Alloys

Demanding applications: a new report on alloy optimization

A Finland-based industry-driven research consortium FIMECC DEMAPP, has just produced a remarkable report. Part of the joint R&D work related to “new corrosion-resistant materials and solutions”. The aim was to develop cost-efficient stainless steels and new products to serve the pulp & paper, auto, energy and other industries. FIMECC’s collaborative research is leading to the development of new ferritic stainless steels with better formability, new manufacturing methods for low-Ni and Ni-free stainless steels, and new welding procedures. FIMECC DEMAPP’s work will profoundly influence the way stainless steels are fabricated and welded, and is already leading to the development of new alloys.

By James Chater

FIMECC DEMAPP

In recent years fluctuations in the price of nickel and molybdenum has led to the development of lower-alloyed alternatives to austenitic grades in many applications. The challenge is to discover and develop lower-alloyed materials without compromising their properties. This issue is central to the research programme known as FIMECC DEMAPP (Finnish Metals and Engineering Competence Cluster; DEMAPP is short for “demanding applications”). FIMECC DEMAPP is a Finland-based public-private partnership programme of 26 companies and five research organizations. Active from 2009 to 2014, it has just issued its final report (1). The industry-driven research addresses challenges related to critical wear, corrosion, friction and fatigue, and proposes solutions for demanding applications in the process, energy and engineering industries.

The DEMAPP consortium worked with a number of international industrial partners, and some of the results achieved are already having an impact. For example, Outokumpu’s new ferritic grade, which is being tested by potential customers; Ruukki Metals’ (today SSAB Europe) light, energy-efficient solutions for transport and better performance for harsh crushing and mining applications; and Alteams’ new cast aluminium alloys, which improve thermal conductivity by 50%. The research included efforts to reduce friction in cars, wind turbines, paper machines, diesel engines and other machinery, and wear in elevators and cranes. The work undertaken by the programme fell under five projects: (1) Wear-resistant materials and solutions; (2) New corrosion resistant materials and solutions; (3) Extreme service conditions; (4) Friction and energy; and (5) Production technologies for demanding applications.

Project 2, related to corrosion, breaks down into four sub-projects: (1) New-generation ferritics with enhanced corrosion resistance; (2) Fabrication and service performance of advanced stainless steels for demanding exhaust applications; (3) Development of manganese- and nitrogen-alloyed stainless steels for alkaline environments; and (4) New methods for optimizing the performance of welds in corrosive industrial environments. We will examine these four areas in greater detail.

1) New-generation ferritics with enhanced corrosion resistance

This project set out to solve the technical problems in manufacturing high-chromium ferritic grades so as to improve their corrosion resistance, formability and toughness. By experimenting with various manufacturing parameters it was found that problems such as brittleness and roping (unacceptable surface striations) after forming operations could be overcome, without recourse to expensive investment in new production technology.

The result was Outokumpu’s 21Cr ferritic grade, 4622 (EN 1.4422). Its corrosion resistance is comparable to common austenitic grades 1.4301 (304) and 1.4307 (304L), and even superior in certain environments. Its PRE lies between 304L and 316L. Because of its high Cr content, it has better corrosion resistance than most ferritics. Apart from its resistance to chloride-induced stress corrosion cracking, the grade has better deep drawing properties than austenitic grades, good corrosion resistance after welding and good machinability. This new stainless has reached the trial production stage and is currently being tested and evaluated by several potential users across the globe. Laboratory testing has already demonstrated that the steel outperforms equivalent steels and has corrosion resistance at least on a par with the austenitic grades it is intended to replace. Potential

Table 5. Chemical composition of 1.4622.

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<tr>
<th></th>
<th>C</th>
<th>Cr</th>
<th>Mn</th>
<th>Fe</th>
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<tr>
<td></td>
<td>0.02</td>
<td>21</td>
<td>0.4</td>
<td>Balance</td>
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Ferritics are a favourite material for use in kitches. Photos courtesy of Outokumpu.

Brazilian pulp mill.

Laser welding of ferritic stainless tubular products. Photo courtesy of OSTP Finland Oy.
knowledge will foster development for advanced ferritics. It is hoped this selection and fabrication guidelines
high temperatures and provide material and fabricability, to acquire knowledge understanding of production techniques
conditions. The project set out to gain understanding of production techniques and fabricability, to acquire knowledge of oxidation, corrosion and fatigue at high temperatures and provide material selection and fabrication guidelines for advanced ferritics. It is hoped this knowledge will foster development of new products and grades.


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- Location: Kunsthaus Graz, Austria
- Contact: Mrs. Melanie Baumgartner; Phone: +43 (0) 3842 402 2291; Fax: +43 (0) 3842 402 2202
- Email: training@mobilityoilandgas.com; Website: http://www.stainlesssteel2015.org/about-conference

**NASCC The Steel Conference 2015**

- Location: Dallas, Texas, USA
- Contact: Maddie Metcalf; Phone: 312.670.5448
- Email: metcalf@aisc.org; Website: https://www.aisc.org/content.aspx?id=37922

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<td>15–19 March 2015</td>
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In 2015, four of ASME’s major conferences come together to create an event of major impact for the Power and Energy sector. ASME Power & Energy 2015 is the only conference and exhibition dedicated to fossil, nuclear, and renewable fuel applications and much more will be discussed in each of the four concurrent conferences within this large event.

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Location: Istanbul Expo Center, Turkey
Email: info@ihlasfuar.com; Website: http://www.borufair.com

**Tubitaly 2015**

- Location: Piacenza, Italy
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- Contact: Liza Paul; Phone: 312.670.5448
- Email: calae.mcdermott@nace.org; Website: http://events.nace.org/conferences/c2015/index.asp

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**OFFSHORE TECHNOLOGY CONFERENCE 2015**

- Location: Galveston, Texas, USA
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- Contact: Organizer: I·HLAS FUAR A.S
- Website: http://www.indowater.merebo.com

**Corrosion Control in the Oil and Gas Industry**

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susceptible to SCC; (ii) Mo alloying has an adverse effect and Cr alloying a positive effect on the corrosion resistance of stainless steels in Na2S-containing caustic environments.

4) New methods for optimizing the performance of welds in corrosive industrial environments. Fluctuating nickel prices have led to a demand for low-nickel alloyed stainless steels, and their use is expected to grow in the pulp & paper and process industries. But substitution of existing materials requires better understanding of joining and joint performance in the service environment. Novel stainless steels need to be researched to improve knowledge of their corrosion characteristics and behaviour, and to understand how weld metallurgy and corrosion resistance of welded joints interact. Better welding procedures, with the emphasis on, advanced, high-productivity technologies, need to be established. During trials, laser-arc hybrid welding was used. This is as a fusion-welding process where both a laser beam and welding arc – typically MIG/MAG or TIG – are focused simultaneously in the same weld pool. Trials were conducted on three base materials, two ferritic (1.4509 and 1.4622) and one duplex (1.4162) stainless steel, using four different types of filler metals and three joint configurations. Various adjustments were found to be possible with regard to weld metallurgy, dilution rates and weld chemistry.

Next Wave – FIMECC BSA & Hybrids
FIMECC is now running two follow-on programmes exploiting the ecosystem and the active co-operation model proven by DEMAPP. FIMECC BSA (Breakthrough Steels and Applications) develops use of stainless steels in various application areas, e.g. in the process and energy industries (2). The programme also includes basic R&D on characteristics of the new 21% Cr stainless steels 4622 and 4420, and development of completely new generic stainless steel alloys with optimized property combinations. FIMECC Hybrids (Hybrid Materials), in turn, creates innovative solutions through functional coatings and combinations of engineering materials (3). This industry-driven R&D co-operation (budget EUR 80 million for 2014–18) brings together 63 companies and nine research organizations, including the FIMECC Breakthrough Materials Doctoral School, with 34 positions.

References
(2) See www.fimecc.com/programs/bsa.
(3) See www.fimecc.com/programs/hybrid.

Field corrosion measurements at a pulp mill conducted by Saving Forest Ltd (left). Scanning electron microscope picture of a stress corrosion crack in AISI 304 austenitic stainless steel after two-week exposure to a simulated hot black liquor environment (right), showing a flux of iron emanating from the middle of the crack (selective dissolution of iron).

Schmidt + Clemens promotes new nickel alloy
During a recent event organized by sister publication Pump Engineer we ran into an old friend, Mr Christian Lenz, from Schmidt + Clemens. At the show, he was actively promoting a new nickel alloy which, he said, could be a very interesting and economical alternative to existing nickel alloys in, for instance, pumps for chemical industry applications. To see Mr Lenz’s video interview on this new grade, please go to: www.stainless-steel-world.net/SGSMo.

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