair.

The three projects approved at the Global TAC Meeting include: Project 364 – Duplex Stainless Steels at Elevated Temperatures. This project was formed, following the conclusion of Project 307 – Short Term Use of Duplex Stainless Steels (DSS) at Elevated Temperatures, to fill in some of the gaps in knowledge of the effect on mechanical properties of DSS after repeated exposures, as well as the order of the aging exposures. A series of exposures will be conducted, and mechanical properties tested and compared to draw conclusions of the ability of these alloys to withstand short term exposure above recommended temperatures; Project 354 – Dual Laminate Training Course will be a follow up to the popular FRP Inspection course offered by MTI and will cover dual laminate vessel fabrication and inspection; the third project approved was Project 353 – PSA Structural Integrity Assessment, which will evaluate the structural integrity of PSA H2 vessels used for the purification of hydrogen.

The fourth approved project, #367 – Corrosion Data Collection, Nickel Alloys, Phase II, was submitted by AsiaTAC. The purpose of this project is to develop corrosion data for selected common nickel alloys that then may be used by MTI members. Currently, five types of nickel alloys have been selected by the project team based on their popularities, including UNS N06022, N06600, N06625, N08825A, and N10276.

"The projects approved by the board truly represent the global impact of MTI," he remarks.

Looking to the coming year, Barber also highlighted several points the board discussed during their meeting, particularly with the outlook that COVID-19 could continue to affect many members and the organization:

- The BOD is still hopeful to conduct face-to-face TAC meetings in 2021
- The BOD is working parallel paths for the February AmeriTAC meeting so that a virtual meeting can be held
- The BOD is anticipating that projects will proceed by using virtual meetings to the extent as possible
- The BOD encourages new project ideas, because MTI is in good financial position and funding is available
- The BOD will continue to watch the global economy and may offer another dues discount if the BOD believes that it is warranted

"The past year has been challenging for us all, but the Board of Directors is proud to represent members of MTI worldwide and would like to thank everyone for your ongoing participation and membership," he concludes.

If you have questions, issues or comments you would like the MTI BOD to address, please visit the Directory at www.mti-global.org to connect with any of the BOD members. ▪

*Eileen Chant announced her resignation November 4 as she pursues another career path.

DUAL LAMINATE TRAINING PROGRAM TO SHARE

MTI has successfully completed projects that delivered FRP Inspector Training for new and in-Service equipment. Some of the members attending those sessions expressed strong interest in additional training focused on dual laminate constructed equipment. To meet that need, an MTI Project Team formed and is currently hard at work on a comprehensive two-day Dual Laminate Training Course.

BEST PRACTICES

The course will cover a wide range of valuable information, including dual laminate materials and design fundamentals, manufacturing techniques for pipe and equipment, applicable codes and testing, fabricator qualification, installation, inspection and repair options, as well as a review of case histories. "All of these things must be understood and done right to gain the benefits of dual laminate construction," explains Debra McCauley (Chemours), who is Project Co-Champion with Dale Keeler (Dow).

The Project Champions know of no formal training available in industry that covers this range of dual laminate topics. In addition, the course will be taught by instructors who have successfully completed numerous dual laminate projects and learned important lessons from a few mistakes along the way. These experts have more than 150 years of combined experience and bring a wide range of subject matter knowledge to the table.

"The goal is to provide lessons learned to short-cut member companies' learning curve," explains Keeler. "Nowhere is there training of the whole enchilada. I imagine when we end up having live training sessions, there will also be a 'show and tell' aspect to this. This is where many questions are answered, and attendees get to touch and feel what is being discussed."

As a byproduct of developing this course, the Project Team will end up creating its own set of best practices built on the instructors' and members' personal experiences as well as current industry knowledge. "Several global standards exist and are used depending on geographical location," notes McCauley. "Over the years, all have developed in parallel and leverage off each other. It is good to know what is considered best practice, and that is the goal of this training. The need to outline minimum requirements and expectations in certain regions of the world is another goal of this training."

The first live Dual Laminate Training session is tentatively scheduled for May 2021, and a set of webinars may also be in the works, based on member needs. Watch for updates at mti-global.org as more information becomes available. ▪

NELSON AND RENTSCH: AMERITAC'S NEW LEADERSHIP TEAM

DISCUSS ROLES, GOALS AND PLANS FOR FUTURE MEETINGS

MTI membership voted on the next AmeriTAC Chair and Vice Chair as part of the 2020 Annual Meeting in October. Stepping into these leadership positions are Jeremy Nelson (Koch Industries) as the new TAC Chair and Andrew Rentsch (Huntsman) assuming the position of Vice Chair. The AmeriTAC leadership team is responsible for identifying content and providing input to organize and run the three TAC meetings per year. The duo is looking forward to their roles and charging forward with the hopes of holding face-to-face meetings in the new year.

Nelson first started attending AmeriTAC in 2015 at the TAC 118 meeting in Houston. Since then he has been an active participant in TAC meetings, the TAC Forum, multiple projects, including serving as Champion on a few, and most recently serving the last few years as AmeriTAC Vice Chair with Marc Cook (Dow), former AmeriTAC Chair, where he reluctantly relinquishes his role of ringing the zirconium bell to Rentsch.

The new TAC Chair already has a few ideas and goals outlined as they get started and is optimistic that MTI will be able to hold in person meetings in 2021.

"The goal for my term is to see how much productive dialogue we can create in our TAC meetings," Nelson remarks. "There is a blend of content and technology involved in getting there. I will try to meet the standards that previous Chairs have set, but also using the increased flexibility in getting there."

MTI project work and development are another aspect of TAC

Jeremy Nelson, Koch Industries

meetings that Nelson holds in high regard.

"I think the focus on projects is what is most valuable to me as Chair," he explains. "We want to keep bringing member company problems into the TAC and pulling together the different perspectives to introduce solutions to our industry that are not commonly available today. If anything, I hope the next few TACs see many useful bite-sized projects get kicked-off, other projects get the feedback from the TAC they need to be successful, and awareness levels raised in the non-TAC audience of what we're working on during the TAC."

Rentsch, being new to the team, says he plans to listen, learn and, where needed, help drive improvements in support of the TAC Chair. He hopes they can also create more opportunities for open technical dialogue between MTI member companies on materials engineering challenges.

The Vice Chair, while newer to the AmeriTAC scene – his first meeting was in October 2018 – did not hesitate to begin participating when he signed up for MTI member access. He is active in the online TAC Forum discussion, project meetings, during TAC meetings and more. As the new AmeriTAC Vice Chair, he says there are some areas of the TAC meetings he will work with Nelson to adjust.

In review of the 2020 meetings amid the pandemic, both Nelson and Rentsch agreed there have been some new elements of virtual meetings that MTI was required to make in order continue providing membership value.

"I'm glad we decided to plan for a virtual meeting in June 2020," Nelson remarks. "We had a lot of concern about quality of internet affecting the participants, but it seems like that has for the most part not been an issue. The international MTI members' participation has been wonderfully increased as well. I hope we can keep and improve a chat function for the 'typical TAC meetings.'"

Rentsch agrees that the virtual platform allowed for additional

"I'd like to provide high-level current project status information to members before breaking out into Project Team Sessions," Rentsch outlines. "Visual tools can help direct new or infrequent members to projects in concept phases or in need of additional membership participation."

opportunities, such as recording sessions, that MTI has not done in the past. The international participation was at a level not experienced during in-person AmeriTAC meetings, and he also adds that the newest feature to showcase technical presentations by MTI members was a success.

"The Industrial Showcase segment was tried for the first time during the online AmeriTAC 133, which received great feedback and should be considered for future meetings. Web conferencing allowed for easy audio and video recording, which created some great visual content to be added to MTI's library. This pandemic has forced all segments of our world to embrace technology in new ways – I suspect future years will benefit from that innovation," he surmises.

In addition, Nelson is even considering a hybrid format when in-person meetings restart.

"I would like to make AmeriTAC easier for contributors who are not able to travel. I think it probably would be good to keep a hybrid format when face-to-face meetings resume," he describes. "Some of the vague ideas we have been kicking around include building more time into the agenda for project highlights/feedback sessions from the wider TAC, and getting more presenters on practical topics that appeal to "materials adjacent" subject matter experts, such as fixed equipment reliability and process plant design engineers."

Now that Nelson and Rentsch are in leadership roles, they shared a few words of wisdom for other MTI members who might be asked to step into these roles someday.

"Keep looking for new ideas, but with an eye for durable knowledge," Nelson simply suggests.

Rentsch expands further from the perspective of a relatively new participant already taking on a significant leadership role within MTI.

Andrew Rentsch, Huntsman

"Spend some time learning about how MTI is structured," he advises. "Grab a coffee with one of the MTI staff members and learn about the origins of MTI, past successful projects, and how MTI has changed over the years. Attend AmeriTAC meetings on a regular basis and consider getting involved in a current project."

Both Rentsch and Nelson are looking forward to serving MTI as the leaders of AmeriTAC and ready to take on the challenges of virtual, face-to-face or hybrid meetings amid the ongoing COVID-19 concerns. The team would like members to know they are open to ideas, suggestions and questions at any time.

"New and old materials challenges persist every day. As such, interesting technical content at our meetings will never be lacking," Rentsch concludes. "As we continue to adapt our meetings to mitigate this pandemic, please reach out to me, Jeremy Nelson (AmeriTAC Chair), or MTI staff with your suggestions and questions so we can best serve the membership."

Congratulations to Jeremy and Andrew on your new roles at MTI and we look forward to your leadership! ▪

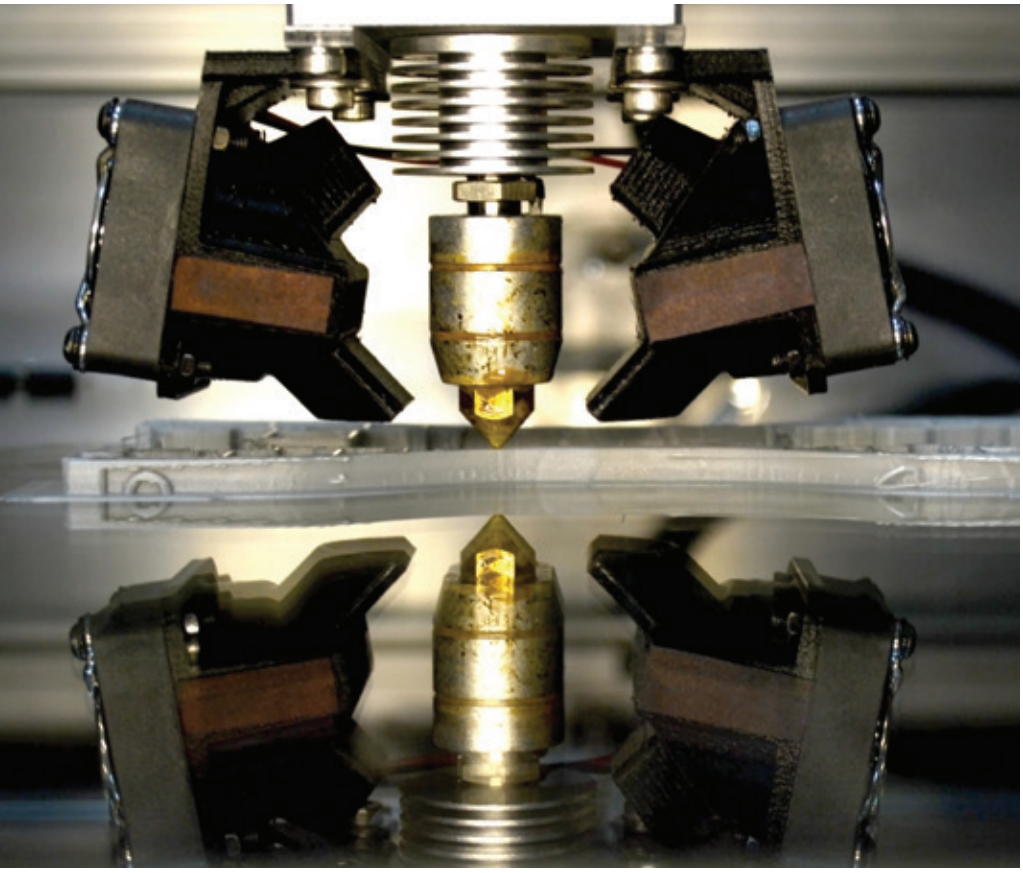
BUILDING MTI'S ADDITIVE MANUFACTURING KNOWLEDGE BASE

MTI PREPARES TO HOST HALF-DAY ROUNDTABLE IN FEBRUARY 2021

MTI is committed to continue providing valuable technical content and information to its members, driven by members. To kickstart 2021, MTI will host a half-day Additive Manufacturing (AM) Roundtable, tentatively scheduled for Monday, February 22. TAC leadership identified the need to host the roundtable after hearing talks of AM among members.

"Based on discussions in the Metals PDC (project development committee) and conversations with other members, there is a need for increased understanding to utilize this method in fabricating process equipment," explains Jeremy Nelson (Koch Industries), AmeriTAC Chair.

According to Nelson, MTI member companies are interested in many aspects of AM, such as producing raw ingredients for printer consumable material, designing unique "impossible to machine" components for process plants, and even developing the additive printing machines themselves. However, the AM techniques have not become commonplace in hazardous fluid service. Some of the possible reasons for this include a lack of RAGAGEP (Recognized And Generally Accepted Good Engineering Practices) to qualify AM components as safe and reliable, perceived high costs, and doubts about the AM component materials properties versus conventionally manufactured (isotropic) alternatives.



MTI has historically focused on the practical applications of new technology, and this Best Practices conversation will be the same. It will include presenters with both the technical experience in various aspects of process equipment fabrication, as well as the vision and roadmap to sensible adoption of the AM parts in plant designs.

Nelson says the program content is still being developed and speakers identified, but presentations are expected to include:

- Consumable Suppliers
- Device Technique Developers
- End User Adoption/Q&A Experiences
- Standardizations
- Panel Discussion

"We expect the panel discussion to give the audience a chance to delve more deeply into aspects of what the presenters cover," he adds. "Also, we hope to generate some project ideas to take back to the Metals PDC."

Due to uncertainty still surrounding face-to-face meetings from the impact of COVID-19, the MTI Board voted in early December to hold a virtual event in February 2021. Nelson notes that the TAC 134 planning committee is organizing the roundtable virtually as a result, and the team encourages you to bring your questions about using AM components to improve safety, sustainability, reliability, and profitability in the plant.

Mark your calendar for February 22, 2021 and watch your email for announcements or stay tuned at www.mti-global.org. ▪

BEST PRACTICES FOR WORKING WITH SMES PROJECT UNDERWAY

MTI EXPANDS EFFORTS IN KNOWLEDGE TRANSFER AND MANAGEMENT

In a world where unexpected changes have become the new norm, it is critical to capture important, sometimes irreplaceable information from your subject matter experts (SMEs) before it suddenly vanishes. When a knowledgeable employee decides to pursue a new job, retire, or is no longer available for other reasons, you may be left without a source of reliable answers.

"Gathering, preserving and transferring knowledge that you need to support a viable enterprise is the heart of knowledge management," explains Peggy Salvatore, author of Retaining Expert Knowledge: What to Keep in an Age of Information Overload (published by CRC Press in 2018). "The pandemic has accelerated this issue to hyperdrive. You may have lost people due to attrition, layoffs or distance that you or they could not have anticipated." Salvatore is currently consulting with MTI on Knowledge Management-related projects that will help capture and preserve vital, sometimes irreplaceable information.

During MTI's Global TAC meeting in October 2020, participants in one of those projects, "Best Practices for Working with SMEs," discussed the importance of developing guidelines for working with their busy subject matter experts to gather and safely store the critical knowledge they have built before it is lost forever. Several members provided valuable input that MTI staff will use to develop a Strategic Project Summary that will be ready for review by February 2021. In the meantime, staff and Knowledge Management PDC leadership have developed a set of preliminary project objectives that include:

- Help members define their critical knowledge and SMEs
- Identify best practices for documenting and transferring information
- Explore software and other solutions for retention and retrieval of critical knowledge
- Share best practices for overcoming hurdles (e.g. generational and cultural communication issues)
- Provide a framework for justifying an SMEs/KM program with senior management

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TITANIUM GRADE 12 – UNS R53400

ALTERNATIVE ALLOY FOR COST REDUCTION AND CORROSION RESISTANCE

CHARLES YOUNG, TRICOR

Titanium Grade 2/2H (UNS R50400) is the workhouse alloy used in the Chemical Processing Industry (CPI) to combat against corrosion and give a long, maintenance-free life. This Grade is essentially pure titanium with a yield strength minimum of 40 ksi and a minimum ultimate tensile strength of 58 ksi for Grade 2H.

When the service becomes too aggressive in terms of corrosion or the pressure and temperature would require a very thick section of Titanium Grade 2/2H, an alternate alloy, Titanium Grade 12 (UNS R53400), can be cost effectively used. Titanium Grade 12 is composed primarily of titanium with additions of molybdenum (0.3%) and nickel (0.8%). It has higher mechanical properties than Grade 2/2H, with a minimum yield strength of 50 ksi and a minimum ultimate tensile strength of 70 ksi.

Figure 1 shows the design allowable stresses (Section VIII, Div 1) for Ti Grade 2H and Ti Grade 12 developed by the ASME (American Society of Mechanical Engineers) for alloys used in the construction of equipment (vessels, exchangers, etc.) for the CPI.

The benefit of the higher strength of Titanium Grade 12 in reducing the thickness of alloy required can be shown at 100 °F (38 °C) and 300 °F (149 °C) in Figures 2 and 3. To withstand 100 psi pressure at 300 °F (149 °C), the thickness of a Ti Grade 2/2H vessel wall would have to be a minimum of 0.55 inches. Since plate only comes in certain thicknesses (unless the

Figure 1 ***ASME Design Allowables***

Temperature Degrees	R50400 2H Psi	R53400 12 Psi
100 °F (38 °C)	16600	20000
150 °F (66 °C)	15900	20000
200 °F (93 °C)	14400	18700
250 °F (121 °C)	13100	17400
300 °F (149 °C)	12000	16200
350 °F (177 °C)	11100	15200
400 °F (204 °C)	10200	14300
450 °F (232 °C)	9500	13600
500 °F (260 °C)	8800	13100
550 °F (288 °C)	8200	12700
600 °F (315 °C)	7600	12300

Titanium Grade 12 Vessel

quantity justifies a special mill run), this would require a plate thickness of 0.625 inches – 5/8 in. nominal thickness. With Ti Grade 12, the thickness required would be 0.41 inches and the actual plate thickness used would be 0.4375 inches – 7/16 in. nominal thickness. Using Ti Grade 12 as an alternative to Ti Grade 2/2H would result in a savings of 30 percent of material.

If the pressure is increased to 300 psi at 300 °F (149 °C), the comparison becomes a plate thickness of 1.53 in. (which would require 1.75 inches – 1 ¾ in. nominal thickness plate) for Ti Grade 2/2H versus a calculated thickness of 1.14 inches (requiring a 1.25 inches – 1 ¾ in. nominal thickness plate) for Ti Grade 12. This again would give a savings of roughly 28 percent for the total weight of plate required.

Currently, costs of Ti Grade 2/2H and Ti Grade 12 are $13.34 per lb. and $15.07 per lb. respectively (a 15 percent difference). Even though Ti Grade 12 is more expensive on a per pound basis, the overall cost of the material for a vessel manufactured in Ti Grade 12 is 21 percent less than if it was fabricated using Ti Grade 2/2H. Considering that the cost of fabrication for Ti Grade 2/2H and Ti Grade 12 is about the same – with similar forming and welding techniques used, this means that vessels fabricated in Titanium Grade 12 can be more cost effective than in Titanium Grade 2/2H in some circumstances.

Titanium Grade 12 also has corrosion resistance superior to Grade 2/2H in most applications and especially gives additional crevice corrosion and under deposit crevice corrosion protection. Figure 4 shows the corrosion resistance of Ti Grade 2/2H versus Ti Grade 12 to crevice corrosion in concentrated brine solution at various temperatures and pH.

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Figure 2 ***Minimum Thickness at 100 psi***

Temperature Degrees	Grade 2H Thickness (inches)	Grade 12 Thickness (inches)
100 °F (38 °C)	0.40	0.33
200 °F (93 °C)	0.46	0.35
300 °F (149 °C)	0.55	0.41
400 °F (204 °C)	0.64	0.46
500 °F (260 °C)	0.74	0.50
600 °F (315 °C)	0.86	0.53

Figure 3 ***Minimum Thickness at 300 psi***

Temperature Degrees	Grade 2H Thickness (inches)	Grade 12 Thickness (inches)
100 °F (38 °C)	1.11	0.93
200 °F (93 °C)	1.28	0.99
300 °F (149 °C)	1.53	1.14
400 °F (204 °C)	1.80	1.29
500 °F (260 °C)	2.08	1.41
600 °F (315 °C)	2.40	1.50

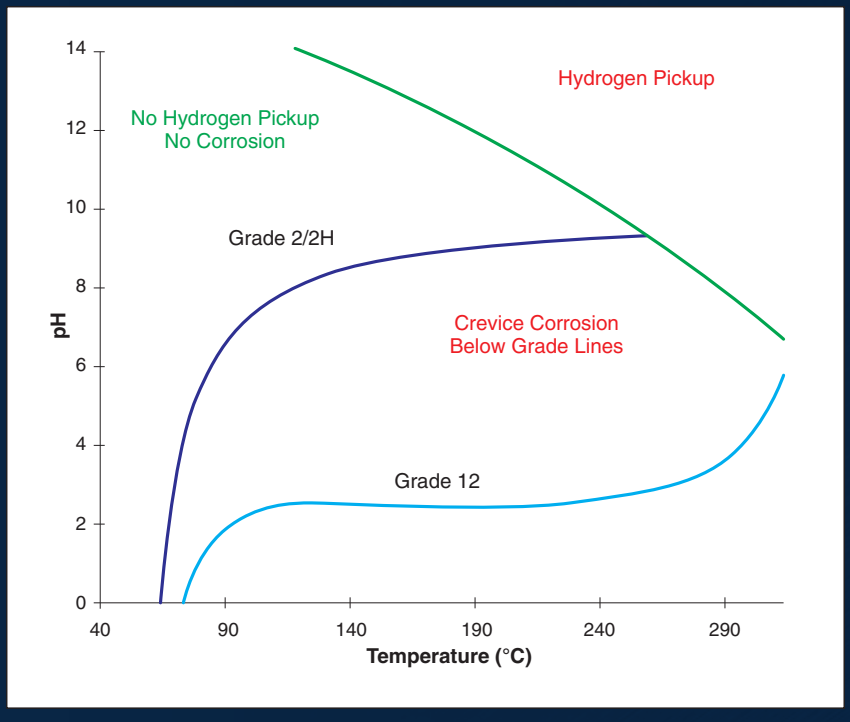
Titanium Grade 12 Piping

Above a pH of 2, Ti Grade 12 can be used up to a temperature of 464 °F (240 °C) where Ti Grade 2/2H, even at a pH of 2, can be vulnerable to crevice corrosion. Neither Titanium Grade is subject to hydrogen pickup in this corrosive environment, except at high pH levels, and Grade 2/2H is regularly used in chloride service where crevice corrosion, or under deposit corrosion, are not an issue.

Ti Grade 12 offers superior service in boiling HCl up to a pH of about 2 as shown in Figure 5. Ti Grade 2/2H is good only up to about 0.1 pH and is almost never used in HCl service. In other corrosive chemical environments the difference in corrosion resistance is much the same, with Ti Grade 12 showing better overall corrosion resistance and superior resistance to crevice and under deposit corrosion.

There are many other chemicals where Ti Grade 12 offers better

Figure 4 ***Crevice Corrosion in Saturated Brine***

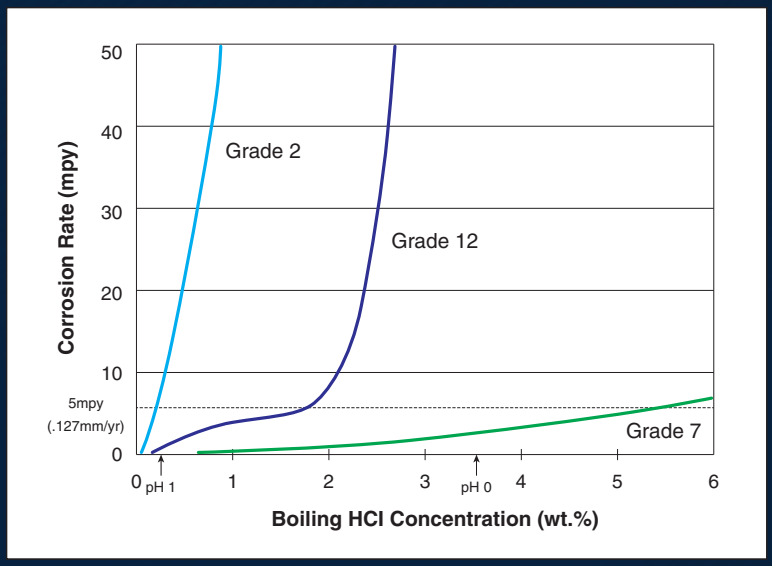


corrosion resistance than Ti Grade 2H and can offer the possibility of using thinner sections to reduce the cost of the overall project. You can find more corrosion data on all of the titanium Grades in a number of publications on the internet from titanium producers and other organizations like MTI, NACE, ANNA, API and the Chlorine Institute. If you don't find applicable data, it may be wise to perform some preliminary corrosion tests in your exact environment. Samples of all titanium Grades, as well as other alloys, are also available from Tricor Metals – as well as assistance in evaluating which alloy may be best for your application.

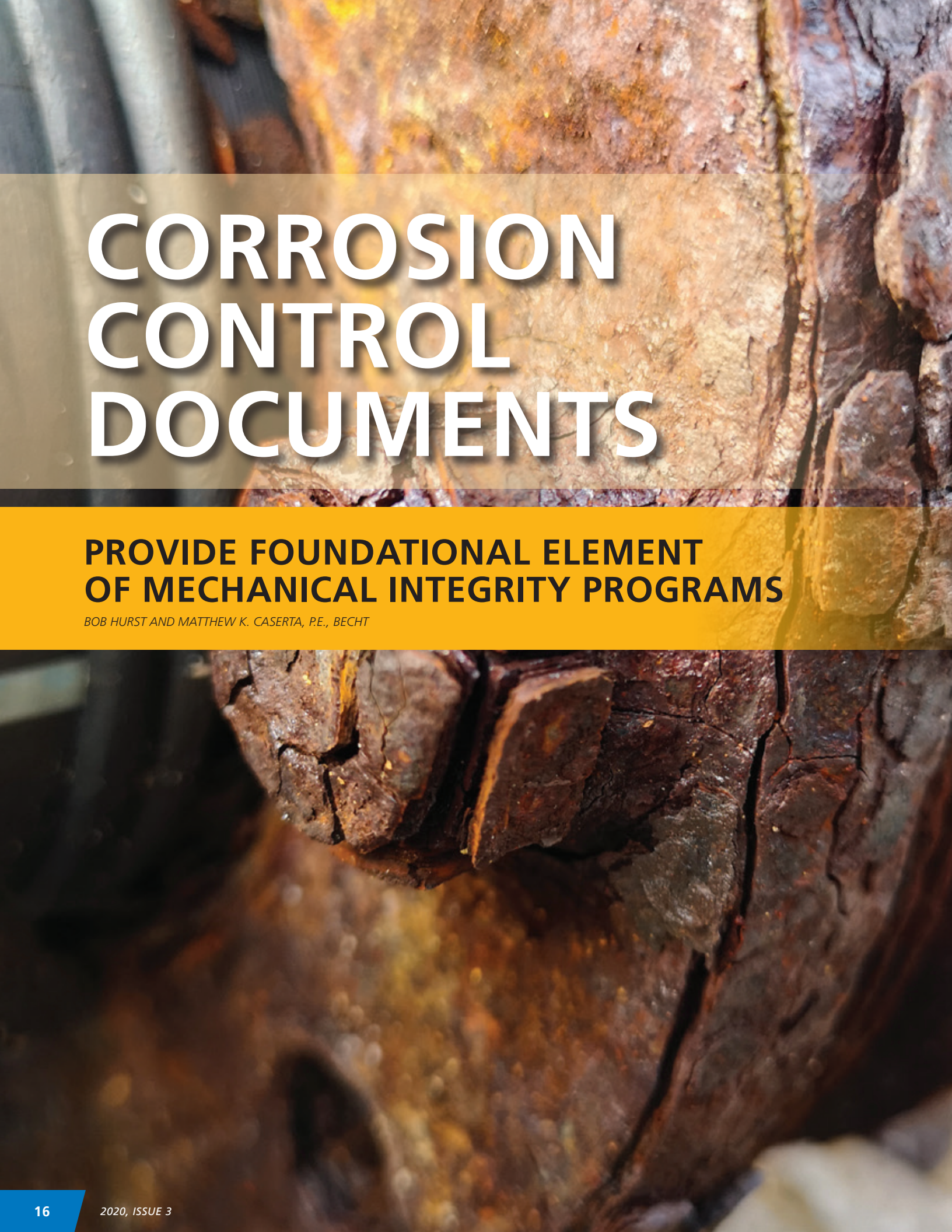
While most applications of titanium in the CPI are in static service, there may be some where vibration comes into play (e.g., heat exchangers and piping, agitators, etc.) and knowledge of the fatigue strength or endurance limit of the titanium alloy may be helpful in determining which alloy to use. The fatigue strength of Ti Grade 2 was investigated by Wardlaw & Hall and reported in ASTM STP728 -1981 and found to be at least 45 ksi at 107 cycles at room temperature. Analysis further indicated that Ti Grade 2 is also tolerant of reasonable surface defect severities for fatigue loading with maximum stresses within ASME Code specifications. Research into the fatigue endurance limits of other titanium alloys (including Ti Grade 12) has also shown similar results – with the endurance limit well above 50 percent of the ultimate tensile strength. In addition, it has been noted that finer grain size and slightly higher oxygen contents slightly increase the endurance limit while welding, when performed correctly, and has no effect on the fatigue characteristics of titanium alloys.

In conclusion, Ti Grade 12 offers some significant advantages in strength and corrosion resistance over Ti Grade 2H, while providing similar fatigue limits for applications in the Chemical Process Industry. It would be worthwhile to evaluate Ti Grade 12 to reduce the cost of a titanium project and to gain valuable corrosion resistance. ▪

Figure 5 ***Ti Grades in Boiling Hydrochloric Acid***



...vessels fabricated in Titanium Grade 12 can be more cost effective than in Titanium Grade 2/2H in some circumstances.



CORROSION CONTROL DOCUMENTS

PROVIDE FOUNDATIONAL ELEMENT OF MECHANICAL INTEGRITY PROGRAMS

BOB HURST AND MATTHEW K. CASERTA, P.E., BECHT

Corrosion control documents (CCDs) have gained widespread use as an essential element of a high-functioning mechanical integrity (MI) program. First developed in the refining industry, these documents are seeing increased usage in the wider Chemical Process Industry (CPI). CCDs unite process operations and conditions, materials of construction, damage mechanisms, inspection requirements, integrity operating windows (IOWs), and other items into a comprehensive document that provides the necessary information for an effective MI program. API RP 970 - Corrosion Control Documents provides guidance on the preparation, required elements and development of CCDs.

Industry incidents, such as a California Crude Sidestream Sulfidation failure and a Washington state High Temperature Hydrogen Attack failure, have resulted in regulators requiring that companies perform damage mechanism reviews and consider fixed equipment degradation in their unit process hazard analyses. Even when not required in a jurisdiction, CCDs are becoming recognized and generally accepted good engineering practice.

CCDs can act as the foundational document of a risk-based inspection (RBI) program. In an ideal world, the preparation of a CCD will precede the implementation of an RBI program and be used as damage mechanism inputs to the RBI program. In cases where an RBI program is already in place, the system can work in reverse and RBI data will be input to the CCD. This data should be reviewed to be sure it is correct. In any case, a CCD and RBI should work together and be aligned – changes in one should be reflected in the other.

Preparation and Maintenance

The preparation of a CCD is a team effort. Normally, a subject matter expert in materials engineering will take the lead; however, process engineering, operations, inspection, and other relevant personnel need to be involved. These groups will provide necessary information and input during the development of the CCD.

The preparation of a CCD begins with gathering information on process conditions and the listing of all the fixed equipment in a process unit. Equipment of similar materials of construction and similar process conditions will be grouped into corrosion systems—sometimes referred to as loops. Similar materials and similar conditions should result in similar degradation mechanisms within the system. The elements of a CCD as described above will be listed for each system. The probable mechanisms are then assigned to the equipment with a determination of the severity of the degradation; e.g., corrosion rates for thinning mechanisms, probability of cracking for SCC, etc. With damage mechanisms determined, inspection techniques can be evaluated for their effectiveness in detecting equipment deterioration.

After necessary data is collected, a draft document is developed prior to a review meeting. Meetings are held to review draft documents before a final document is produced with the necessary participants listed above. Without involvement of any of these groups critical information can be missed, which will result in a sub-optimal CCD.

> CONTINUED ON PAGE 18

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There is not a fixed format for CCDs. Different operating sites and companies have developed specific formats that suit their requirements. However, there is a consensus that the essential items of a CCD include:

- Process description and important factors and precursors for damage (basis)
- Mechanical/Materials information on the equipment and piping
- Process information such as temperature and pressure
- Summary of key inspection history
- Anticipated damage mechanisms
- Some level of likelihood and/or thinning rate for each mechanism
- Discusses nuances of the damage mechanisms on a loop level
- Identification of applicable Integrity Operating Windows (IOWs)

Other items that may be included are:

- Identification of mix points, injections points and PFD/P&ID level deadlegs
- Highlights special start-up/shutdown issues
- Identification of special inspection recommendations
- Recommendations such as alloy upgrading, probes, sample stations or other risk mitigation suggestions
- Documentation of assumptions/basis status of programs such as alloy verification and other special emphasis programs

Once prepared and distributed, a CCD needs to be maintained. Changes in process conditions, equipment, or other items need to be recorded and edited into the CCD. Many sites have a revalidation system in which, after a given period of time, the CCD will be reviewed and updated. The same groups involved in the original preparation need to be involved in the update.

Integrity Operating Windows

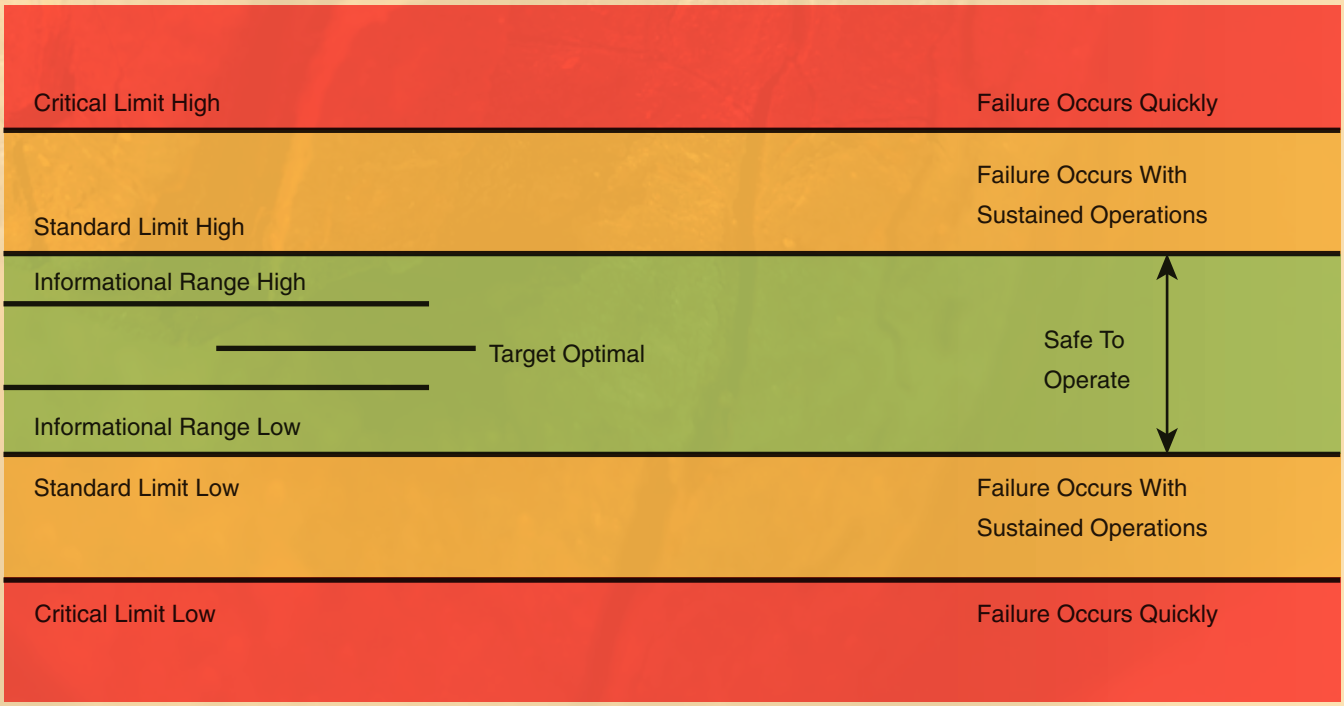
A critical element of a CCD is the Integrity Operating Windows (IOWs). API RP 584 - Integrity Operating Windows defines an IOW as established limits for process variables (parameters) that can affect the integrity of the equipment if the process operation deviates from the established limits for a predetermined length of time. Examples of IOWs are a temperature limit on furnace tubes to prevent creep or pH limits on an aqueous process fluid.

For a particular parameter, different limits can be set depending on the degree of deviation from safe operations. API 584 lists three levels. An informational limit is tracked, but no specific correctional activity is required if the limit is exceeded. An informational limit can serve as a warning that an operating parameter is headed in the wrong direction and requires closer scrutiny. Exceeding a standard limit will cause an increase in degradation and requires correction within some specified time limit, for example 72 hours. An unacceptable level of degradation can occur with continued operations if corrective action is not taken. A critical limit, if exceeded, will result in immediate unacceptable damage, and requires prompt action. For a particular parameter, limits can be high, low or both.

Figure 1 shows an example of different limits. A target value can be set, which represents optimal safe operations. The first level outside the target would be informational, the next standard, and the last critical. All these are not required for a specific parameter but only what are appropriate. In the case of creep, for example, high limits would be necessary but not lower limits.

In conclusion, CCDs provide a foundational element of any mechanical integrity program by clearly defining the expected damage mechanisms within a process unit. By involving key stakeholders of the process unit, CCDs function as a repository of key mechanical integrity information. ▪

Figure 1



MTI HIRES DANIEL RASMUSSEN

FILLS NEW MEMBERSHIP COMMUNICATIONS AND MARKETING MANAGER POSITION

MTI added another full-time staff member to its St. Louis office. In September, Daniel Rasmussen joined the team in the new role of Membership Communications and Marketing Manager. His primary responsibilities include market research on prospective members to boost MTI outreach, managing the member ambassador and mentor match programs, and managing the organization's membership database. He will also be vital to the marketing and communications departments and will assist in maintaining the MTI website, social media channels, contributing to various marketing and communications materials, and he will work at trade shows to promote MTI membership.

"When Lindsey, Kirk and I interviewed him we saw the skills and potential he had to enhance our marketing and communications departments," remarks Byron Keelin, MTI Operations Director.

"He has an extensive background in market research and other areas of marketing and communications that will be a great addition to the organization."

Daniel graduated from the University of Missouri in 2019 where he earned an international business dual degree. He holds a bachelor's degree in business administration with a marketing emphasis and a bachelor's degree in international studies with a Spanish emphasis.

His marketing journey began in the Summer of 2018 where he worked as an intern in Barcelona, Spain for Nektria, a software startup that focused on Software as a Service (SaaS) and last-mile logistics. Rasmussen then continued his career with a second internship at Standing

Daniel Rasmussen

Partnership, a marketing and communications consulting firm in St. Louis, Mo., from October 2019 to May 2020. Between his two internships he gained extensive knowledge with marketing research, website management and marketing and communications content creation.

"Interning in Barcelona was the first opportunity I had to dive into a company's website and provide in-depth research on their current and potential clients," Rasmussen shares. "It really solidified my interest in the marketing industry, so I am delighted to find a job that utilizes those skills and allows me to continue along a path that I am passionate about."

On top of bringing his knowledge to the team, Daniel is looking forward to learning from and collaborating with the organization's members and staff, specifically at the TAC meetings.

"I am thrilled to accept this position with an organization that values collaboration so highly," he explains. "I can't wait to begin meeting our members, helping out and participating in live events when the country returns back to some sort of normalcy."

Until then, Rasmussen will have to meet members virtually and continue working to expand member communications and marketing. He has already hit the ground running by answering new member website user questions, helping to manage the virtual Global TAC Fall meeting registration, launching the Mentor Match program, and collaborating with both the Director of Communications and Director of Sales and Marketing on several projects.

So how did Rasmussen settle on a career in St. Louis with his international business dual degree and experience working abroad? St. Louis has been home for much of his life, he says.

"I was born in St. Louis and, although I moved around quite a bit in my early childhood, I was raised here for most of my life. This made it an easy decision to return here to start a career as I have family, friends and familiarity with the location," he explains. "On top of this, I have immediate and extended family all across the U.S., so being in the heart of the country gives me the best possible opportunity to visit each of them."

Rasmussen also notes that he's excited to be back in his hometown so he can explore local and county parks that he hasn't visited before, where he likes to spend time hiking and jogging—important aspects of his daily life.

MTI is delighted to bring Daniel's various skills and experiences to the team. Many members have already had the opportunity to interact with him through website communications, but if not, please be sure to welcome Daniel to the MTI community! ▪

Q&A

WITH ABDULMOHSIN AL-SAHLI

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 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 Abdulmohsin Al-Sahli (SABIC) to learn more about his roles within MTI, his company and how his leadership experience produced a successful event for Project 370 – Digitalization Roundtable, despite the challenges of accommodating global speakers and attendees in a virtual format.

Q: ***Please describe your role at SABIC.***

A: I'm a Materials Engineer at SABIC Asset Technology Center, and I'm also leading SABIC High Temperature Expert Group. My responsibilities include: providing technical support to the mitigation of corrosion and other forms of materials degradation problems at SABIC's plants; the development of standards and procedures to improve equipment integrity and reliability; and the organization of training and networking events for building competency and capability.

Q: ***How long have you been participating in MTI and how have you benefitted from your involvement?***

A: I have been a member with MTI since 2014, and I assumed the role of SABIC designated representative at MTI in 2017. Joining MTI helped me to improve the performance of several SABIC assets by utilizing MTI resources (e.g., forum, manuals, trainings, etc.).

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

A: The first time I attended an MTI TAC meeting was in 2017 and I met a wonderful group of people. They all encouraged me to join MTI projects as a member, and to lead MTI projects in the future. They also explained to me how they are benefiting from MTI projects and discussed several projects with me.

Q: ***How did you become a project champion? Perhaps you were eager to volunteer or other members encouraged you? Please tell us how you came to take on this role and what skills and/or experience you believe you can offer the team.***

A: I was discussing with Paul, Pradip and Byron (MTI Staff) conducting an FRP training in the Middle East. I suggested during the meeting to conduct a roundtable on digitalization for asset reliability and integrity. Paul encouraged me to lead this initiative and he and Byron offered a great support to ensure the success of the event.

Q: ***Was the final product the same as the initial idea? What changed and why did you implement those changes?***

A: The final product was very similar to what we envisioned. The primary challenge was on conducting the event virtually, and accommodating different time zones, as we had speakers and attendees from different regions.

Q: ***Tell us about the Digitalization Roundtable – Project 370. How did it go?***

A: Digitalization is a topic of critical importance and common interest to the petrochemical industry, including many of the MTI members. Therefore, we arranged the roundtable to enable digitalization in the petrochemical industry by addressing the following key questions:

- What does digital transformation mean for the Petrochemical Industry?
- How could digital transformation improve plant reliability and integrity in the Petrochemical Industry?
- What are the challenges that can impact a successful transformational journey?
- Can existing technologies enable digital transformation needs?

The roundtable was conducted in a format that combined presentations from multiple well-distinguished Subject Matter Experts with interactive discussions between all participants to address these questions and share experiences, deep insights on different digitalization topics, and how to utilize digitalization to improve petrochemical plant reliability and integrity. The objectives of the program were to provide attendees with insights on how to effectively implement digital transformation initiatives and to enable networking and the exchange of experiences with peer industry experts. The program was intended for managers and engineers from different disciplines desiring to improve their knowledge and understanding with respect to digitalization.

In total, more than 200 attendees from different companies and countries across the globe participated in the event.

Q: ***Please explain what you've learned from your experiences as a team member of other MTI projects (or what you've observed while attending project meetings) and how that has helped you as a first-time project champion.***

A: Motivating teams and aligning teams from different companies is a crucial success factor.

Q: ***What did you gain from this experience as a project champion?***

A: Having a clear vision and strategy from the beginning to execute the project in a meaningful way to all MTI members is a key success factor.

Q: ***Just for Fun, what is the best city you have ever visited and why?***

A: Barcelona, Spain. The architecture was unique and fascinating.

Q: ***Briefly talk about one exciting/proud moment in your professional career.***

A: I'm proud of every positive impact I made to SABIC plants. I'm most proud of the significant improvements I achieved with the High Temperature Expert Group on SABIC Furnaces Reliability and Integrity.

CONNECT thanks Abdulmohsin for taking the time to speak with us and for successfully championing the virtual Digitalization Roundtable. MTI members interested in the recording can head to the MTI website where it can be accessed by the end of the year. ▪

Technical Awareness Bulletins (TAC Bulletins) published by MTI are brief industry-related topics that have evergreen value. The TAC Bulletins Committee develops ideas to produce new bulletin topics that will have an impact on MTI members and the industry, as well as regularly reviews and revises past bulletins to keep them up to date with best practices and industry standards.

In this issue of CONNECT, MTI is releasing Bulletin No. 4 – Pickling and Passivation of Stainless Steel and Bulletin No. 10 – Water Treatment: Closed Cooling Systems. Bulletins released to the public can be downloaded by visiting www.mti-global.org/participate/tac-bulletins.

Materials Technology Institute

Technical Awareness Bulletin

Pickling and Passivation of Stainless Steel | No. 4

Stainless steel relies on the naturally forming chromium oxide film, commonly referred as a passive film, for its corrosion resistance. However, if there is surface contamination then that can lead to deterioration of the materials performance in service.

There are various sources of surface contamination on stainless steel. Here are some examples: welding, which can produce a colored oxide layer known as heat tint; forming or working operations, which can introduce iron or carbon contamination; and storage or adhesive labeling, which can be a source for dirt and other contaminants on the surface.

The heat input to the surface during the welding process can result in a formation of an oxide layer. Beneath this layer, there can be a depletion of chromium. Since a lower chromium content in the passive film can deteriorate the performance of a material in corrosive solution, it is often necessary to clean stainless steel equipment after fabrication and before placing it into service. Pickling and passivation are chemical treatments applied to remove contaminants and assist in the formation of a continuous passive film.

Need to Degrease

It should be noted that pickling and passivation do not remove grease and oils. Before pickling and passivation treatments, any deposits of oil and grease should be removed by using an alkaline cleaner or steam cleaning.

If the fabricated component is dirty, it is essential to use mild cleaning solution or a hot alkaline cleaning before pickling or passivation.

Mild cleaning with detergents and non-scratching abrasives is followed by rinsing with clean water and drying. Removal of fingerprints and ink marks can usually be done with fairly non-aggressive solutions.

Hot alkaline cleaning removes drawing compounds and lubricants and is followed by water rinsing and drying, and/or solvent degreasing. Electrolytic cleaning may be employed to enhance alkaline methods. Degreasing can be performed using liquids, vapors or a solid-fluid mixture used in vapor blasting.

Pickling

Pickling removes adherent oxides formed during hot processing or welding. The preferred pickling method depend upon the type of stainless steel and the extent of scale. Pickling treatment of a stainless-steel results in the removal of scale and underlying chromium depleted layer. Furthermore, it restores the surface corrosion resistance. A commonly used pickling solution is a mixture of nitric acid(HNO3) and hydrofluoric acid (HF). Other chemical solutions may also be considered for pickling treatment. The chemicals used for pickling treatments are hazardous and corrosive, and require great care in handling, use and disposal.

Pickling pastes, where the solution is mixed with an inert carrier, are commonly used to treat selected areas such as welds. Pickling involves metal removal and a change or dulling in the visual brightness of the metal.

Passivation

Passivation removes superficial iron or rust contamination and restores the protective oxide film. Common passivation treatments, including nitric acid (HNO3) solutions or pastes, will clean the free iron contaminants from the stainless-steel surface. Care must be taken in selecting and using passivation treatments to ensure the selected treatment will target the contaminant. Passivation will also aid in the rapid development of the passive oxide film and does not usually result in a marked change in appearance of the steel surface.

It should be noted that most of the commonly used pickling solutions contain an oxidizing acid (like, nitric acid) that passivates the surface. Therefore, passivation, after pickling, is not required for every application.

It is essential that all pickling and passivating chemicals are thoroughly removed by rinsing the component after completing the process. Any residual hydrofluoric acid from a pickling process has the potential to initiate pitting corrosion on stainless steel.

Summary

- Recognize the level of cleaning required for fabrication or maintenance and select a method that accomplishes the task with minimum impact on equipment integrity and disposal of solvents.
- Special precautions must be taken to control exposure to chlorides and chlorinated compounds during cleaning of stainless steels to prevent pitting and cracking risks.
- Passivation, in addition to pickling, may not be needed for every application.
- Cleaning may include removal of oxides from hot fabrication steps and heat treatment, removal of iron contamination, and removal of machining fluids and other dirt, grease, grime, debris, and stains that occur during fabrication, handling and storage.

References

(1) ASTM A380: Standard Practice of Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and System
(2) ASTM A967: Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

Reviewed/Revised July 2020

Materials Technology Institute

Technical Awareness Bulletin

Water Treatment – Closed Cooling Systems | No. 10

What is a Closed Cooling Water System?

A closed cooling water system is one in which there is no make-up after the initial charge (except to replace accidental leakage) and no blowdown. Because this arrangement gives no opportunity for evaporation, the water chemistry, once established, can be easily and inexpensively maintained. These systems are used primarily when precise control of temperature or water purity is necessary. They are found in automobile radiators, tempered water systems, and in some pharmaceutical manufacturing processes. The heating of the cooling water that occurs in a closed system is removed by an air-cooled heat exchanger or other external cooling system.

See Figure 1 below.

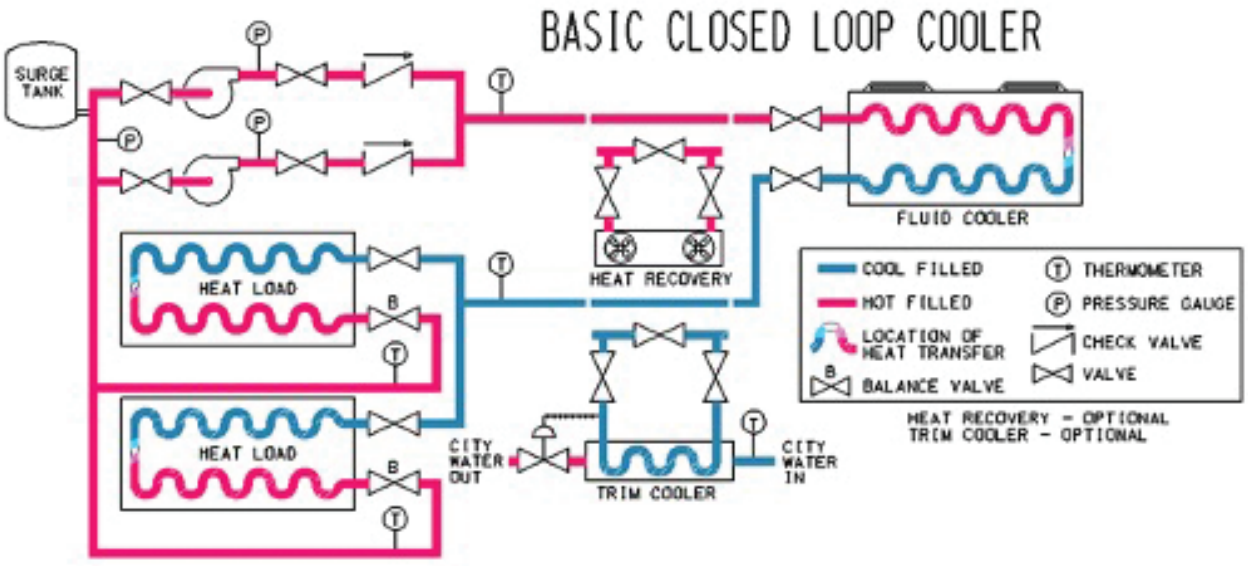
In contrast, an open cooling water system is one in which some amount of make-up water is required on a continuing basis. Cooling water systems with a cooling tower are an example of open cooling water systems.

Closed Cooling Water Systems… How Corrosive are They?

Because of the design features described in the preceding paragraphs, closed cooling water systems should have essentially no corrosion or fouling. The cooling water is relatively easy to control, at least in theory. There should also be essentially no water loss from the loop and no make-up required.

However, there are several factors to consider ensuring that the system is truly closed and that little or no make-up water is required.

Figure 1 – Basic Closed Loop Cooler



The following precautions and controls will ensure that both corrosion and fouling in closed-loop systems are near zero:

- Pre-clean the cooling loop to remove grease, oil, corrosion products, mill scale and dirt, then, pre-film the system to promote rapid formation of an inhibiting film over surfaces of the entire cooling system.
- Pre-treat the make-up water to ensure that there will be no settling of suspended solids or precipitation of salts from solution. This step may involve filtration and/or softening of the make-up water.
- Add a suitable non-oxidizing biocide to control microbiological activity. Biocide activity will dissipate over time, so the system may need to be dosed on a regular basis.
- Control corrosion of carbon steel by removing all dissolved oxygen by either de-aeration or adding oxygen scavengers, taking steps to avoid oxygen infiltration, and adding a suitable corrosion inhibitor. The most commonly used inhibitors include sodium nitrite (for carbon steel) and nitrite-borate-silicate blends for systems with mixed metallurgy.
- Ensure that pH is in the neutral range, which should not be a problem in the absence of contamination. Blended inhibitors typically buffer the pH to a suitable range.

If the system is truly closed, the on-going costs for maintaining the quality of the water are minimal.

Water Treatment Partners

It is often helpful to develop a commercial agreement with a company that provides water treatment services. These vendors have dedicated technical support to complement a plant's own water treatment resources. It is often beneficial due to limited resources to rely on these vendors to manage the entire water treatment program; however, it is important to review their periodic reports to make sure that there are no issues with the system – chemical additions are not unusually high, water quality parameters are with specified limits (prior to additions), etc.

References

C. P. Dillon; Corrosion Control in the Chemical Process Industries –Second Edition; MTI Publication 45; 1994.

A. J. Freedman, A. S. Krisher, and D. Steinmeyer; Guidelines for Troubleshooting Water Cooled Heat Exchangers; Published by MTI in 2004.

Reviewed/Revised October 2018

BEST PRACTICES FOR WORKING WITH SMES PROJECT UNDERWAY

> CONTINUED FROM PAGE 19

For those who plan to start gathering information from their SMEs before MTI completes its best practices project, Salvatore suggests gaining a good understanding about the strategic direction of your organization. "What you think is important on the shop floor can be very different from where the C-suite plans to take the company next year," she cautions. "This is a difficult problem because often you will not know that for a variety of reasons that are outside the scope of your question. But you need to be aware of it because it may be the reason why you don't get the resources or support for your efforts from the executive suite."

If and when you do get senior management support for a knowledge management program, Salvatore recommends inventorying your SMEs. "You need to stratify them according to how important they are to your operation and your customers and how tenuous their association with your company," she says. "Get those with the most critical knowledge and those who are most likely to retire first." Salvatore is working on a Special Report for MTI that will include a downloadable spreadsheet for recording this valuable information and will feature checklists and other tools to kickstart your knowledge management program. MTI will also continue to develop its own platform for gathering and storing valuable technical information, so members can retrieve that information on demand, when they need it most.

"You never know when you will need information to solve a business problem or a technical problem," observes Salvatore. "Often, it is the intuitive knowledge of those who have been around the longest that is hardest to capture but is also the most valuable, which is why you want to have several ways to capture it." That has never been more important than it is today, when companies in the CPI, Oil & Gas, and other industries face black swans (unpredictable events) more frequently than ever before.

MTI invites members to join the "Best Practices for Working with SMEs" and its sister project, "Business Cases for Knowledge Management Continuous Improvement." Participants in the initial meetings have already made an impact with valuable suggestions. For more information on MTI's Knowledge Management efforts or to sign up for a project team community, visit mti-global.org. ▪

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MTI INVITES INDUSTRY EXPERTS TO SUBMIT ABSTRACTS FOR 2022 GLOBAL SOLUTIONS SYMPOSIUM

Preparations for the 2022 Symposium are already underway following the success of MTI's first Global Solutions Symposium held in February 2020. The technical two-day conference will focus on Practical Knowledge and Innovative Solutions for the Process Industries and feature technical education tracks, a track dedicated to knowledge management, and the global solutions marketplace for the opportunity to meet with materials manufacturers, fabricators, and engineering experts who will be exhibiting.

The steering committee met in November to outline the program and to determine the technical tracks and possible topics within those areas of interest.

"The committee would like to invite experts from all aspects of the processing industries to submit abstracts for consideration at the 2022 Symposium," says Chuck Young (Tricor), Symposium Co-Chair and MTI member.

"Knowledge management topics, technical presentations or case studies focused around any of our suggested session topics will be accepted through June 30."

Abstracts should be 100-200 words outlining the presentation topic and scope. Please include a relevant presentation title, the track you're submitting to, and speaker contact information with the abstract. Formal papers are not required for consideration. Presentations should be prepared to fill 30 minutes, including questions, be technical or knowledge management related, and should avoid commercial or marketing content. Speakers will receive discounted meeting registration to attend the event.

Please submit abstracts to mtisymposium@mti-global.org by Wednesday, June 30, 2021, and watch for additional symposium announcements in future issues, at www.mti-global.org and via email communications from MTI. ▪

The committee is requesting presentations related to the following areas:

Emerging Technology
(With an emphasis on utilizing the following technology with ASME and ASTM compliance for use in chemical plants or refineries):

- Additive Manufacturing
- 3D Printing
- Artificial Intelligence/Robotics
- Virtual Reality

High Temperature Damage Mechanisms

Sustainability in the Materials Processing Industry

- Energy Conservation
- Recycling
- Life Cycle
- Processing Efficiency

Safety/Maintenance

- Inspection (Metals/Non-Metals)
- RBI
- Damage Assessment

Knowledge Management

- Workforce Development
- In-Person/Virtual Technical
- Training Tools
- Working with SMEs