IMOA®
INTERNATIONAL MOLYBDENUM ASSOCIATION

NEWSLETTER
JANUARY 2005

# 16th Annual General Meeting

*Top: Dieter and Judith Strathmann (right) with Dick and Flo De Cesare*

*Middle: John Graell (IMOA President) centre right, with colleagues from South America*

*Bottom: Fite Hempel*

Our hosts were two famous trading companies in Düsseldorf, FW Hempel Metallurgical GmbH and Metherma GmbH, and their generous hospitality included an evening at the world-famous "Uerige", a traditional and popular bar in the Old Town with its own in-house brewery; and an evening on the "River Lady" cruising down the Rhine.They also arranged entertainment by a world-famous ventriloquist during the IMOA dinner at the Schloss Hugenpoet, a traditional moated castle dating back to the 17th century and not only an architectural jewel of the Ruhr valley but also a superb restaurant.

The meeting was attended by a record number of delegates (120) who were fortunate to receive some of the best presentations ever made at these AGMs, including:

- "The Wind of Change in the Global Steel Industry" by Professor Dieter Ameling, Chairman of the German Steel Institute and President of the German Steel Federation.
- "Why and Where – Moly in Steels" by Dr Ing Jacques Charles, Innovation Vice-President, Arcelor Stainless.
- "Molybdenum Market Update" by Mr Terry Adams, Managing Director of Adams Metals Ltd.
- "Chemical Applications of Molybdenum" by Dr Philip Mitchell, Professor of Chemistry at the University of Reading.
- "China's Growth Miracle – Fact and Fiction" by Mr Daniel Sale, China Affairs, HSBC Holdings.
- "Substitution Trends in the Stainless Steel Industry – What is in there for Moly" by Dkfm Ing Marcus Moll, Managing Director of Steel & Metals Market Research (SMR).

IMOA's domestic affairs centred on reports on market development (see page 7) and HSE work programmes, whilst Thomas Eisenhöfer (General Manager, Hardmetals and Chemicals Business Groups, HC Starck GmbH) and Oscar Gonzalez Rocha (President and General Director of Southern Peru Copper Corp) were elected to the Executive Committee.

## 17th Annual General Meeting

This event will be kindly hosted in Shanghai by Jinduicheng Molybdenum Mining Corp, owners of the largest moly mine in China, during the week beginning 12 September 2005.

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# Molybdenum Containing Stainless Steel Keeps Hot Spring Water Tanks Running

*This case study has been prepared by Dr Koichiro Osozawa, Consultant to Yakin Kawasaki Co Ltd, Japan*

## SUMMARY

Hot spring water is used for hotels and various facilities in the hot spring resort towns of Japan. In districts where the volume of hot spring water is low because of excessive use, circulation systems are needed. Some hot spring waters contain large amounts of corrosive compounds, especially chloride ions, which can cause corrosion of the storage tanks in the circulation system. In some areas, the material of the tanks has been replaced with a high molybdenum austenitic stainless steel. No corrosion has been experienced since the installation two years ago.

## THE PROCESS

There are about 26,000 hot spring wells throughout Japan, most of which are used for supplying hot water to hotels, houses and various other facilities in the hot spring resort towns. The hot water is supplied by piping from the well. As the volume of the hot water is becoming insufficient in some districts, circulation systems are adopted, in which storage tanks are installed and excess hot water is returned to the tanks with pumps, as schematically shown in ***Fig.1.***

***Case A:*** An old hot spring resort town, located near the coast of the Pacific Ocean, near Mount Fuji, adopted the circulation system in 1974. Five storage tanks, ranging from 100 to 300$m^3$ in volume are connected with resin piping which is covered with heat insulation. The temperature of the hot water circulating in the system is about 61°C with pH 8.4. The chemistry of the water is 568 mg/kg $Cl^-$, 374 mg/kg $SO_4^{2-}$, 62 mg/kg $HCO_3^-$, and a hardness of 540 in mg/kg.

***Case B***: A small hot spring resort town near the coast of the Japan Sea adopted the circulation system in 1992 using a tank of 250$m^3$ in volume constructed from ordinary steel clad with SUS 304L (UNS S30403, EN 1.4307) stainless steel sheet. The hot spring water of pH 7.1, containing 770 mg/kg $Cl^-$, 296 mg/kg $SO_4^{2-}$ and 69 mg/kg $HCO_3^-$, is circulated at 55°C.

## THE CORROSION

***Case A***: The original storage tanks were constructed from ordinary steel lined with epoxy resin. When the hot water in the tank has been emptied once a year for cleaning, the epoxy resin lining has often peeled off and had to be repaired. If the lining has peeled off locally during use, the steel has been exposed to the hot water and has corroded.

***Case B***: Leaking of hot water from the tank was found after six years of use. Pitting and stress corrosion cracking were observed at and near the welds of the stainless steel surface inside the tank. It is estimated that the first localized corrosion of the inside occurred one to three years after installation. Although the most severely corroded parts were patched with a sheet of the same stainless steel, stress corrosion cracking occurred in less than one year.

## THE SOLUTION

***Case A***: Welded test pieces of a super austenitic stainless steel SUS 836L (NAS 254N, UNS S32053), a duplex stainless steel SUS 329J4L (UNS S32506) and a moly-containing standard austenitic stainless steel SUS316L (UNS S31603, EN 1.4404) were immersed for six months in the hot water tank. Although none of the test pieces revealed any corrosion, the town

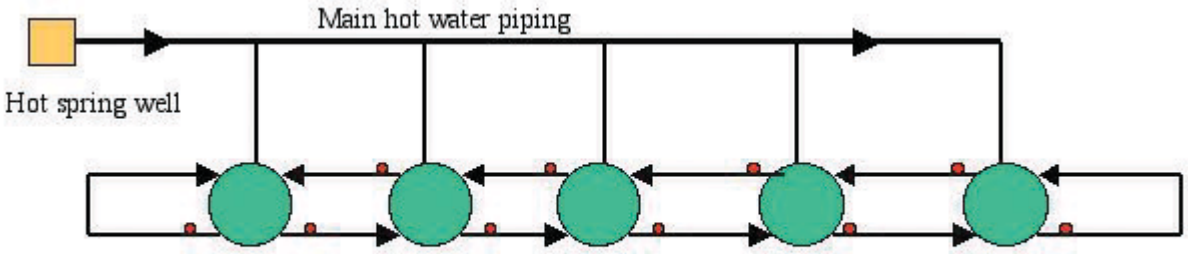



Fig.1 Hot spring water circulation system(schematic)

| | Composition (weight %) | | | | |
|---|---|---|---|---|---|
| | Ni | Cr | Mo | N | Other |
| SUS 304L (UNS S30403, EN 1.4307) | 9 | 18 | - | - | |
| SUS 316L (UNS S31603, EN 1.4404) | 12 | 17 | 2 | - | |
| SUS 836L (UNS S32053) | 25 | 23 | 5.5 | 0.2 | |
| SUS 329J4L (UNS S32506) | 25 | 6 | 3 | 0.12 | |
| HASTELLOY© C-22© (UNS N06022) | 56 | 22 | 13 | | Co, W, Fe |

***Table 1***: Typical chemical composition of stainless steels and nickel base alloys
Hastelloy and C-22 are registered trademarks of Haynes International, Inc.

decided to use the super austenitic stainless steel as it is more reliable for a longer period. Three tanks were lined with 2 mm thick sheets of this stainless steel using Hastelloy © C-22© welding rod. The outside of the 250m³ tank lined with super austenitic stainless steel is shown in ***Fig.2.***

In ***Case B*** the tank itself was replaced with one fabricated from 6 mm thick sheet of the same super austenitic stainless steel.

In both cases there has been no corrosion since the installation two years ago.

## THE COST SAVINGS

The hot water tank of the super austenitic stainless steel is more reliable from a corrosion point of view and a longer life is expected without maintenance. Its life-cycle cost will be lower than that of the tanks lined with epoxy resin or SUS 304L sheet, as these conventional tanks must be repaired periodically. The positive experience in these two towns will enhance the use of super austenitic stainless steel in other hot spring resorts where more corrosive hot water is utilized.

***Fig.2*** The hot spring water tank lined with the super austenitic stainless steel SUS836L

# Thanks to Molybdenum Stainless Steel, Swimming Pools Last "Forever"

*An article by IMOA's Technical Director, Dr Nicole Kinsman*

Molybdenum containing stainless steels are widely used to line indoor and outdoor swimming pools across Europe. The first stainless steel linings have been installed around 1970 in Austria. Today, there are over 5000 installations in Europe, mainly in Austria, Germany and Switzerland, but also in Belgium, France, Italy, Czech Republic and Slovakia among others.

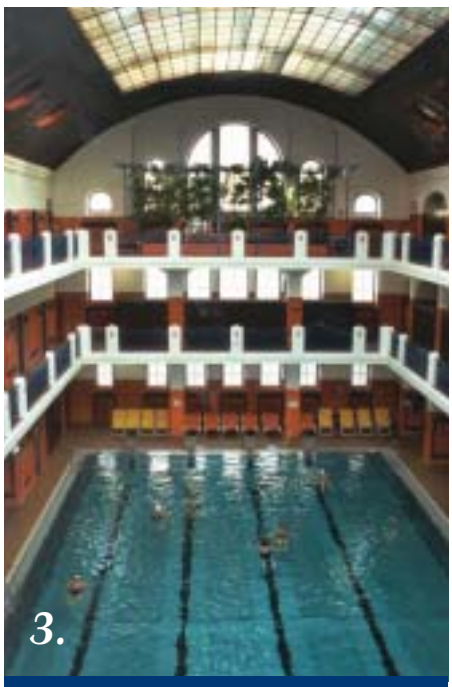
In the early years the molybdenum-free 1.4301 (Type 304, UNS S30400) stainless steel has been used for outdoor pools and the 2% molybdenum containing 1.4404 (Type 316L, UNS S31603) stainless steel for the harsher conditions in indoor pools. However, for many years now 1.4404 stainless steel is the standard material for indoor and outdoor applications because of its increased corrosion resistance in chloride containing waters. Stainless steel grades with higher molybdenum content are necessary in swimming pools with more aggressive waters, such as hot spring, brine or seawater pools.Stainless steel can be used for new installations and to restore older pools. Both applications are about equally frequent.

***Figures 1, 2 and 3*** show the installation of a stainless steel lining in an indoor pool in Vienna, Austria. The goal was the rehabilitation and modernization of the pool. The existing basin has been lined with a new stainless steel skin.This successful renovation project showcases the harmonic integration of a modern stainless steel pool into a grand historic structure. The weight of this stainless steel multi-purpose pool is about thirteen metric tons.
Berndorf Bäderbau in Berndorf, Austria is the industry leader in Europe and has built over 4000 installations. They have an annual consumption of about 2000 metric tons of stainless steel.

Stainless steel linings provide many advantages over conventional tile or plastic pools:

Hygiene: They are more hygienic because they have a smoother, joint-free surface where bacteria and deposits do not attach easily. The smooth surface can also be cleaned easily. Because of their superior hygienic properties, stainless steels are widely used in sanitary applications such as clean rooms, hospitals, dairies and food processing plants as well as pharmaceutical and chemical plants.






***Figures 1-3***:

Rehabilitation of a historic indoor pool in Vienna, Austria.
Top: demolition works
Center: assembly and installation
Below: finished pool

*(Pictures courtesy of Berndorf Bäderbau / www.berndorf-baederbau.com)*


## Maintenance:

Due to the corrosion and weather resistance of stainless steel the maintenance is minimal. All that is required to maintain the original finish of the stainless steel is wiping or cleaning of the surfaces.

## Longevity:

Stainless steel pools do not change their appearance over time. If properly maintained they keep their original finish indefinitely. Stainless steel will remain leak-free as long as the water chemistry is properly maintained. Stainless steel does not need to be retiled or patched.Stainless steel is also extremely resistant to shock and other mechanical influences. It does not crack or erode easily.

## Installation:

Stainless steel pools are prefabricated at the company and then fit on the building site. This is much faster than installation of tiles which has to be done mostly on site. Installation of outdoor stainless steel pools can also be carried out in winter when it is difficult to install other lining materials. This is a big advantage in the case of retrofits. The restoration can be carried out during the winter season when public outdoor pools are closed without losing any business. It is also possible to integrate stainless steel, stairs, jets, slides, showers, and other swimming pool equipment directly into the skin without creating discontinuities and sites for potential leaks. The walls can be curved or have any conceivable shape ***(Figures 4 and 5)***. A stainless steel pool can either be built by lining the walls and floors of a pre-built basin with stainless steel sheet or it can be built as a freestanding, self supporting structure that does not necessarily require extensive preparation of the site.

## Design changes:

If a pool design has to be changed, for example if the size of the pool has to be increased or decreased or if new installations have to be made, it is easy to cut and weld the stainless steel and blend any changes so they become invisible. It is much more difficult to blend the old with the new with tile and almost impossible with plastic liners.

## Winterising:

Stainless steel pools do not need any special protective measures. The cost of stainless steel pools is at the high end of the spectrum compared to alternative materials, comparable with high quality tile installations. However, the longevity and the low maintenance cost quickly make up for the higher initial investment. For this reason many communities across Europe have chosen this economical solution.


***Figures 4 and 5:*** Outdoor and indoor pool installations with several attractions.

*(Pictures courtesy of Berndorf Bäderbau / www.berndorf-baederbau.com)*

# New US Air Force Memorial Will Use Type 316

*By Catherine Houska, TMR Stainless (Consultants to IMOA)*

The most visible feature of the new Air Force Memorial in Arlington, VA will be three molybdenum-containing Type 316 stainless steel spires soaring skyward. The heights of the outwardly curving spires vary with the smallest being 64m (210 ft) and the tallest 82m (270 feet) tall. The spires will be on a promontory overlooking the Pentagon making the Memorial highly visible on the Washington, DC skyline.

The project's architect is the internationally renowned James Ingo Freed of Pei Cobb Freed & Partners, Architects. The project owner is the Air Force Memorial Foundation.

The spires will rely on exterior walls of about 345 tonnes (380 tons) of 19 mm (0.75 inch) thick, Type 316 plate for their structural integrity. The finished memorial will rank among the world's largest stainless steel structural applications both in height and tonnage. The elegant curved shape of the spires may make this the most challenging stainless steel structural design application to date. The international structural engineering firm Arup has worked closely with Pei Cobb Freed on the project to ensure its success. Construction began in 2004 with completion scheduled for 2006.

The Memorial will honor aviation pioneers, the over 53,000 patriotic men and women who have died in combat, and all those who have distinguished themselves in the United States Air Force and its predecessors. The Air Force is the only US military branch not to already have a memorial in the Washington, DC area.

Type 316 was selected because the owner wants the memorial to retain its attractive appearance for years to come. Manual cleaning is not practical and corrosion staining is not acceptable. Although Washington is not coastal, the memorial is close to busy highways where deicing salt is used. It is also possible that global warming may increase exposure to coastal salt over the structure's life. Washington has moderate levels of pollution. The molybdenum alloying addition in Type 316 makes it more resistant to corrosion by salt and pollution and makes Type 316 a wise choice.

*Photo courtesy of Pei Cobb Freed*

# Membership

Welcome to the following companies which joined IMOA in the second half of 2004:

**■ AB Ferrolegeringar**
-Producer's agent, and supplier of ferroalloys and warehousing facilities

**■ Grondmet Metall-und Rohstoffvertriebs GmbH**
-Trading and converting Ferro Molybdenum and other noble alloys

**■ Pars Molybden Co**
- Producer of Molybdenum Trioxide (Technical Grade), Ferro Molybdenum, Pure Molybdenum Oxide and Molybdenum Metal Powder

**■ Samsun Logix Corp**
- Producer and supplier of Molybdenum briquettes and Ferro Molybdenum.

and to the following which have already joined in 2005:

**■ Estudios Antofagasta Copper Ltda**
- Investigation, analysis and study of copper and subproducts uses, including molybdenum in the different markets.

**■ Luoyang Luanchuan Molybdenum Group Co Ltd**
- Producer of Molybdenum Concentrate, Molybdenum Oxide and Ferro Molybdenum

**■ Plansee Aktiengesellschaft**
- Development and manufacture of Mo mill products and finished products for applications in lighting and electronics industries, high-temperature furnace construction as well as medical and coating technologies.

**■ Sheng Tong Enterprises (USA) Corp**
- Exporting Ferro Molybdenum and Roasted Molybdenum Concentrate from China and buyers of Molybdenum concentrate.

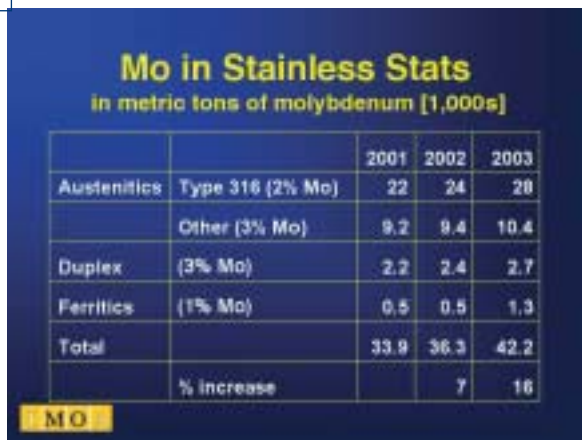
**■ TS Metals (UK) Ltd**
- Suppliers of Ferro Molybdneum, Moly Oxide Powder, Briquettes and buyers of Molybdenum concentrate. Traders of moly Products.

Contact details are given under the full list of IMOA members on the facing and back pages.

# Market Development

One of the problems facing any organisation conducting market development is the ability to assess the results of its efforts. IMOA's work programme has been outlined in previous Newsletters and there is not the space for an update in this issue.

But, given the current programme's focus on the metallurgical sector, and in particular stainless steels, delegates at the recent AGM were interested to receive from Dr Nicole Kinsman (IMOA Technical Director) some statistics which appear to have made all our endeavours worthwhile:

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