The Canadian Delegate Report

International Institute of Welding Commission XI Pipelines and Pressure Vessels

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This is a brief summary of the actions of IIW Commission XI during the conference in Melbourne, Australia. Should additional information be required the specific document which is published on the IIW web site.

INTERNATIONAL INSTITUTE OF WELDING
COMMISSION VIII HEALTH AND SAFETY

ANNUAL ASSEMBLY MEETING 10 July – 13 July 2016

Melbourne Convention and Exhibition Centre, 1 Convention Centre Place South Wharf

Melbourne, Australia

Summary
Ms. Teresa Melfi from the USA chairs this commission.
Its focus is in the areas of pressure vessels, boilers and pipelines. The IIW Commission XI meetings have two main purposes: to gather together experts from around the world to discuss welding related issues, and to allow the flow of information between the member welding societies in the parent countries. The meetings with commission XI were done in the form of papers given by experts in the field of welding and some discussions regarding the working groups. I will provide short descriptions of the papers given. The full texts of the papers are available by contacting the CCIIW.

July 11th, 2016 – Commission XI Meetings

Welding in the World
A presentation on the success of welding in the world was made to the attendees. 47% of the papers submitted have been approved for publication. An effort is being made to shorten the time period from submission to publication. The committee was looking for more reviewer to help shorten this time, as the peer review process has been slowing down the publication.

XI-1040-16: Aberrant P91 base and weld metals and the issue of component safe remaining life assessment - Authors: *Ahmed Shibli, European Technology Development, Leatherhead, Surrey, UK*

Utilities and power plants have been discovering 'abnormal' (or 'aberrant') P91 base metal and welded joints in their plants. Although it is now well known that correct heat treatment is critical in achieving full strength in high Cr martensitic steels, it is clear that for various reasons many materials suppliers, manufacturers or welding companies have failed to realize this criticality. This practice is unfortunately still widespread. As a result, there is a worldwide problem with P91 base metals and/or whole welded joints that have not been heat treated to specifications and/or best practices, resulting in hardness below the acceptable limit and/or the microstructure not in the fully martensitic condition resulting in premature Type IV failures. Many abnormal P91 components/welds have only been found some years after entering service, either during scheduled inspection outages or sometimes because there has been a premature failure. Not all of the abnormal components/welds can be replaced in the immediate future and many will have to remain in service indefinitely. However, this presents a very serious problem because the plant owners / operators do not know how to treat these components in the absence of long term material creep strength data or guidelines. To make matters worse, the traditional NDE techniques are failing to find damage in these components at an early stage in life and as a result plant operators are finding it difficult to assure the safe

performance of such components.
In view of this international industrial community has started two new initiatives: one dealing with generating long term (30kh) stress rupture data on a number of aberrant P91 base metal and weldment combinations often found in power plants, and, the second on developing and demonstrating new and innovative NDE techniques for detecting and quantifying early stage damage in P91 and P92 steel welded structures. These issues and new initiatives are discussed in this paper.

XI-1042-16: Dissimilar Metal Welds Between Martensitic and advanced Austenitic High Temperature Creep Resisting Steels – Creep Rupture Test Results and Fusion Line Investigatgion - Authors: *S. Huysmans, J. Vekeman, C. Hautfenne (Engie Lab – Laborelec, and BWI – Belgian Welding Institute)*

Modern and future power plants will use more elaborated and complex materials to withstand the higher steam pressures as well as thermal cycling. As such, dissimilar metal welds (DMWs) will be much more widespread in new design than before and will need to demonstrate resistance to combinations of severe creep, corrosion/oxidation and low cycle fatigue. The DMWs between different steels are an underestimated topic. Experienced and documented premature failures reveal the criticality of DMWs.

This study focused on the DMWs between martensitic and advanced austenitic stainless steels. Two collaborative projects related to a 18%Cr and 25%Cr austenitic creep resisting stainless delivered data concerning base metal characterization and weldability of similar and dissimilar welding. The specific features of dissimilar welding are further approached in more detail in this analysis. Two main methodologies i.e. direct welding and buttering techniques using different filler metals were investigated and characterized via uni-axial creep rupture testing and metallographic examination particularly focusing on the fusion line carbide formation and morphology.

For the limited exposure times on 10kh in this project, the results show that aligned and linked up type I carbide formation is occurring when A617 type filler metals are used. The selection of P87 or A82 filler metals demonstrated isolated to partly aligned carbides respectively at the fusion line. Due to a risk for corrosion and the somewhat better creep rupture strengths at comparable conditions, buttering techniques seem to be recommended above direct welding.

XI-1043-16: Characterizing Elevated Temperature Time-Dependent Properties for API and ASME Life Assessment – Authors: *Martin Prager (Welding Research Council, USA)*

XI-1044-16: Recent and potential compositional, weld metal and heat treatment changes to P91 in ASME – Authors: *Teresa Melfi (Lincoln Electric and ASME CSEF task group, USA)*

Afternoon Tea (Foyer) 16:00–16:30

XI-1040-16: New inspection & life assessment techniques and methodologies for P91 & P92 welded components – Authors: *Ahmed Shibli, European Technology Development, Leatherhead, Surrey, UK*

See above
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XI-1046-16: Update on Hydrogen Attack of C – 0.5 Mo Steel – Authors: *C. Lundin, M. Bharadwaj, M. Prager (University of Tennessee, WRC/MPC, USA)*

Visit from CEO, *Cécile Mayer:* 17:40-18:00

July 12th, 2016 – Commission XI Meetings

XI-yyyy-16: C-XI administrative matters - *Teresa Melfi*

XI-1045-16: Assessment of residual stress, hardness, and defect tolerance in a tee joint in as-welded and after post-weld heat- treatment - Authors: *P Grace, Jemena M Law, A Paradowska, ANSTO*

The risk of hydrogen assisted cold cracking (HACC) is often conflated with the risk of brittle fracture. However, if delayed non-destructive testing (NDT) methods shows there are no defects, or defects below the critical crack size, then brittle fracture is not possible. Post-weld heat-treatment (PWHT) is known to reduce the risk of HACC but is not always possible to perform. To assess the effects of PWHT, the residual stresses and hardness values were measured before and after PWHT to assess the effects of PWHT on HACC susceptibility and on the critical defect sizes. The residual stresses were lower than code-based estimates. PWHT reduced the residual stress and hardness, and increased the critical crack size.

XI-1047-16: Experimental Measurements of Cathode and Anode Fall Voltages in GMAW – Authors: *Cory McIntosh, Patricio Mendez (University of Alberta, Canada*

The presentation is available on line.

XI-1054-16; XI-1055-16: Potential of error for arc welding processes -Where can I make mistakes and how they affect the component? – Authors: *André Hälsig,* (*Technische Universität Chemnitz, Germany)*

This is a power point presentation and is available, it providing information on weld calculations of weld power, seam geometry, and heat input into the component. A slide is also provided to show the potential for error and how great that may be.

Afternoon Tea (Foyer)   16:00–16:30

XI-1041-16; (*XII-2306-16):* Implications of Recent GMAW Process Developments and Heat Input Research in Relation to International Fabrication Standards – Authors: *John Norrish, Australia*

XI-1048: Effect of Current on Metal Transfer in Submerged Arc Welding – Authors: *Patricio F. Mendez, Vivek Sengupta (U of Alberta, Canada)*

This is a power point presentation and it is available.

Metal transfer mode in SAW (DCEP)
Number of droplets detaching increases with increasing current. At lower current (500 A), the molten metal detaches without forming a tail. A whipping tail detachment is seen to be developed at high currents (600 A and above). Molten metal detaching are spherical at lower current (500A) but completely lose their shape at higher currents. The very high magnetic due to high currents is responsible for this type of phenomenon. The weld pool is highly depressed by the arc at high currents (800 A and above)

Conclusion
At lower current (500 A), the molten metal detaches without forming a tail both in DCEP and in AC. A whipping tail detachment is seen to be developed at high currents (600 A and above) in DCEP and EP cycle of AC. In EN cycle, cathode spots can be seen moving all over the droplet surface. The weld pool is highly depressed by the plasma jets between 600-700 A in DCEP and 700-800 A in AC.

XI-1049: Effect of Welding Fluxes on Metal Transfer in Submerged Arc Welding – Authors: *Vivek Sengupta, Patricio F. Mendez, (U of Alberta, Canada)*

What is the effect of welding fluxes on metal transfer in in submerged arc welding?
Flux has a minimal role in determining mode of metal transfer in SAW between 500-A to 1000-A.
The detachment frequency with high CaF_2 fluxes was observed to be low compared to the oxide based fluxes. The arc length under high CaF_2 containing fluxes was observed to be relatively shorter compared to the oxide based fluxes between power inputs of 15kW to 30.4 kW. Above this power, input arc lengths among all the fluxes were similar.

July 13th, 2016 Session 1 – Commission XI Meetings

XI-zzzz-16: IIW Administrative matters and Review of C-XI-E Intermediate Meeting - *Teresa Melfi*

XI-1050-16: Position Statement – IIW Commission II Classification of Submerged Arc Fluxes According to ISO 14174 – Authors *Damian Kotecki, USA Delegation*

A round robin of flux analysis was conducted by IIW Commission II Arc Welding and Filler Metals. Five commercially available fluxes, from four different manufacturers, were analyzed by twelve laboratories. The results, summarized in IIW Document II-1942-15r1, are to be published shortly in *Welding in the World*. The results revealed good reproducibility of measurement for the major flux constituents used for classification in ISO 14174:2012 *Welding consumables – Fluxes for submerged arc welding and electroslag welding – Classification*. However, the results also revealed that more than one classification according to ISO 14174 could be assigned to four of the five fluxes. This is not considered satisfactory for commercial application of the standard.

XI-1051-16: Liquid Metal Embrittlement: Reducing Cracking Risks in Welded Pipe – Authors: *John Procario, Lincoln Electric, USA*

XI-1052-16: Keyhole TIG Process – Authors: *Andy Sales, K-TIG Australia*

Keyhole GTAW is a relatively new welding variant of the GTAW process, a process which has been traditionally a very good option for welding of CRA materials. The keyhole variant was developed by CSIRO in the late 1990's. Subsequently a limited amount of research has been published on its application to joining corrosion resistant alloys (CRA's). Those studies all found it to have the potential for significant productivity gains. In particular, Keyhole GTAW is suited to single pass, full penetration welds on CRA pipe or plate typically up to 12mm thickness (the maximum thickness is material dependent). Little to no filler metal or edge preparation is required. Completed welds have particularly good aesthetics when welding titanium, zirconium, nickel and stainless steels. Additional to acceptable visual attributes, good mechanical and corrosion resistant properties have been exhibited on all CRA materials welded with the process. For instance, for a single pass on super duplex plate material the resulting ferrite content was acceptable and corrosion resistant testing exhibited no weight loss whatsoever. Additionally, impact toughness tests performed on austenitic stainless steel gave better results than multi pass welds using filler metal. More recently residual stress study was carried out at ANSTO to better understand weld residual stress and distortion. These results proved to be somewhat better than what traditional multi pass welding processes with filler.

This paper reviews past studies, provides an overview of recent applications and investigations, and identifies possible optimisation for performance.

Morning Tea (Foyer) - 10:30–11:00

XI-1060-16: Solid State welding for 9-12% Cr creep resistant steel for fusion nuclear reactor – Authors: *Huijun Li et al.*

XI-1061-16: A study on the Development of Welding Consumables Applied to ASTM T/P 91 Steel for Thermal Power Plants – Authors: *Y. Banno et al.*

It is performed to investigate microstructure, Ac1 temperature and creep rupture time of P91 deposited metals. Reductions of Mn and Ni contents promoted the formation of retained δ-ferrite. In contrast, it was revealed that addition of 0.4-0.8 % Co was effective to suppress the δ-ferrite formation. Moreover, as the Mn+Ni content decreased, the Ac1 and Ae1 temperatures rose. And an addition of 0.4-0.8 % Co had no effect on them. Furthermore, the reduction of the Ni content lengthened the creep rupture time.

July 13th, 2016 Session 2 – Commission XI Meetings
This session was combined with Commissions II (Arc welding and Filler Metals) and Commission IX (Behavior of metals subjected to welding)