



Report and minutes

No 6

from the meeting **7-8 September 2010** at ESAB, Gothenburg, and University West, Trollhättan, Sweden.

Present:

Lars Cederqvist, SKB, Sweden (chair)
Mathias Lundin, SWC, Sweden (secr)
Magnus Andersson, Esab, Sweden
Anna-Karin Christiansson, University West, Sweden
Sören Claesson, Exova, Sweden
Jeroen de Backer, University West, Sweden
Johan Fremling, SAPA Technology, Sweden
Per-Arne Forsman, Esab, Sweden
Torbjörn Ilar, University West, Sweden
Leif Magne Kaalaas, Marine Aluminium, Norway
Eva Lind-Ulmgren, Swerea Kimab, Sweden
Wojciech Osikowicz, Sapa Technology, Sweden
Kati Savolainen, Helsinki University of Technology, Finland
Sven-Olov Sjöväg, Sapa Profiler AB, Sweden
Mikael Soron, Esab, Sweden
Stefan Stoltz, Esab, Sweden
Mikael Tigerström, SKB, Sweden

Minutes from the meeting 7 September

1. Opening of the meeting (12.30 h)

The chairman Lars Cederqvist opened the meeting wishing everyone welcome and thanking Esab for the invitation.

Round of presentation. Noted the following about those who participated their first meeting: Torbjörn Ilar is working with FSW and Laser. Per-Arne Forsman is taking over after Kari Lahti as a global manager Esab engineering. Sylve Antonsson is retiring this month and Stefan Stoltz is replacing him. Woishec Osikowicz is working exclusively with R&D projects on FSW at SAPA. Eva Lind-Ulmgren is working with different projects at Kimab. Sven-Olov Sjöväg has worked with FSW in Finspång.

Apologies where noted from Johan Nordström, Esab, David Hjertsén, Exova, Sylve Antonsson, Esab, and Joakim Hedegård, Swerea Kimab.

2. Approval of the agenda

The agenda was approved noting that the presentation from University West under item 5 will be held day 2 during the visit in Trollhättan.

3. Minutes (nr 5) of the last meeting 2009-10-13/14 in Helsinki, Finland

The chairman briefly went through the minutes which were approved with no changes.

4. Short presentation of the organisation and activities of new participants

Eva just reported that Kimab is focusing on NDT for FSW. A project on this is coordinated by TWI. Kimab has also just finished a literature study on hybrid-FSW.

5. Presentations

a) *Welding R&D centre established in Gothenburg, ESAB*

Magnus Andersson presented the plans to concentrate R&D effort within Esab to Gothenburg (**Appendix 1**). Have already the R&D on consumable in Gothenburg. However, the R&D facilities for FSW is not transferred from Laxå to Gothenburg.

The incentive for the concentration is to meet customer demands on a constantly reducing cost. Exploit e.g. the greater possibilities to attract competent staff e.g. with the closeness to Universities, and also the ability to communicate locally and globally.

b) *Weld zone differences: FSW in air vs Argon, Helsinki University*

Kati Savolainen reported on the results on trials made at SKB (**Appendix 2**) comparing welding in air with welding under an argon shield, as well as the use of oxide removal.

Oxide removal had much less effect on the amount of inclusions than using an argon shield. The oxide removal seems to work only in combination with an argon shield. Most inclusions were found on the retreating side (oxide line). The plunge depth seems to have effect on the amount of inclusions under the weld.

The samples were also examined with SEM. For that to be possible the samples must be hydrogen annealed.

Grain growth appeared in the HAZ. Sometimes grain growth also appeared in the area of the weld at the retreating side.

Mechanical testing was also performed on one sample. Tensile strength and elongation is approx. the same for the weld and the parent material. Compared to EBW the mechanical properties are much higher since the EB welds have much larger weld grain size. EB welds fractured in the centre of the weld.

How to get rid of the oxide line? Maybe the better cleaning. Maybe mechanical cleaning and argon in combination.

In welding aluminium these defects is not unusual depending e.g. on to high welding speed.

c) *Processes differences: FSW in air vs Argon, SKB*

Lars Cederqvist presented on weld trials in air and with an argon shield comparing different weld parameters and process stability (**Appendix 3**). The process appeared more stable with an argon shield. Also helped the regulator doing a better job keeping the parameters in line. Process stability is controlled trying to keep the probe temperature between 790 and 910 °C, mean 840 °C. Under which wormholes can appear and over which the risk of probe fracture gets high which is critical for welding the canister. The argon shield result in a minimal fluctuation in probe temperature with some ± 5 °C around mean.

Also the probe life was extended with the argon shield. Detected little or no wear on the convex scroll shoulder. Welding in air gave more flash, especially in the end of the weld.

6. Messages and Reports – 8th FSW symposium, articles etc

8th International Symposium on Friction Stir Welding was held 18-20 May 2010 in Germany.

The chair showed a CD with all the presentations. The program listing all the presentations can be downloaded at

www.twi.co.uk/fsw/downloads/8th_Int_FSW_Symposium_Web%20programme.pdf.

The presentations covered a lot of welding in steel and titanium.

Kati mentioned TMS 2011 conference 27 February 2011 in San Diego where one session is on FSW. The chair meant this is the second best conference on FSW after the TWI Symposiums. More info on the TMS conference see www.tms.org/meetings/annual-11/AM11home.aspx. For the program including abstracts see <http://www.programmaster.org/PM/PM.nsf/UpcomingSymposia/365A2B07B080BA62852576DB007A9C99?OpenDocument&ParentUNID=6A6933B363A6AE63852574B900410EAA>

Other FSW conferences where abstract due date not yet passed:

<http://www.thermec2011.ca/>

<http://www.isopec.org/call4papers/2011/Call-2011%20FSW-0903.pdf>

Magnus presented ESABs Technical handbook on FSW, a tool for potential costumers. Michel Soron and Kari Lahti made most of it.

The chairman mentioned a book, Friction stir welding: From basics to applications, se <http://www.woodheadpublishing.com/en/book.aspx?bookID=1503>

7. Licence and patent issues

The chairman presented a report (**Appendix 4**) from the licence holders meeting in conjunction with the 8th International Symposium on Friction Stir Welding.

The last of the original patents expires 27 November 2012. However, TWI bought the Hydro patent including tilting the probe and featured tools. Most of the application is dependant on this. According to TWI this gives them the right to charge the industry for licences as present until 25 September 2015.

The presentation also included statistics on the number of licences world wide which up till now is over 225.

8. Short report on FSW standardisation activities in IIW (ISO/DIS 25239-1 to -5)

Mathias gave a report on the status of these drafts. They where approved for final vote by IIW Commission III-B1 in December 2009. The drafts arrived last week to ISO Central Secretariat.

Concerning the schedule, we have to wait 2 months for the completion of the translations into French and German. Then the preparation of the projects for the vote will start (this takes an average of 2,5 months but may be longer to take into account the Christmas break). After the vote, the documents should be published within one month. Mr Perrad at ISO/CS anticipates a publication in May/June of 2011.

Mathias has tried for the last week to get the drafts with no luck. As soon as they are available they will be posted at www.svets.se/ag52 (under "Info & documents").

The chair showed the "update on FSW standards" (**Appendix 5**) presented at the 8th International Symposium, however, including some inaccuracies on the ISO-project, see above. The presentation mentions AWS D 17.3 on FSW for aerospace applications. There is also a standard activity developing a code case 2593 under ASME section VIII.

There is also starting an IIW project on an ISO standard for FSSW.

SAPA use the draft ISO/DIS 25239 for their qualification of the process.

9. Working program and member issues (prospective participants etc)

The chair noted the importance of prospective members.

Noted that Volvo Aero is a potential member of AG 52. They are spending a lot of man hours on getting started on FSW of aluminium and inconel. They run a project with ESAB.

Cryo AB has a number of applications of tanks for which they are investigating FSW.

Noted that Fredrik Tuveesson gone from University West to Westinghouse and does no longer work in the field of FSW. Kjell Hurtig and Jeroen is replacing.

SAAB Automotive is in the project at UW and could be a potential member. Torbjörn Ilar will make contact.

Webra, Enköping (possible competition with SAPA) is making cooling blocks and have substituted adhesive bonding with FSW with equipment recently bought from ESAB. Magnus Andersson will make contact

Lasertool previously in Norrköping moved their facilities to the Baltic States and is not of now interested.

List of members in AG 52 is attached to the minutes as **Appendix 6**.

10. Arrangement for subsequent meeting

The next meeting was preliminary decided for 10-11 May 2011 preliminary at SAPA Finspång.

A theme on NDT for FSW was discussed. Suggested items for presentations:

- NDT project at Kimab
- NDT project at SKB
- NDT activities at Exova.

Mike Russel or Jonathan Martin or someone else from TWI may be interested to come to the group and make a presentation.

Please contact the chair, Lars Cederqvist, or the secretary, Mathias Lundin, on additional agenda items.

More details to come in the meeting invitation.

11. Closure of the meeting

The chairman thanked everyone for their attendance and contribution.

Technical visit (Day 1) at ESAB Process Center

After the meeting session a tour at the ESAB Process Centre was made.

The purpose to have some place to train people, both internal and for costumers. Then also for providing costumer support, making e.g. welding procedures etc.

Technical visit (Day 2) at Inovatum, University West in Trollhättan

At the visit Lars Pejeryd and Prof. Nils Stenbacka from UW, and Tommy Christensen (Saab) joined.

Anna-Karin Christiansson gave a background on University West. UW was founded 1989 and today half is research and half education.

Lars Pejeryd explained about Production Technology Centre, PTC, at UW that was founded by Volvo Aero and Saab. Partners since March 2010 also include JMAC Scandinavia, Tour & Andersson, Siemens Turbomachinery, Midroc Automation, SULZER METCO Europe, Swerea IVF, Permanova Lasersystem AB and RDS Robotics.

Anna-Karin on the organisation. Per Nylén is leading the PTC where recently Lars-Erik Svensson and Nils Stenbacka was appointed professors at the Welding & Cutting Department.

Nils Stenbacka explained about the structure at the Welding & Cutting Department. Senior scientist are Mikael Ericsson, Torbjörn Ilar, Conny Lampa, Isabelle Choquet and Kjell Niklasson, and further some PhD students.

The laboratory equipment involves most welding processes. Also includes e.g. pyrometer, camera equipment, laser scanner, IR camera, Spectroscope, Material lab and model & simulation tools.

Examples on research projects are simulation of the welding arc and simulation of the weld pool which are very theoretical and on a high level. Also made studies on so called cold laps. Also modelling of the microstructure in titanium alloys.

An application to the KK foundation for two major areas in welding, process optimization and lightweight structures will be submitted soon. The aim is a long term cooperation with ten industrial partners for six years with 6 MSEK/year for the hole PTC.

The activities in the field of welding at UW is fairly unknown to the Swedish welding community.

Jeroen de Backer, University West, gave a presentation (**Appendix 7**) on the current FSW R&D efforts surrounding the new robot from Esab and the StiRoLight project in particular.

It is founded by VINNOVA and partnered by Volvo Aero, Saab and Esab. Turnover 6,3 MSEK for 6 years.

Using robot is flexible, handling complex geometries, but limited down-force, limited temperature.

Have done 3 m/min in 3 mm lap joints with good results. Will also look in to (pre-study) on robotic FSW of hard materials (e.g. by laser hybrid FSW). Jeroen aims for his licentiate thesis in the spring of 2012.

Applications are body parts for Saab and turbine wheels for Volvo Aero.

Testing optical joint tracking reaching 1,5 % pin diameter deviation.

Main incitement for Saab is weight reduction. E.g. making joints in areas where rivets can not be used and how that can reduce weight. Also the possibility to elaborate with stiffness.

The day was concluded with a round tour of PTC and a demonstration of the FSW robot.

Meeting secretary



Mathias Lundin