FORCE TECHNOLOGY

Material News

No. 8 A newsletter from FORCE Technology on corrosion, metallurgy and chemical analysis May 2009

This issue

Editorial

Dear Reader,

As you all know, we live in a globalised world with the advantages and disadvantages to which such a world leads.

It is easy to trade and purchase goods all over the world, and prices are often much lower than in Denmark. On the other hand, in many production fields we often experience that the quality of the cheap goods do not always meet our expectations.

In this issue of Material News, we will describe how important the steel quality is in order to attain the necessary welding properties. For steel there is also a causality between price and quality. If you choose to buy cheap steel, it may be a good idea to spend some of the saved money on ensuring that the steel has the desired properties. It is almost always a very expensive experience to realise the problem too late!

Furthermore, we have the pleasure of telling you about the NACE Corrosion conference, award of FORCE Technology's Materials Award, a new innovation network and not least news on personnel and course activities.

Enjoy your reading!

Nils Linde Olsen
Divisionschef

The welding ghosts of the past may also appear today

FORCE Technology was assigned to examine cracks in some welded brackets. It turned out to be hot cracks that had occurred by welding of ordinary black steel.

Figure 1: Welded brackets with cracks along the welding.

The cracks appeared during cooling of the welds, while the weld was still cherry red. The cracks ran along the edge of the weld in the base material, as shown in figure 1. There were no cracks in the actual weld metal. The cracked surfaces were quite clearly blue-tempered.

Chemical analysis

We performed a chemical analysis of the black steel and it showed a composition with rather high chromium and copper contents and a significant amount of impurities such as arsenic and tin, cf. the analysis in figure 2. Such abnormalities are seen from time to time, especially when the steel originates from East European or certain Asian steelworks.

Examination in microscope

Examination of the surfaces in a scanning electron microscope revealed intercrystalline crack morphology, cf. figure 3. The surfaces were covered by oxides, which again confirm that the cracks occur while the weld zone is still red-hot. These oxides result in the characteristic blue-temper colour.

Analysis by Optical Emission Spectrometry

FORCE

Division for Materials and Analysis

Performed using a SPECTROLAB S instrument according to ASTM E 415 and ASTM E 305
With instrument specific modifications.

C	Si	Mn	P	S	Cr	Mo
%	%	%	%	%	%	%
0,059	0,12	0,46	0,027	0,045	0,15	0,013

Ni	Al	Co	Cu	Nb	Ti	V
%	%	%	%	%	%	%
0,13	0,002	0,012	0,47	0,001	0,002	0,001

W	Pb	Sn	Mg	As	Zr	Se
%	%	%	%	%	%	%
0,008	0,005	0,018	0,0002	0,014	<0,0001	<0,002

B	Zn	Ta	N	Fe
%	%	%	%	%
0,0002	0,014	<0,003	0,008	98,4

Figure 2: Extract of analysis form concerning the basic material.

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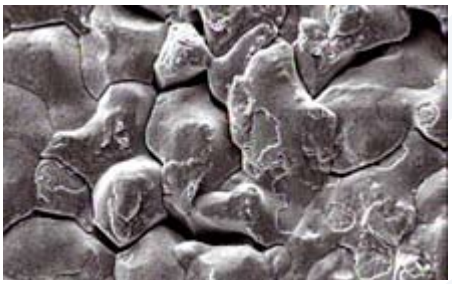

Figure 3: Scanning electron microscope photo of exposed crack surface. The surfaces are covered by a thin layer of oxide but the intercrystallinic crack sequence is obvious.

Metallographic examination

Furthermore, a cross section of a cracked weld was submitted for metallographic examination which confirmed that the cracks run exclusively in the base material, cf. figure 4. The crack path follows the former austenite grain boundaries, where some thickening is seen along with the presence of particles and contamination.

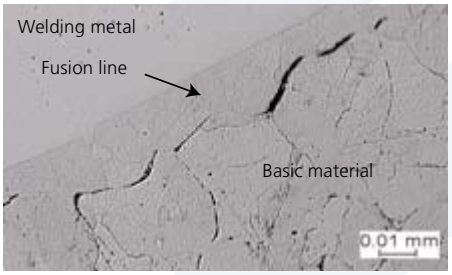

Figure 4: Crack formation occurs in the basic material along previous austenit grain boundaries. Note that in severeal case, the cracks cross the 'new' ferrite grain boundaries.

Chemical composition

The chemical composition of the steel showed a rather low manganese/sulphur combination. Usually manganese would tie the sulphur as manganese sulphides, but if the manganese/sulphur content is too low, part of the sulphur will be present as iron sulphides. The iron sulphides will gather in the austenite grain boundaries while the steel is still hot. When the material has cooled off and gets below 750°C, the austenite will convert into ferrite and pearlite. The ferrite/pearlite structure is less voluminous than the austenite, thereby introducing internal stress in the material. The melting point of iron sulphide is below 750°C and is thus still liquid when the internal stress occurs. If too many iron sulphides are present in the previous austenite grain boundaries, they may form a more or less continuous layer of fluid that cannot transfer mechanical tensions.

Hot cracking or 'liquation cracking'

Cracking will appear in the old grain boundaries providing the crack surface with its characteristic intercrystalline look. The crack phenomenon is called hot cracking or 'liquation cracking', and it is usually dependent on the manganese/sulphur combination in relation to the carbon content, as shown in figure 5. Earlier, steel contained more carbon and to preserve good weldability, it was necessary to maintain a sufficiently high manganese/sulphur ratio to stay out of the cracking zone, cf. figure 5. The star in the figure shows the values of the examined steel. The point of data is outside the examination matrix (the grey area) but the extrapolated dotted line implies that the material is within the area where crack formation may occur. It should be stressed that the degree of fixation and heat input during welding is of great importance when determining whether the cracking will occur, and presence of impurity elements in the steel, i.e. arsenic or tin may worsen the situation. It should also be mentioned that the arsenic and tin contents themselves may lead to temper brittleness.

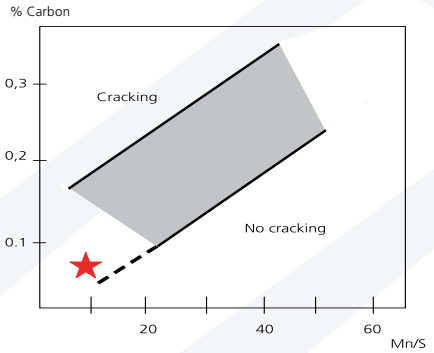

Figure 5: Copy of a diagram used in a previous project carried out by Welding Institute UK (TWI).

Conclusion

The conclusion to this case is that the crack formation is caused by 'liquation cracking' primarily due to a too low manganese/sulphur combination in the steel. The customer was recommended to apply steel with a higher manganese/sulphur ratio. Alternatively, it may be specified that the steel must pass a welding test without cracking prior to acceptance of a delivery.

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FORCE Technology well-represented at the NACE Corrosion 2009 conference

With almost 5000 participants the annual 'NACE Corrosion' conference was a success again this year. FORCE Technology participated with three professional contributions and we had a stand at the exhibition. Globally, this conference is the largest recurring of its kind within the field of corrosion.

Jan Frantsen and Troels Mathiesen presented a double article on surface requirements and corrosion resistance for stainless steel equipment in the brewery, dairy and pharmaceutical industries. Experience from several building projects has shown that often complex questions occur when specifying and verifying the surface quality of the supplied and delivered equipment. Furthermore, typical defect types, that would weaken the corrosion resistance when erecting processing plants, were also reviewed and presented. The articles answer many classical questions from this industry as regards handling and acceptance criteria for stainless steel.

Lene Marita Green spoke about cathodic protection of floating structures in sea water, i.e. production rigs for oil extraction. The article illustrates how relatively small sub-systems such as mooring chains may have huge influence on the achieved protection. By applying FORCE Technology's computer models such matters may be dealt with in the design phase.

FORCE Technology's stand at the exibition.

PlastNet – a new innovation network

Together with a number of universities, (AAU-Esbjerg, SDU, DTU), companies (Lego, Fiberline Composites, Ulfoss Plastic, Triax, Coloplast etc.) and Sydvestjysk Udviklingsforum, FORCE Technology and Plast Center Danmark have received approval for a 4-years nationwide innovation network called PlastNet.

PlastNet's professional focus areas are, apart from increasing general knowhow on plastics, to further and innovate the use of plastics, both within the plastics business, but also across business areas. From a plastics and polymer technical point of view, the purpose of the network cooperation is to allow Danish companies to keep abreast of the global competition.

In connection with the innovation network, 9 different projects of plastic technical nature will be carried out in cooperation with a number of chosen businesses from the network. FORCE Technology participates in all the projects, and will be project managers in 3 of the projects within: 'Degradation of Plastics', 'Failure analysis in plastic materials' and 'Disposable biodegradable plastics'.

PlastNet will regularly communicate the latest results and arrange networking activities such as technical seminars, post-workday meetings, company visits and matchmaking.

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New employees

Nana Eckhardt

39 years old and a M.Sc. specialising in materials and process technology; employed 1 January as a specialist by the Department for Corrosion and Metallurgy with FORCE Technology, Aarhus.

Nana's primary fields of work will be service life examinations at power plants and damage and failure examinations and investigations.

Previously, Nana was employed as supervisor with the Danish Working Environment Authority (WEA) and has performed inspections in the automotive industry, within agriculture and the iron and metals industry. Before that, she worked as an environmental consultant with Eurofins A/S in Galten., where she handled tasks in the wind turbine, automotive and the construction materials industry.

Nana graduated from the Institute for Process technology at DTU, where she specialised in metallurgy and surface treatment of metals. She wrote her thesis with Mercedes Benz in Stuttgart on delamination of paints, based on damaged areas.

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Michael Pilgaard

41 years old and polymerchemist; employed 1 February 2009 in the department of Chemical Analysis where he is to handle tasks pertaining plastics and polymers.

Michael has a background in structural chemistry, and since 1996 he has worked with material science, biological activity of molecules and process development, primarily in utilising polymers for medical devices.

Previously, Michael worked as a specialist in materials development at AMBU A/S, where he worked with development of polymer systems, clinical documentation/toxicology and process development for electrodes for ECG and EEG measurements, teaching chemistry and developing databases.

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Tommy Nielsen

35 years old; employed 1 February 2009 as a technician with the Department for Corrosion and Metallurgy in Aarhus.

At FORCE Technology, Tommy will be part of the large and all-round group of materials technicians that participate in solving the many tasks within materials selection and failure and damage analysis. His primary working areas will be electrochemical corrosion examinations and service life examinations at power plants, but he will also partake in a number of other tasks in the department.

Tommy is a locksmith and he has been employed in the business for 13 years. The last 6 years, he has worked both in Greenland and Denmark as a blacksmith, fuel operator and much more.

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Rajan Ambat receives the Materials Award 2009

FORCE Technology's Materials foundation has just presented Mr. Rajan Ambat with the Materials award 2009. He is an associate professor at the Technical University of Denmark. With the honour is a cheque for DKK 20,000.

The Materials Award is awarded a person, who has made a remarkable effort within materials technology. Rajan Ambat has been renowned for his work with corrosion and corrosion testing at the micro level. The award is presented every other year.

In continuation of the award ceremony, Mr. Rajan Ambat gave a presentation with examples as to where and how he works with corrosion tests.

Courses in 'Corrosion and materials' technology' and 'Maintenance' in 2009

Area	Course no.	Title	Duration	Date	Price DKK
Aluminium	A.5	Aluminium – joints	2 days	6-7 October	8.300
Building	B.3	Domestic/feed water installations, materials and corrosion prevention	2 days	15-16 September	8.300
	B.5	Legionella and water quality in the feed water systems	1 day	8 December	4.900
Energy systems	E.1	Maintenance of boiler plants/systems	3 days	17-19 November	11.300
	E.80a	Cooling with sea water	1 day	22 September	4.900
	E.80b	Cooling with fresh water	2 days	27-28 October	8.300
Stainless steel	R.5	Stainless steel – joints	3 days	8-10 September	11.300
	R.8	Food safety – stainless production equipment	2 days	29-30 September	8.300
Steel	St.3a	Steel – surface treatment, corrosion protection	2 days	24-25 November	8.300
	St.52-II	Steel metallurgy for non-metallurgists, II	2 days	3-4 November	8.300
Systematic maintenance	V.06	Inspection and maintenance, module 1 (Materials and decomposition)	3 days	19-21 October	11.300
	V.07	Inspection and maintenance, module 2 (NDE and NDT methods)	4 days	9-12 November	14.200
	V.08	Inspection and maintenance, module 3 (Planning the inspection and maintenance)	3 days	30 November – 2 December	11.300

Registration

Please register with Jette Jacobsen by tel.: + 45 43 26 74 26, on e-mail jtj@force.dk or at our website forcetechnology.com.

Great success with course in hygienic production

Focus has increased on production equipment and hygiene. FORCE Technology recently held the course 'Food safety – stainless steel production equipment', which was a great success.

The participants gained a thorough insight into which conditions are significant to the production hygiene; including the importance of food companies specifying requirements to materials, welds and hygienic design already at the beginning of the process.

Correct requirements specification is alpha and omega

If the requirements have not been specified correctly from the beginning, the production system may get hygiene problems when commencing. A well-known problem is a layer of biofilm, which forms in the system and which can be very difficult to remove by cleaning.

Biofilm was one of the subjects that the participants were thoroughly introduced to during the course: What is biofilm, how is it formed and which food safety and production quality risks are connected to biofilm?

Cleaning spiced with practical examples

Since both insufficient cleaning and corrosion may result in significantly shorter service lives, the course focused on choice of cleaning procedures and chemicals, which are both very important factors in that connection.

The technical contributions on materials specifications, welding, hygienic design, biofilm and cleaning/chemicals were spiced with examples from everyday life.

Sign up for the next course

The next course is planned to take place on 29 – 30 September 2009.

If your company is interested in providing your production and service assistants with widespread knowledge on this important subject, we also offer the course in a customised version to fit the needs of your company.

Learn more about the course on www.forcetechnology.com/courses/r8.

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For more information please use our website: www.forcetechnology.com

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