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Sent to: members of AG 52 FSW Processing and B Pekkari

Report and minutes

No 7

from the meeting **10-11 May 2011** at SAPA Technology, Finnspång, Sweden.

Present:

Lars Cederqvist, SKB, Sweden (chair)
Mathias Lundin, SWC, Sweden (secr)
Anna-Karin Christiansson, University West, Sweden
Sören Claesson, Exova, Sweden
Jeroen deBacker, University West, Sweden
Johan Fremling, SAPA Technology, Sweden
Leif Magne Kaalaas, Marine Aluminium, Norway
Sören Kahl, SAPA technology
Eva Lind-Ulmgren, Swerea Kimab, Sweden
Wojciech Osikowicz, Sapa Technology, Sweden
Timo Salonen, Posiva OY, Finland
Kati Savolainen, Helsinki University of Technology, Finland
Sven-Olov Sjövåg, Sapa Profiler AB, Sweden
Mikael Tigerström, SKB, Sweden and
Christer Jönsson and Henrik Nyström, SAPA, for their presentations

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Minutes from the meeting 11 May

1. Opening of the meeting (08.30 h)

   The chairman Lars Cederqvist opened the meeting wishing everyone welcome and thanking SAPA Technology for the invitation and for last night's dinner.

2. Approval of the agenda

   The agenda was approved noting that presentations under item 5 will be slightly changed. Christer Jönsson and Henrik Nyström, will give the presentation of SAPA. Anna-Karin will make a short input on possible projects. Mikael Soron was otherwise engaged and not able to come.

3. Minutes (nr 6) of the last meeting 2010-09-07/08 in Gothenburg, Sweden

   The chairman briefly went trough the minutes which where approved with no changes.

   Noted that Webra, SAAB Automobile, Cryo should be approached further concerning participation in the group.

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

   Round the table short presentation of all participants was made.

5. Presentations

   a) Presentation of SAPA – Christer Jönsson, SAPA

   Christer is responsible for the profile product portfolio.

   SAPA has 14800 employees in 30 countries (Europe, North America, China, India and Vietnam). Fast growing in Asia. Have moved from 35 to 118 press lines in a couple of years.

Profiles are used a lot for building systems which is a division within SAPA. Also producing strips for heat exchange solution. Deliver 950 000 tons/year with a 2,7 % operating margin.

SAPA Technology is the R&D part of SAPA. Also just started up in Shanghai. There are 72 employees in Finspång and 18 in Shanghai. Heat transfer application is a very R&D intensive area.

Maximum size of profiles depends on shape. For example 620x80 or 300x300, with a force of 6500 tons.

About the competition with steel for the automotive industry. Can see as a trend an increase in the use of aluminum in combination with high strength steels and less normal mild steel.

Christer also gave a short presentation on the history of Finspång from the year 1580 with the production of canons. Through Louise de Geer, Metallverks AB, AB Svenska Metallverken, Gränges, SAPA which is now owned by Norwegian Orcla.

b) Aluminium Extrusion,– Henrik Nyström, SAPA Mass Transportation

Henrik presented (**Appendix 1**) the application of FSW panels in cruise vessels, fast ferries, the Littoral Combat Ship, the hoist deck of Wallenius vessels, floor and main structure of structures.

He also presented the rolling stock segment, train and metros, and applications with panels for the whole car body, roof, side and floor.

He showed details on SAPA delivery for the Victoria Line Underground upgrade which is done by Bombardier.

Further he presented liquid coolers applications.

Henrik claimed SAPA is going from an extrusion supplier only to being a "solution provider" with prefabricated panels ready for assembly and painting.

SAPA produces 300 000 m welds per year, single sided and double sided, whereof 50-60 000 m on panels. Wear gives 350-800 m weld per tool, normally 500 m. All welding is on 6000-series aluminum.

Henrik stressed the necessity of having the same management for the extrusion of profile and for the welding, to get the right quality throughout the logistic line.

c) The influence of small voids on the fatigue strength of friction stir welds in the aluminum alloy AA6061-T6 – Sören Kahl, SAPA

Sören presented the trails to investigate the appearance and influence of voids in welding the AA6061-T6 aluminum alloy.

The tensile strength will decrease 10 % and the ductility 50 % when voids are present. Also when a void is present the shear deformation does not contribute as much to the elongation.

Generally the fatigue strength where high for all welds. All fatigue cracks where initiated in HAZ. Voids reduce fatigue strength with 20 %. The conclusion would be that 20 % of the life time is spent for the nucleation of the fatigue crack. Cracks in "void-free" specimen will initiate in the edge of the weld track.

The best method to detect voids is to look at cross sections and tensile testing.

There was a discussion on the influence of surface oxides influence on the formation of voids.

d) FSW generic contributions from R&D on 5 cm Cu at SKB – Lars Cederqvist

Lars presented the influence of the shoulder geometry, concave versus convex, using position control versus force control. (**Appendix 2**)

The convex shoulder is optimal for the position control. The theory could work for other application (Al).

Worked with the issue of the increased flash at the end of the cycle. Ssurface treatment did not solve the situation, but Lars think that it could be a solution for other applications such as welding of Ti. However the use of Ar shielding gas worked to decrease the flash in the SKB application.

The D70 convex scroll showed best results in relation to flash and forming of defects.

The correlation between the probe temperature and wormholes was also studied, showed excellent correlation. Will also study the probe temperature process influence dependence on the axial force.

Discussed the situation when the process control feed-back of temperature or force is lost. You can either chose to park the process and fix the problem or alternatively you can decide that you have enough process knowledge to finish the weld just based on the power input.

Even though the temperature probe in the shoulder have better response time and better location in relation to where the wormholes are formed, high on the advancing side of the probe, the correlation is still better with the temperature in the probe.

Defendant on the good correlation shown Lars concluded that the use of thermo couples to avoid voids could be applicable also to aluminum.

e) Influence of plate thickness variation & path deviations in robotic welding – Jeroen deBacker

Jeroen presented a summary of the last 6 month result in his project at UV.

The main topics of SAAB are effect of tool deviation, visual quality, temperature control in 2D and 3D, and design rules.

Stress test of the process was made by trials with the probe up to 3 mm of the weld line. The tensile strength will lower significantly at 1,5 mm from the weld line.

One option is Image Processing Control for the compensation of the deviation. Another option is by laser measurement.

Jeroen noted that the position of the robot has a big influence on the possibility to handle the deviation with a control system. Discussed the reproducibility if the position is constantly changed by position control.

He showed that (in theory?) FSSW will give the same strength as a clinch joint and a 35 mm FSW seem the same strength as a rivet joint.

He also showed that a little penetration into the bottom sheet in an overlap joint gives the optimum strength. However, when increasing the penetration into the bottom sheet, by a longer probe, the strength is lowered. Clamping seems to have a large influence on the weld quality.

The future work items are sensor based process control, producing of demonstrators and design rules for robotic FSW. And also of cause to get it implemented in Swedish automotive industry.

It was noted that the top surface of the weld will never be on the outside of the car body.

f) Posiva plan for determining welding process – Timo Salonen

Timo presented the status of the Finnish project for end storage equivalent to the SKB project.

The Olkilouto site will be ready for final disposal about year 2025. Timo showed the timeline for the activities before that. He also showed the criteria for the choice of sealing method.

The long term safety issues are creep ductility, corrosion, stress corrosion cracking. The specification of the canister is set by requirements.

g) StiRoLight continuation? – Anna-Karin

Anna-Karin presented the status in the project. She also invited to a Workshop 16 June 2011 in Trollhättan (video access available). Plan to seek funding with the KK-foundation. She showed the outline of possible work packages for a continuation project on robotics, NDT, economy, etc.

6. Messages and Reports – TMS Annual meeting 2011, articles etc

   FSWP a small conference in France, TWI international conference in Alabama, Transient welding research in Chicago AWS was mentioned.

7. Licence and patent issues

   Nothing discussed.

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

   Mathias presented the status of the drafts:

ISO/FDIS 25239-1	Friction stir welding – Aluminium – Part 1: Vocabulary
ISO/FDIS 25239-2	Friction stir welding – Aluminium – Part 2: Design of weld joints
ISO/FDIS 25239-3	Friction stir welding – Aluminium – Part 3: Qualification of welding operators
ISO/FDIS 25239-4	Friction stir welding – Aluminium – Part 4: Specification and qualification of welding Procedures
ISO/FDIS 25239-5	Friction stir welding – Aluminium – Part 5: Quality and inspection requirements

   Formal vote ended a couple of days ago, 3 May. No result available yet, however, there are no indication that the vote would fail.

   There was no statement included of the applicability to Cu (with necessary adjustments), however there seem to be no reason that the main part of the requirements are also applicable to Cu.

   No technical changes are allowed at and after the formal vote.

   Similar project on spot welding, FSSW, is started and processed in IIW C-III-B-WGB4

9. Information projects – Inventory

   Mathias explained the new Swedish Welding Commission policy that all working units within the network shall focus on and list projects for spreading information on particulars of the field. The purpose is to reach outside the group with products of information such as e.g. articles in Svetsen, specifications, checklists, forms and other tools.

   Availability of the papers on the internet was discussed. The inventory was postponed.

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

    Mathias shall contact Cryo AB.

    Anna Karin sends info on Volvo Aero. She will also check with Torbjörn about SAAB.

    Discussed an idea to ask AG 41b on the possibility to present applications where AG 52 would evaluate FSW as joining process.

11. Arrangement for subsequent meetings

    The next meeting was decided for 7-8 February 2011 preliminary at SKB or possible Esab.

    A theme on NDT for FSW was discussed. Suggested items for presentations: NDT project at Kimab, at SKB and at Exova respectively.

12. Closure of the meeting

    The chairman thanked everyone for their attendance and contribution.

Meeting secretary

Mathias Lundin