

Final project report

Project ID: 2002/11.05
Title: Marine corrosion of stainless steels in Polar seawater

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Duration: 2 years
Assigned funding: € 15.400,00

Activities and results

The instrumentation immersed in Antarctica in February 2003 was recovered in February 2004 by PNRA SCUBA-divers. This instrumentation consisted in an underwater automatic system bearing 32 channels for data acquisition, realised within PNRA project, for monitoring electrochemical behaviour of stainless steel samples. After having changed the samples, the instrumentation was immersed at February 2005. The recovered s.s. samples were analysed and observed in order to evaluate the dry weight of biofilm settled on, the percentage of organic matter of the biofilm itself and the weight loss of the corroded samples. In May 2005 the instrumentation immersed at Ny-Alesund (Svalbard Islands) at November 2003 was recovered. The s.s. samples were treated as the Antarctic ones. Both in Arctica and in Antarctica the same s.s. grades were tested: AISI 304 and 316, AvestaPolarit 904L and 254 SMO. The instrumentation, after changing batteries and samples, was immersed in the same period. The analysis of the corrosion behaviour of the s.s. utilized, showed that a stainless steel of intermediate quality, cheaper than both 904L and 254 SMO, should be utilised in such environmental conditions. The AvestaPolarit supplied us with the duplex 2205. So, starting from 2005, only this s.s. was utilized. In February 2006 the recovery of the apparatus, immersed in Antarctica in February 2005, failed owing to unfavourable meteo-marine conditions. Unfortunately, owing to logistic problems, the PNRA was not able to tray the recovery again both in 2007 and in 2008 Campaigns. At the end of June 2006, the apparatus, immersed in May 2005 at NyAlesund, was recovered.

Finally, the corrosion behaviour of s.s. steels in polar seawaters was defined, as it follows:

- also in polar seawater the biofilm growth induces an electrochemical effect as well as in temperate seawater: biofilm acts as a catalyst of cathodic reactions on s.s. surfaces.
- the difference between polar and temperate seawater consists of the incubation time for biofilm growth. This time is in the order of some days in temperate seawater and in the order of one month at 5 °C. It increased to 4 months by decreasing seawater temperature towards 0 °C.

Regarding the corrosion behaviour of the s.s types tested we can highlight:

- corrosion attack was heavy and very frequent (70-100%) on AISI 304 samples at Svalbard Islands; it was similarly heavy but less frequent in Antarctica (25-50%),
 - a light corrosion propagation was observed on AISI 316 and the frequency of localised attack increased with the exposure time (from 10 to 100%),
 - the AISI 304 weight losses were obviously function of the permanence time in active state,
 - the little weight losses observed on AISI 316 were due to short permanence times in active state; during these periods, the corrosion currents were in the same magnitude as AISI 304,
- the s.s. types AvestaPolarit 254 SMO, 904 L and the duplex 2205 did not suffer corrosion.
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Products

A – papers in scientific magazines

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B – book chapters

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C - proceedings of international conferences

1. ALABISO G., SCOTTO V., MOLLICA A., MONTINI U., MILILLO M., PACIFICO P. (2002) - Stainless steels corrosion in polar seawaters. Proceedings 15th International Corrosion Congress. CD-ROM. Granada (Spain) September 22 to 27 September 2002. Paper n. 352. pp 8

D – proceedings of national meetings and conferences

1. ALABISO G., MOLLICA A. (2003) - Comportamento alla corrosione degli acciai inossidabili in acque polari.. Atti del Convegno "Progetto Strategico Artico: Inquadramento e Prospettive", Roma, 18 Dicembre 2002. *Polarnet Technical Report*. vol. 2/2003. p 63-64.
2. ALABISO G., MOLLICA A., MONTINI U., MILILLO M., PACIFICO P. (2003) - Stainless steel corrosion in polar seawater: 1999-2001 - Results and perspectives. Extended abstract Meeting Nazionale sulle Tecnologie del PNRA Risultati del Triennio 1999-2001 Obiettivi futuri. Frascati (Rm) 14-16 maggio 2003. pp3.
3. ALABISO G., MOLLICA A., MONTINI U., MILILLO M. (2007) - Technological aspects of Italian research in polar seawaters: the role of marine biofilm on stainless steels corrosion. Abstract Book 1° Forum IAMC - Giardini Naxos, 6 – 9 Maggio 2007.

E – thematic maps

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F – patents, prototypes and data bases

1. Two prototype of submersible underwater automatic systems for data acquisition. These multi-channel systems (80 and 32 channels) are able to operate for more than one year without maintenance and allows:
 - the acquisition of potential and corrosion current of the tested samples,
 - the redox potential, temperature and salinity of seawater.
2. Moreover, it is possible to modify the configuration of the acquisition channels to adapt them to specific measurement.

G – exhibits, organization of conferences, editing and similar

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H - formation (PhD thesis, research fellowships, etc.)

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Research units

Date: 18/11/2008

Notes

At the present time, the attempt to recover the apparatus immersed in Antarctica is in course; it can allow to compare the corrosion behaviour of 2205 s.s. to that observed in Arctica. Moreover, the definition of cathodic reaction on s.s surface in the different environmental situations can be confirmed. Waiting for the data from the above quoted recovery, we are joining all the results of 10 year experiments carried out in both polar seawater to publish the corrosion behaviour of five s.s. grade characterized by different costs.