IMOA®
INTERNATIONAL MOLYBDENUM ASSOCIATION

NEWSLETTER

JANUARY 2008

Membership

Welcome to (in 2007):

General Moly Inc is a molybdenum exploration and development company in the USA focused on the development of the Mt Hope and Hall-Tonopah moly deposits, located in Nevada.

David J Joseph Co, a US company, brokers a complete line of ferro-alloys and specialty pig iron products. The group's customers are steel mills and foundries.

KTC Korea Co Ltd, a Korean company, trading molybdenum, with its own Kwangyang Ferroalloy Roasting Plant.

Philips Advanced Metal Solutions, a Belgian company, is a specialist in the production of tungsten and molybdenum components for a wide range of applications and industries, including aerospace, automotive, health, electronics, music, nuclear and chemical industries.

and in 2008,

Galway Resources Ltd, a US Company, which is advancing the Victorio Molybdenum/ Tungsten project located in South-West New Mexico. The deposit contains over 200 million pounds of both Tungsten and Molybdenum.

The IMOA website has been re-structured and readers are strongly recommended to renew their acquaintance with

www.imoa.info

Molybdenum is a part of life, being an essential trace element in humans, animals and plants, and a part also of our lives. Extensive information about "Moly's" sources and markets, applications, benefits and characteristics is presented on this website.

19th Annual General Meeting

Hosted generously and efficiently by Climax Molybdenum Company in the "mile high city" of Denver, 180 delegates were welcomed by David Thornton, President both of Climax and IMOA, beginning with dinner at The Fort (where the photos were taken).

Thornton noted that Denver had the thinnest and fittest population in the USA, despite the largest number of microbreweries per capita and said that the next altitude test would face those 100 delegates visiting the Henderson Mine which was two miles high.

David Thornton (left), President of Climax Molybdenum and IMOA with Mario Vinageras, Vice-President Commercial of Southern Copper Corp

Mark Smith (right), President of Chevron Mining, with Jack Goth, formerly Senior Executive Vice-President of Amax

Addressing IMOA's extensive work programme at the AGM the next day, he praised the work of the HSE Committee in providing a pool of data and information on moly to enable the industry to face the global challenges concerning moly exposure. Similarly, the Association's market development programme continued to offer an education in the benefits and applications of moly, leading to increased demand.

In the context of HSE, the Association's initiative to form a Consortium to assist industry to implement REACH legislation which had come into force in June had not only attracted an immediate and positive response,but its progress was also ahead of most other metal industries.

In general, Thornton remarked that membership had increased by 25% to 70 companies in 2007 and that he was proud of the solidly structured and financed organisation which would remain when he retired as President.

After thanking his fellow members on the Executive Committee, members of the HSE and MD Committees, all IMOA members and staff for their support during his 2-year term of office,Thornton paid tribute to two long-serving members of the Executive Committee who were resigning.

Dick De Cesare was retiring from Thompson Creek Metals and from the industry in which he had figured so prominently for 40 years. He was a key player behind the foundation of IMOA although he did not join the Executive Committee until 1995. He served as President from 1998 through 2001 – for two terms, as the careful plans for succession failed for the first time – and his leadership and insights into the many challenges facing IMOA would be greatly missed.

John Graell joined Molymet in 1983 and the Executive Committee in 1996, serving as President from *(continued over)*

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2002 through 2005, again a two-term stint for the same reason. He initiated a Strategic Plan for IMOA – a two-day session for the Executive Committee in Boston conducted by MIT Professor Arnoldo Hax – which is regularly reviewed. Hopefully John would attend future AGMs from time to time in his continuing capacity as Executive President of Molymet.

Lastly, Thornton expressed appreciation to Chevron Mining (formerly Molycorp) for offering to host a dinner at the Denver Art Museum.

The quality of the following presentations and the magnetism of the speakers ensured a crowded meeting room at all times:

- An Anecdotal History of Climax in Colorado" by Mr Jack Goth, formerly Senior Executive Vice-President of Amax.
- Moly Market - an Update" by Mr Terry Adams, Managing Director, Adams Metals Ltd.
- Long Term Trends, Cycles, and Super Cycles in Metals Prices" by Dr John Cuddington, Coulter Professor of Mineral Economics at the Colorado School of Mines.
- An Overview of Superalloy Compositions and Comparative Data and Examples of Applications" by Mr Lee Flower, Marketing Manager, Haynes International.

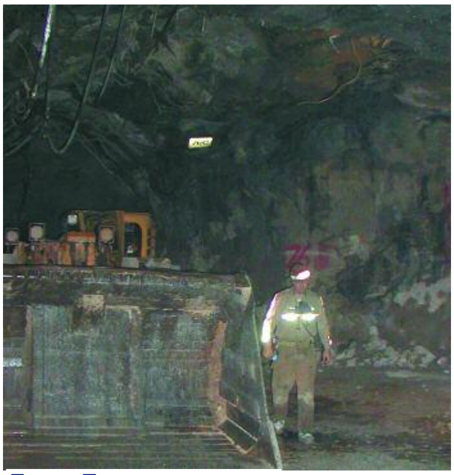
HSE Issues, including plans for the REACH Consortium were addressed by Guido Provoost (Managing Director of Sadaci NV) and Sandra Carey with the HSE Team.

The Market Development Session was led by Nicole Kinsman and focussed on Architecture, Desalination and Structural Uses of Stainless Steel.

Some Notes on the Henderson Mine

The Henderson Mine is the largest primary moly mine in the world and is located in the Rocky Mountains, 50 miles west of Denver. The construction project was a remarkable feat of engineering because the mill and tailing area were on different sides of the Continental Divide – the mine on the east and the mill fifteen miles away to the west (see photos). First a shaft had to be driven down 3,000ft below the surface on the east, then tunnels were dug from each direction, over a distance long enough to require that the earth's curvature be taken into account, and a conveyor belt installed. Operations began in 1976 and the mine has since produced more than 160 million tonnes of ore and 770 million lbs of moly, according to its website.

to West......



From East......

And the Climax Mine .....

Speculation that there were plans to reopen the famous Climax Mine in Leadville -located at a height marginally greater than Henderson and the first commercial supplier of moly back in 1918 but last operated in 1995 - proved correct, when Freeport - McMoRan Copper and Gold, the owner of both the Henderson and Climax Mines, announced in December their intention to restart the open-pit mine and milling facilities in 2010.

Molybdenum REACH Consortium

The Molybdenum REACH Consortium, initiated by IMOA, is up and running successfully and the first meetings took place in London on 19 December. There are currently 38 members (see the website – **www.molybdenumconsortium.org** for a complete list), with other companies expressing interest as the deadline was extended to 31 January 2008 and the minimum fee reduced to US$15,000.

The Consortium Secretariat's principal efforts in 2008 will be assisting members to pre-register; setting priorities for an extensive research programme of laboratory tests to generate the necessary data to conduct risk assessments on the substances covered by the Consortium Agreement; and organising Lead Registrants

Elections and Appointments:

As President in 2008 and 2009

Victor Pérez, Marketing Director of Codelco, in succession to **David Thornton**.

To the Executive Committee:

Duan Yuxian, Chairman, China Molybdenum Co Ltd

Carlos Letelier, Operations Vice President, Molymet SA, in succession to ***John Graell***

Mark Wilson, Vice President of Sales and Marketing, Thompson Creek Metals Co, in succession to ***Richard De Cesare***

Catherine Houska, IMOA's consultant for stainless steel in architecture, building and construction (ABC) and Dr. Gary Carinci, IMOA's consultant for stainless steel use in drinking water and desalination are reporting here on some recent developments in their work areas. With the help of Catherine and Gary, IMOA is providing decision makers with the information necessary to understand corrosion problems and to justify the use of higher performance Mo-containing stainless steels.

Stainless Steel Helps Prevent Deicing Salt Corrosion.

By Catherine Houska, TMR Stainless, Pittsburgh PA, consultant to IMOA

Road deicing salt has been used since the 1960's to prevent commerce disruption and accidents in cities with regular winter snow (e.g. Düsseldorf and Chicago) or freezing rain exposure (e.g. Beijing or Dallas). Total deicing salt tonnage has continued to increase worldwide and corrosion damage is not limited to highways and vehicles. Building material corrosion and premature failure is a significant and growing problem.

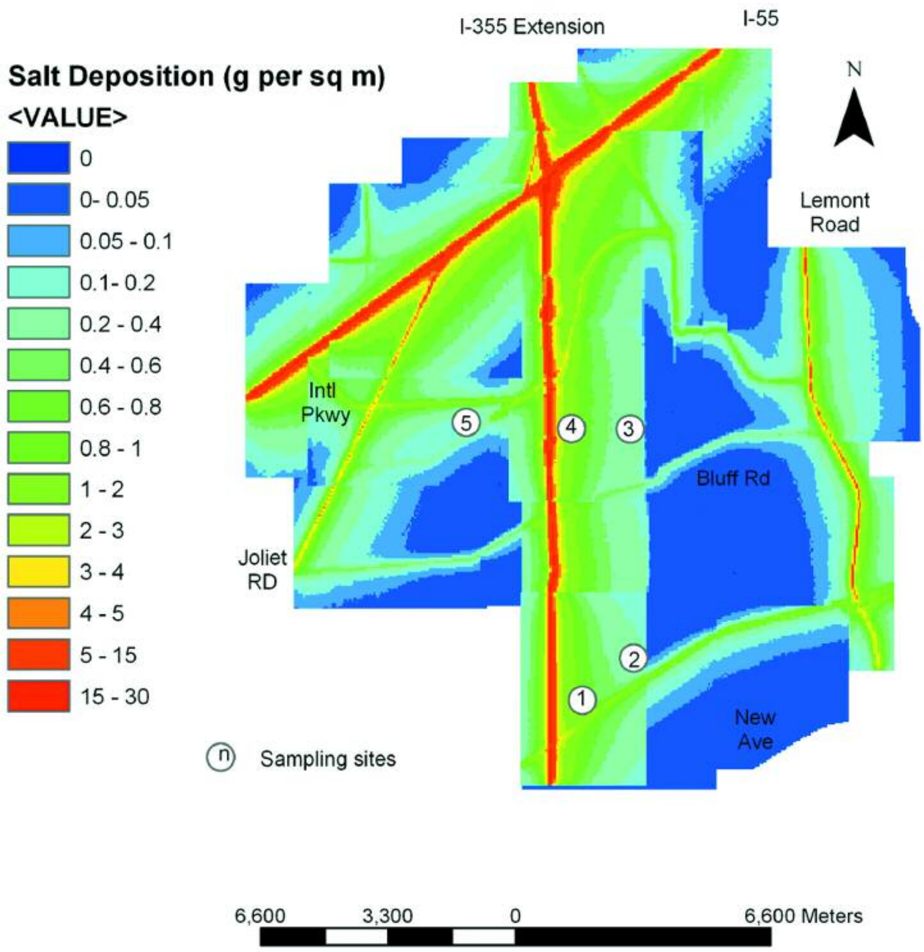


Figure 1: *Model projection of annual deicing salt deposition around highways I-55 and I-355 and small surface roads with the spacing of some test sites shown. Illinois Department of Transportation (DOT) in collaboration with Argonne National Laboratory (ANL) and the U.S. National Atmospheric Deposition Program/National Trends Network (NADP/NTN)*

Road salt mists are formed as the tires of moving vehicles spray tiny particles of salt water or dry salt particles into the air. Hundreds of deicing salt studies have been done but most focused on areas close to roadways. New US research has documented seasonal deicing salt accumulations as much as 1.9 km (1.2 miles) downwind of a major highway outside of Chicago. The researchers collected data between 1997 and 2004 and produced a model ***(Figure 1)*** covering a 5 x 5-km (3.1 x 3.1-mi) area.[1] It shows that sites within 100 m (328 ft) of busy roadways can be comparable to moderate to severe coastal areas.

The researchers theorized that urban areas with busy roadways might have regional deicing salt plumes or mists for several days after a snow event. This increases total salt accumulation on buildings. In Chicago, deicing salt-related metal corrosion has been found up to the 60th floor of one tall building.[2] Exposure levels are likely to be similar in any major city with regular winter snow exposure.

Internationally, it is estimated that over 60 million metric tons (66 million tons) of salt are used for deicing.[3] China, which previously used very little deicing salt, has had a considerable increase in usage and recently became the world's largest producer.

In the US, about 70% of the roads and population areas receive at least 13 cm (5 inches) of snow annually and additional areas are affected by seasonal freezing rain. In recent years, the United States used 13.6 to 18 million metric tons (15 to 20 million tons) of deicing salt per year and Canada used another 3.6 to 4.5 million metric tons (4 to 5 million tons).[4]

Table 1:

Road and bridge snow and ice control procedures in countries that participated in a 2002 European study of Winter maintenance practices[3]

Country	Deicing Products Used	Tons (1,000)	Deicing Period
Austria	NaCl, $CaCl_2$	NA	Nov. - March
Belgium	NaCl, $CaCl_2$	113	Oct. - April
Croatia	NaCl	NA	NA
Czech Republic	NaCl, $CaCl_2$, $MgCl_2$	215	Nov. - April
Denmark	NaCl	115	Oct. - April
Finland	NaCl	NA	Oct. - April
France	NaCl, $CaCl_2$	400 – 1,400	Nov. - March
Germany	NaCl, $CaCl_2$, $MgCl_2$	2,000	Nov. - March
Great Britain	NaCl, $CaCl_2$	2,200	
Hungary	NaCl, $CaCl_2$	NA	Nov. - March
Iceland	NaCl, $CaCl_2$	NA	Oct. - April
Ireland	NaCl	30 - 70	Nov. - April
Norway	NaCl	83	Oct. - April
Poland	No details	NA	NA
Romania	NaCl	108	Nov. - March
Slovenia	NaCl, $CaCl_2$, $MgCl_2$	NA	NA
Spain	NaCl, $CaCl_2$	80	Oct. - April
Sweden	NaCl	300	Oct. - April
Switzerland	NaCl, $CaCl_2$	NA	Oct. - April
The Netherlands	NaCl, $CaCl_2$	135	Oct. - April

NA – total tonnage data not available

The most comprehensive European study was done in 2002 when twenty countries participated in a task group that studied deicing practices. ***Table 1*** summarizes the deicing methods used in each country, and, where available, the annual tonnage. It is evident from this and other data sources that deicing is standard practice throughout Europe.

Unfortunately, many designers are not aware that deicing salt is very corrosive to architectural materials, and inadequate knowledge can lead to inappropriate material selection and premature failure. Molybdenum-containing stainless steels are often a cost-effective choice when long-term performance, aesthetics, security, and/or minimal maintenance are important because the molybdenum alloying addition improves resistance to chloride (salt) corrosion.

Many Europeans incorrectly assume that their deicing salt use is quite minimal, but it is actually similar to North American use. Deicing salt tonnage is increasing in both regions. For example, the salt industry association, Verband der Kali- und Salzindustrie e.V., reported that over 3 million metric tons of deicing salt were used on German roads during both 2005 and 2006, which is a 50% increase since 2002.[5]

Type 316 stainless steel (with 2% molybdenum) with a smooth finish is preferred for many applications exposed to deicing salt. In applications with very high salt exposure levels (i.e. embedded sidewalk lighting and entrance gratings) and areas regularly exposed to salt water splashing, a more corrosion resistant stainless steel or regular cleaning may be necessary. Stainless steels with higher molybdenum contents, like Types 2205, 317LMN, and 904L, are generally sufficient for these seasonal high deicing salt exposure applications.

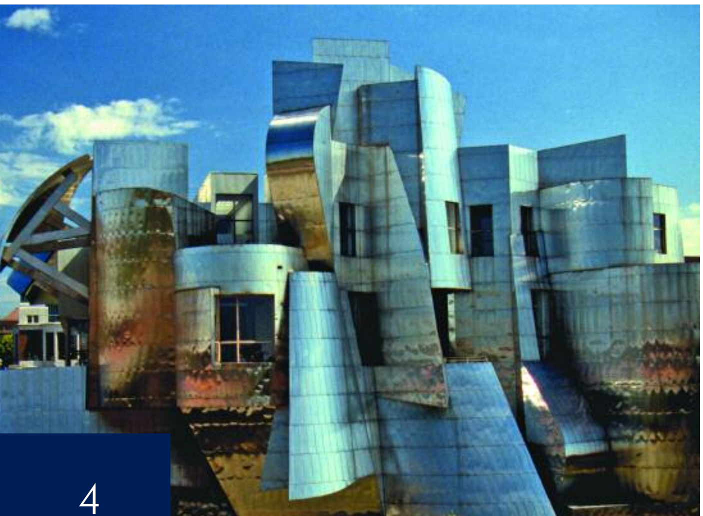


Figure 2:
The Frederick R Weisman Art Museum has a smooth No. 4 finish on its Type 316 stainless steel exterior and is easily rain-washed. Despite five-year gaps between cleanings, no corrosion staining is evident but there is some dirt accumulation.

photo: Nickel Institute

The Type 316 stainless steel exterior of Frank Gehry's Weisman Art Museum ***(Figure 2)*** illustrates that success is readily achievable when an appropriate stainless steel is selected, while ***Figure 3*** shows unacceptable staining on a Type 304 stainless steel panel with less significant deicing salt exposure.

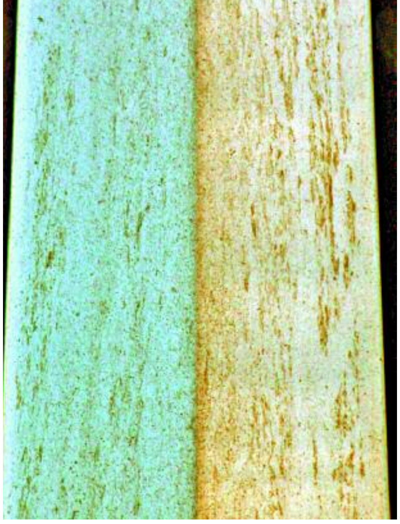


Figure 3:
This Type 304 panel is on the second floor of a building in downtown Pittsburgh. Although it is cleaned more frequently than the building in Figure 2, it is exhibiting significant deicing salt corrosion staining.
Photo: Catherine Houska

Figure 4:
Severe deicing salt corrosion has caused perforation of this aluminum door threshold.   Photo: Catherine Houska

Figure 5:
Deicing salt corrosion of charcoal grey anodized aluminum panels on the second floor of an office building lead to permanent surface damage. Photo:Catherine Houska

To avoid problems, specifiers must be made aware of the severity of the deicing salt problem, comparative metal corrosion rates, and common deicing myths. This makes it necessary to provide information on both stainless steel selection and the relative performance of competitive architectural metals.

For example, there is a common misconception among architects that aluminum's corrosion resistance is similar to that of stainless steel. This is incorrect. In locations that are exposed to chlorides (coastal or deicing salt), the corrosion rate of aluminum is typically 10 to 100 times that of stainless steel. The white to grayish white color of aluminum corrosion product may not bring attention to the problem (as the rusting red of steel does), until permanent aesthetic or structural damage has been done. This lack of knowledge makes aluminum a common replacement for stainless steel when construction costs must be reduced. ***Figures 4*** and ***5*** show severe aluminum corrosion in a deicing salt laden environment and provide a significant contrast to ***Figure 2.***

International "sustainable" design trends have made the specification of long lasting materials even more important. Most of the world's major population centers are exposed to coastal or deicing salt or both. IMOA has developed and posted a new web article on the international impact of deicing salt (see www.imoa.info). It contains the information shared in this article as well as a more in-depth discussion of the relative performance of competitive materials. IMOA is providing decision makers with the information necessary to understand the problem and justify the use of high performance Mo-containing stainless steels.

Notes

1. Allen L. Williams and Gary J. Stensland, "Atmospheric Dispersion Study of Deicing Salt Applied to Roads," Part II Final Report For Period July 2002 to June 2004, in the January 2006 issue of Physical Research Report No. 140, Illinois Department of Transportation.

2. Catherine Houska, "Which Stainless Steel Should Be Specified for Exterior Applications?", International Molybdenum Association, architecture, building and construction series

3. European Task Force TG3, 'Snow and Ice Control on European Roads and Bridges', August 2002

4. Salt Institute, www.saltinstitute.org.

5. The European Salt Company, www.esco-salt.com

Molybdenum-Bearing Duplex Stainless Steel – *The Optimal Material for Desalination*

By Dr. Gary Carinci, TMR Stainless, Pittsburgh PA, consultant to IMOA

Introduction

Water is the most abundant resource on Earth and all life depends on it; however, only one percent of it is available as freshwater. This amount is unevenly distributed, and many arid areas such as the Middle East suffer from alarming shortages where a liter of drinking water is more costly than a liter of gasoline. Desalination is one of the main ways to solve water shortages where energy is readily available. The global water desalination market has been growing at a compound average rate of 12% a year for the past five years, according to *Desalination Markets,* published by *Global Water Intelligence.* With massive projects such as the 800,000 m^3/day independent water and power plant at Jubail Industrial City in Saudi Arabia still to come, there are no signs that the market is slowing down.

Desalination is a process in which dissolved minerals including salt are removed from seawater, brackish water, or treated wastewater. The major technologies available for desalination include distillation and membrane technologies. Distillation is a thermal process in which feed water is heated and then evaporated to separate out dissolved minerals. The most common methods of distillation include multistage flash (MSF) and multiple effect distillation (MED). In membrane processes such as reverse osmosis, feed water is pumped at high pressure through permeable membranes, which separate the salts from the water.

Today the Middle East is the main region where desalination is widely used, with more than half of the total world capacity. Most of the region is below the level of adequate freshwater supplies as defined by the World Health Organization, and the United Arab Emirates, Kuwait, Bahrain and Qatar depend solely on desalination for freshwater. Saudi Arabia is now the world's largest producer of desalinated water with desalination meeting 70% of the country's present drinking water needs and with major urban and industrial centers supplied through a network of water pipes that run for more than 3,700 kilometers. Several new desalination plants are planned, or under construction, which will ultimately bring the total to approximately 40 such facilities.

Multistage Flash Distillation

Distillation technologies which use natural gas or oil fired boiler units are typical in the Middle East because of the low cost of energy in the region. These technologies involve highly corrosive operating environments because of the high salinity and elevated operating temperatures. In multistage flash distillation plants, heated seawater boils rapidly (flash) when the pressure of the vapor is reduced rapidly below the vapor pressure of the liquid at that temperature. Part of this brine flashes into vapor and is condensed on an overhead tube bundle, forming distilled water.
The water is collected in a trough mounted below the tube bundle and forms the end product fresh water ***(Figure 1).***

Multiple Effect Distillation

Multiple effect distillation plants use horizontal tube bundles, where steam is condensed on one side of a tube with heat transfer causing evaporation of seawater on the other side. Steam introduced into the first, highest temperature effect is condensed inside the tubes, and the heat thereby released causes a nearly equal amount of vapor to be evaporated from the feed water on the outside of the tubes. The vapor produced in the

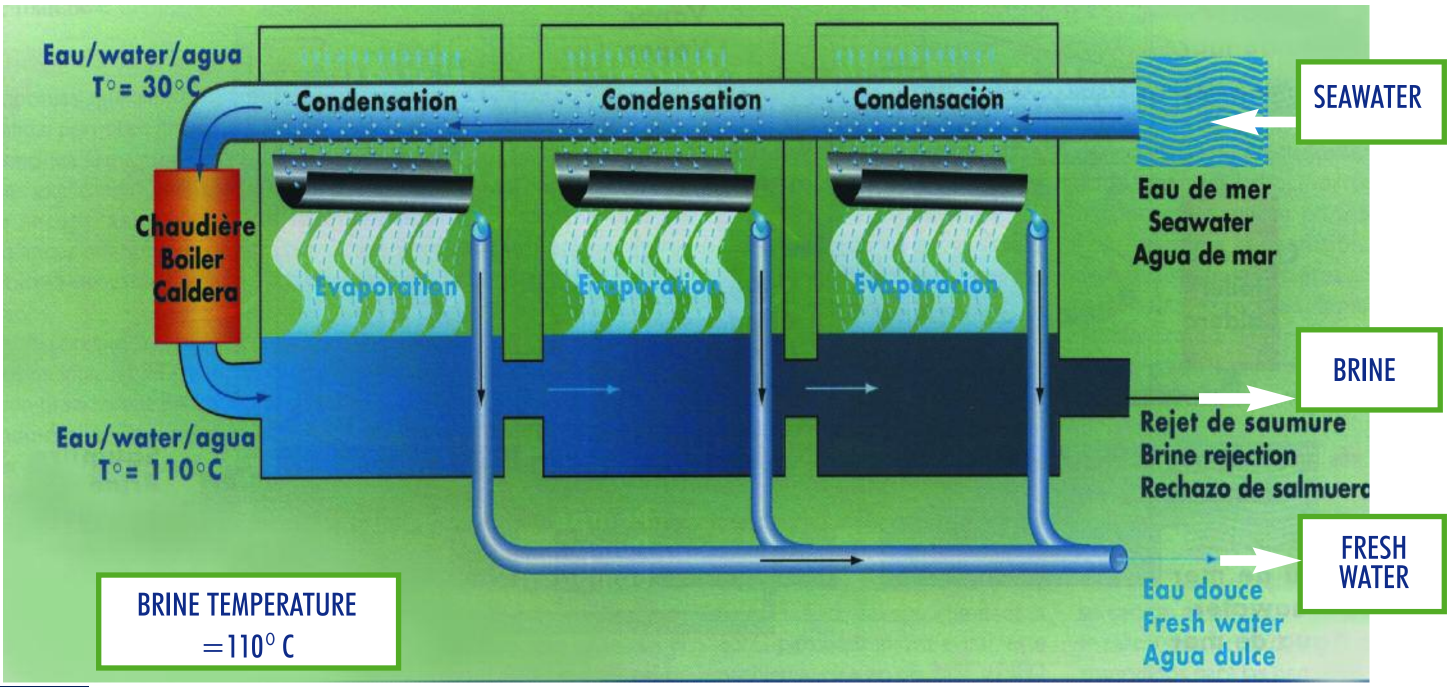


Figure 1. *Typical flow diagram of MSF process where the water is pre-heated in each stage and evaporation takes place in each stage due to vacuum pressure in each flash chamber.*

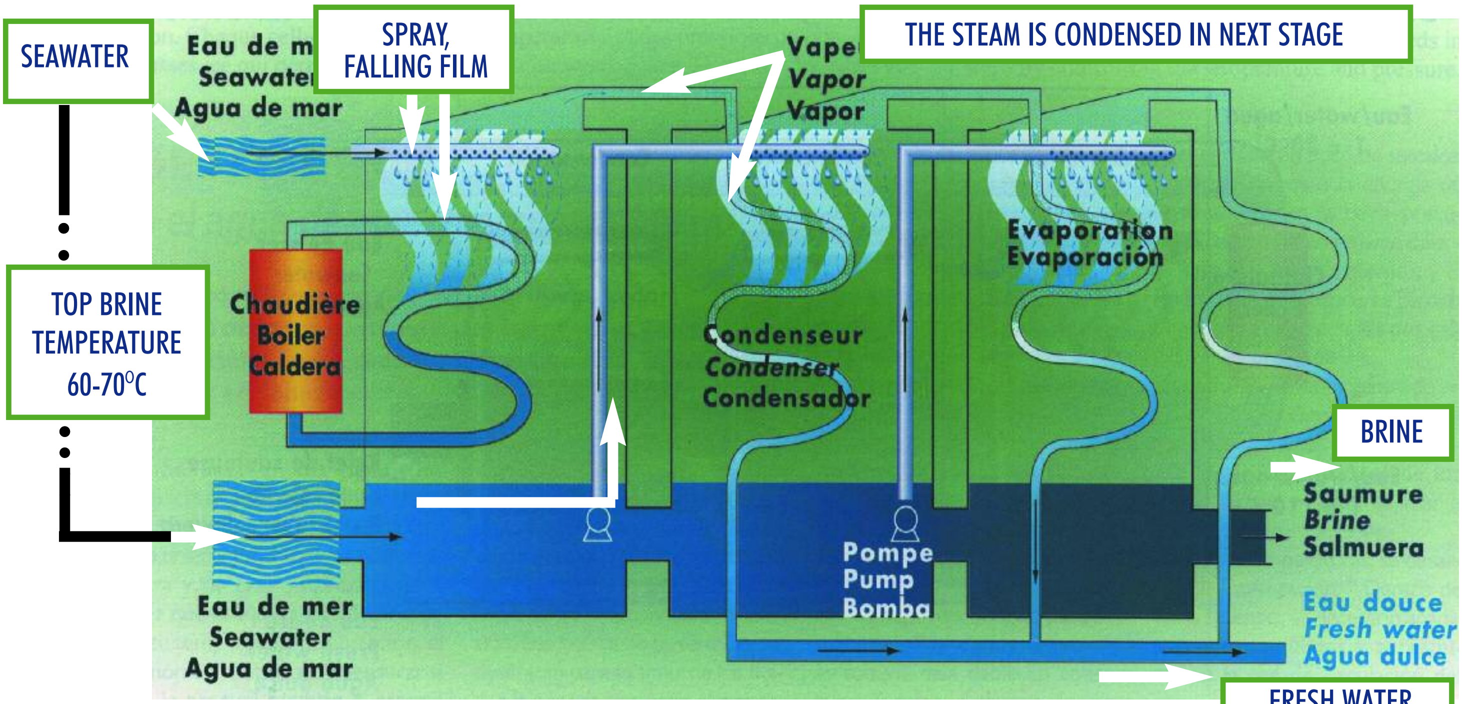


Figure 2. *Typical flow diagram of MED process where the evaporation occurs by heat transfer between condensing vapor on one side and evaporating brine on the other side of the heat exchanger tubes.*

first effect is, in turn, condensed in the second effect, again evaporating a portion of the brine feed water. "Multiple effect" distillation uses more than one boiling chamber or "effect" to produce distilled water ***(Figure 2)***. The lower brine temperatures in this process, compared with the MSF process, result in a less corrosive environment and lower alloyed stainless steels can be used in the construction of MED evaporators. With multiple effect technology, the heat energy contained in the steam generated in the first boiling chamber is reused to boil more water in subsequent boiling chambers. This recycling of energy provides the energy saving feature of multiple effect distillation, which has made this technology an ideal solution for addressing the normally large energy consumption required for desalinating seawater.

Materials

The earliest thermal desalination plants were built using mild steel, but corrosion was a significant problem and later evaporators were built using carbon steel clad with 316L (UNS S31603) stainless steel. Lately duplex stainless steels such as 2205 (UNS S32205) and lean duplex stainless steels have emerged as the optimal grades for desalination plants because of their high corrosion resistance and mechanical strength ***(Table 1)***. Many recent evaporators in the Middle East have been constructed using either 2205 duplex stainless steel or dual duplex construction using 2205 stainless steel in combination with a lean duplex stainless steel for lower temperature MED evaporators. By utilizing the higher mechanical properties of duplex stainless steel, the thickness and weight of the evaporator vessel can in many cases be reduced by as much as 30% compared to austenitic stainless steel or carbon steel construction. Duplex stainless steel evaporators, require less material, less welding and can therefore, be built at lower cost than alternate corrosion resistant materials ***(Figure 3)***. Further benefits of lightweight construction with duplex stainless steel include easier handling and lower environmental impact.

With the global desalination capacity growth predicted at 14% per year and 25 million m^3/day growth forecasted for the Persian Gulf desalination market through 2015 (*Global Water Intelligence*), this development in the Gulf alone will require approximately 275,000 metric tons of duplex stainless steel. Assuming all the evaporator construction is completed using 2205 duplex stainless steel, over 9,000 metric tons of molybdenum will be required for the Persian Gulf desalination projects. The thermal desalination expansion in the Middle East using MED and MSF technologies will provide an important market for molybdenum-bearing duplex stainless steels.

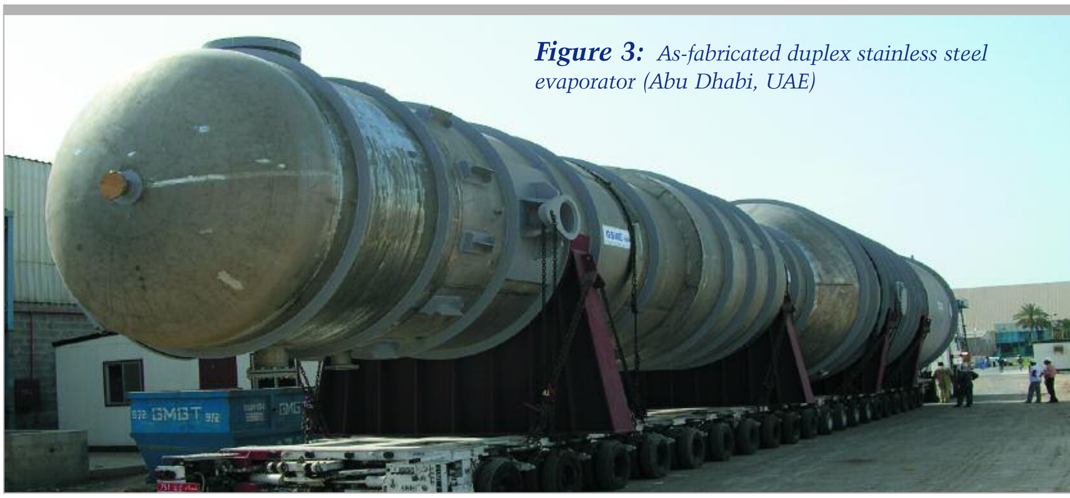


Figure 3: *As-fabricated duplex stainless steel evaporator (Abu Dhabi, UAE)*

Grade	UNS	EN	C (max)	Cr	Ni	Mo	N	Yield, min (MPa)	Tensile, min (MPa)
316L	S31603	1.4404	0.03	17	11	2.1		170	485
2205	S32205	1.4462	0.03	22	5	3.3	0.16	450	655

Table 1: *Stainless steels used in thermal desalination plants (nominal composition in weight %, balance iron)*

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