IMOA™
INTERNATIONAL MOLYBDENUM ASSOCIATION

INTERNATIONAL MOLYBDENUM ASSOCIATION
2 Baron's Gate, 33 Rothschild Road,
London W4 5HT, UK
Tel: + 44 20 8742 2274
Fax: + 44 20 8742 7345
E-Mail: ITIA_IMOA@compuserve.com
http://www.imoa.org.uk

JULY 2000

News Letter

Would readers note our change of address and phone and fax numbers. Our e-mail and website addresses remain the same.

Michael Maby, Secretary-General of IMOA, apologises for not publishing the January issue. Some readers even noticed! Pressure of work occasioned by the departure, after 7 years' service, of my secretary and a decision to find a new office meant that I had to miss the first issue in 11 years. IMOA (and ITIA) is now happily re-located and Kumi Patel has sacrificed an easy life to work for me.

12th Annual General Meeting

15-17 November
Hotel Royal Monceau, Paris

The meeting has been scheduled to precede Metal Bulletin's Ferroalloys Conference, 19-21 November, in Paris but at a different hotel.

Details of the programme have still to be finalised, but an outline follows:

Wednesday, 15 November:

14.00 - 17.00 Meeting of the HSE Committee

Thursday, 16 November:

14.00 - 17.00 Meeting of the Executive Committee

Friday, 17 November:

10.30 - 16.00 AGM

19.00 - 22.30 Cocktails and dinner in the hotel

Presentations will include:

- An update on IMOA's activities in relation to the Market Development Programme
- A report by H Pariser on the Market Survey
- Reports on work of the HSE and Sampling & Assaying Committees
- A paper by a guest speaker on a general topic, perhaps e-commerce

Companies which are not members of IMOA should contact the Secretariat for information about participation.

This Newsletter contains articles of interest, including:

- IMOA's activities regarding market development
- Moly does the job in nuclear power applications
- Summaries of four papers at recent Stainless Steel Conferences which dealt with successful applications of duplex in various industries.

Membership

It is a pleasure to announce the membership of :

Teledyne Advanced Materials,
a powder and alloy stock supplier; and

Liaoning Chaoyang Dongfeng Ferroalloy Plant,
a producer of tech oxide and FeMo.

On the other hand, the resignation of the following companies is mentioned with regret:
Montana Resources
North Metal & Chemical Co
Sekom Handelsges. MbH

Moly does the Job

Summary

A North American nuclear power plant originally had a lined carbon steel service water piping system. The system began to deteriorate within a few years of installation, especially at the welded joints of the carbon steel piping. In a first repair phase, the lined carbon steel piping was relined or replaced with Type 304 and Type 316 stainless steel. However, neither the relining nor the lower alloy stainless steels performed adequately. In 1986, small quantities of 6% molybdenum stainless steel piping began to be installed. On the basis of initial trouble-free performance, many thousands of feet of this piping have since been installed. Inspection cycles can now be extended to twice the normal time, and could potentially even be extended to three to four times the normal time, because of the great performance of this highly corrosion resistant stainless steel. The plant is now saving over $1,200,000 in maintenance and inspection costs and over 1200 staff-hours every cycle of eighteen months.

The Process

A service water system at a nuclear power plant is a piping system that carries cooling water to various heat exchangers. It removes the heat from such auxiliary systems as component cooling heat exchangers, emergency diesel generators, containment coolers, lube oil coolers, room coolers and chiller condensers.

Typically, a system consists of an intake system for the cooling water, a distribution system within the plant and an outlet structure.

In this case the service water system is open loop and is fed by high chloride brackish water which can range in temperature from 32°F (0°C) to 85°F (29°C). Part of the service water system is above ground and some is buried.

Most of the original service water system was constructed of lined carbon steel pipe. Various linings were used including coal tar epoxy, epoxy enamel and cement lining for the larger diameter pipe sizes, cement lining for smaller diameter sizes, and some polyethylene lining. Minor portions of the original piping were Type 316 stainless steel.

The Corrosion

Extensive weld metal and heat affected zone corrosion was observed on the carbon steel piping where the cement lining had cracked at the welds. Polyethylene linings failed due to erosion, which lead to subsequent erosion and corrosion of the underlying carbon steel base material. The Type 316 stainless steel failed due to through-wall pitting corrosion in areas of stagnant water within three years of operation. Galvanic corrosion was observed in joints where carbon steel and stainless steel were welded together. Mating surfaces of Type 316 stainless steel and of rubber lined carbon steel valves showed pitting and crevice corrosion. Finally, extensive exterior corrosion was observed on carbon steel piping under insulation where condensation water was kept in contact with the (unlined) carbon steel.

The brackish, silt-containing water caused the corrosion and erosion on the lined carbon steel in places where the lining was flawed or eroded. Carbon steel has no inherent corrosion resistance under these conditions if the lining fails for any reason.

Type 316 stainless steel is usually resistant to water containing up to 1000-ppm chlorides as long as a sufficient flow rate (approximately > 3-ft. (1m)/ sec.) is maintained. The chloride content of the brackish water at this site varies from 85 to 7,200-ppm, and the flow rate is as low as 0 for extended periods of time in the areas where Type 316 piping was installed. These severe conditions lead to the relatively rapid pitting corrosion failure in some of the stainless steel piping.

The Solution

About ten years into the operation of the power plant, it became apparent that the replacement of some of the lined carbon steel with Types 304 and 316 stainless steel was not a permanent solution. In 1986 the power plant started to install small amounts of highly corrosion resistant 6% molybdenum containing stainless steel. More of the high performance stainless steel was installed at every refuelling outage and thus all of the above ground service water system was gradually replaced. Today only a few spool pieces of lined carbon steel remain in the system. *Figure 1* shows one of these remaining pieces that is exhibiting extensive corrosion. These pieces are very difficult to replace because they penetrate concrete walls and are anchored to these walls. Nevertheless, the engineering staff is in the process of finding ways to replace these last pieces of carbon steel in the system.

The majority of the Type 316 valves and the rubber lined carbon steel valves have also been replaced with 6% molybdenum stainless steel or with aluminum bronze.

The plant has been extremely pleased with the performance of the 6% molybdenum stainless steel. The piping hardly requires any maintenance and no longer needs to be inspected during each outage. All of it remains in perfect condition. *Figure 2* shows the interior of the pump discharge distribution header made of 6% molybdenum stainless steel. The stainless steel has been in continuous service for 30 months and had not been cleaned before this picture was taken. The total time in service for this part of the piping has been six years.

The Cost Savings

In the early eighties, before the 6% molybdenum stainless steel replacement, maintenance and repair of the lined carbon steel service water system were about 40% of the annual maintenance budget of the plant. In those days the pitting corrosion had to be ground out and repair welded wherever the pipe wall had thinned excessively, and then extensive relining was required. These repair expenses are no longer incurred with the new system.

Other cost savings are related to inspection and maintenance of the system. The old system had to be inspected during each refuelling outage, which is about every eighteen months. This inspection alone cost the power plant $1,200,000 and 1200 staff-hours without any repair being performed. Today the 6% molybdenum stainless steel system allows the plant to skip every other cycle and perform the inspection only every 36 months. Because the piping remained in perfect condition after over thirty month of operation, it is estimated that the maintenance cycle can be extended even further, to every third or fourth outage.

In addition to the direct cost of materials, contractors and in-house labour, the repair of the lined steel service water system also took much time. One day of lost electricity production can cost a nuclear power plant several hundred thousand dollars. To become more cost competitive, nuclear power plants have to continually reduce their outage times. This became only possible for this plant because the new 6% molybdenum stainless steel piping does not require any repair.

"Once again – Moly does the Job."

Table 1: Typical Chemical Compositions of the Stainless Steel Grades in this Article. Note: 254 SMO, AL-6XN, INCO alloy 25-6MO and Cronifer 1925 hMo are all 6% molybdenum stainless steels.

	UNS No.	Molybdenum	Chromium	Nickel	Nitrogen	Other
Type 304	S30400	**-**	18	9	-	
Type 316	S31600	**2**	17	11	-	
254 SMO®	S31254	**6**	20	18	0.2	0.75 Cu
AL–6XN®	N08367	**6**	20	24	0.2	
INCO® alloy 25–6MO	N08926	**6**	20	24	0.2	0.75 Cu
Cronifer® 1925 hMo	N08926	**6**	20	24	0.2	0.75 Cu

The 6% molybdenum stainless steel names are protected trademarks of the following companies:

254 SMO	Avesta Sheffield	AL-6XN	Allegheny Ludlum
INCO alloy 25-6MO	Special Metals	Cronifer 1925 hMo	Krupp VDM

Figure 1: Lined carbon steel spool piece from intake structure. Significant corrosion can be observed on the edges of the pipe, where the lining has imperfections.

Figure 2: Interior of the pump discharge distribution header made of 6% molybdenum stainless steel before cleaning. After 30 months of operation no corrosion or other build up has formed on the pipe walls.