

IMOA Annual Review 2014/2015



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IMOA Annual Review

Overview from the Secretary-General



Tim Outteridge
Secretary-General



Welcome to IMOA's Annual Review, highlighting the progress we have made on behalf of our members and in support of the molybdenum industry over the past year.

Health, Safety and Environment

The Health and Safety Committee continues its wide range of activities in support of an evidence-based approach by regulators when dealing with molybdenum. The Secretariat has provided data and engaged in dialogue to guard against molybdenum being included in the list of drinking water contaminants currently being compiled in the U.S.

Likewise, we are providing molybdenum datasets for toxicological reviews by the American Toxic Substances Disease Registry and the USA-Canada Regulatory Cooperation Council. The Committee is also active in seeking to ensure that sound scientific data supports the evaluation of molybdenum in the U.S. Toxic Substances Control Act and the Children's Safe Product Rule.

Key ongoing projects include:

- A biomonitoring pilot study to assess worker exposure to molybdenum.
- Data generation on the bioaccessibility of lead in molybdenite concentrates, in response to an EU Commission proposal to drastically reduce hazard classification thresholds to a very challenging level.
- Assessing whether molybdenite concentrates meet current corrosivity to metals criteria under the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

The Molybdenum Consortium (MoCon) remains active, at a scaled-down level to conserve funding, at least until the last REACH registration deadline in May 2018. The Technical Working Group continues its work in support of members' interests,



meeting once a year to review REACH dossiers and to progress related technical issues.

The MoCon Secretariat has assisted members with issues such as an extended substance identity compliance check; an EU member state assessment of potential further regulatory measures on molybdenum trioxide; and the generation of speciation data about the form of copper in roasted molybdenite concentrates. Similarly, the last subset of REACH data, relating to terrestrial toxicity, is well advanced for peer-reviewed publication.

Market Development

The Market Development team is tasked to maintain and expand the demand for molybdenum by promoting its use in new and existing applications across a wide range of sectors and markets. In the carbon steel area, we have developed long-term relationships with steel producers at a technical level, where we are able to offer advice on optimal alloy composition and processing. As part of the ABC program, we delivered workshops, seminars and presentations to a wide range of specifiers and decision-makers on molybdenum-bearing stainless steels in architecture and structural engineering. In China, IMOA led the organization of a session dedicated to stainless steel

at the 11th International Conference on Green and Energy Efficient Buildings and undertook a range of activities to support the supply chain in the use of molybdenum-bearing stainless steel in building and construction.

IMOA has continued research efforts to discover and develop new or expanded uses and applications for molybdenum. These include projects which have reached or are nearing fruition, as well as new ones, for example:

- A project on the development of improved carburizing steels has concluded, resulting in an alloy which clearly outperforms most existing gear steels. The alloy is now scheduled for trialing with several interested parties.
- A project examining the weldability of bainitic steels has demonstrated the advantages of molybdenum in weldable low-carbon steel.
- Two EU co-funded projects are reaching their conclusion; one investigating ways to facilitate the use of high-strength steels (HSS) in long span structures, which will result in new guidance for structural engineers. Another, examining molybdenum-containing stainless steel bio-digesters and storage tanks, will propose amendments to the Eurocode for structural tank design.

- A long-term project examining stainless steel corrosion in concrete is still active, while another analyzing corrosion resistance synergies in stainless steels has concluded.
- A project has commenced with China's Central Iron and Steel Research Institute (CISRI) to develop a stainless steel performance atlas for use in China to inform future stainless steel selection for architectural outdoor applications.
- Work has started with SSAB on a new project to examine the role of molybdenum in modern direct quenched and tempered steels.

The most recent of a series of technical symposia on molybdenum- and niobium-alloyed steels was held in Brazil. The symposium covered alloy steels for the mining and processing industries, and attracted some 170 participants to hear more than 30 presentations on the importance of molybdenum in wear-resistant steels for a range of applications.

Communications

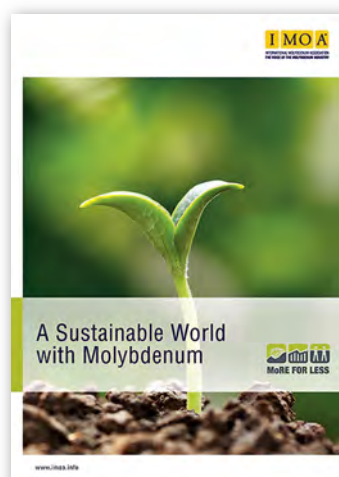
Our ongoing media relations program generated 13 news releases over the year, raising further awareness of molybdenum and its applications and helping to maintain IMO A's reputation as the voice of the industry. Our contact programs, designed to build stronger relationships with targeted publications, yielded positive results, with coverage in a range of metal and steel trade titles in Europe and the U.S. An article highlighting the unique design characteristics of duplex stainless steel appeared in *The Construction Specifier*, North America's premier construction industry technical journal. We have also placed a series of articles relating to molybdenum's applications in steel in *Steel Times International*, a leading industry magazine and website.

We have added social media channels to our online communications, establishing a presence on Twitter and LinkedIn, giving stakeholders broader access to topical and relevant information. Interest in these channels has increased during the year, enabling us to reach a wider audience with our key messages around the value and benefits of molybdenum.

The IMO A website is highly regarded as a valuable source of information, with an average of more than 15,000 unique visitors per month. Work is underway to develop an educational area to give architects and specifiers easy access to existing material that will aid their studies and reinforce the website as the premier destination for information on molybdenum and its applications.

Sustainability

Promoting molybdenum's contribution to sustainable development is now an embedded element within IMO A's overall communications strategy. Our flagship brochure, 'A Sustainable World with Molybdenum' was published in the summer and showcases examples of how molybdenum's unique properties are being harnessed to generate a wide range of sustainable benefits. Examples are illustrated with case studies in brief



and in depth, covering a diverse range of end uses.

This year, we completed two further Life Cycle Assessments. The first, produced in association with PE International (now known as thinkstep), examined the hydrodesulfurization of diesel fuel using molybdenum-containing catalysts. The second, conducted in collaboration with WSP | Parsons Brinckerhoff, measured the environmental savings associated with using 2205 duplex stainless steel to build the Myllysilta bridge in Finland. A total of eleven case studies are now available to download from the IMO A website.

These studies, and others, have generated further media coverage beyond metals industry titles and have helped to raise the profile of molybdenum with a wider audience.

The largest global voluntary building rating systems, including USGBC LEED, reference ASTM International's E60 Sustainability standards. E60 is charged with defining sustainability standards for every industry and application, therefore participation is critical. Our North America consultant has been charged with identifying issues, and encouraging and coordinating metals and mining industry participation on relevant topics, and has been named Chair of the E60.80 General Sustainability subcommittee. She also serves on the E60 Sustainability Executive Committee.

Statistics

We collate and publish statistics showing molybdenum production and use around the world, generating additional press coverage and further fulfilling our strategic aim to be recognized as the most reliable source of information on molybdenum. We also provide in-depth production and use figures and annual end-use reports on molybdenum for members.

Health, Safety and Environment (HSE)



Sandra Carey
IMOA HSE Executive



Health, Safety and Environment

Key activities and achievements in 2014/2015

REACH Molybdenum Consortium (MoCon)

Achieving REACH compliance, in terms of generating the huge volumes of scientific data needed within a few short years, was the single largest challenge IMO had ever faced within its HSE remit. Its legacy is the step-change it has brought to our scientific knowledge, generating data and resources that we continue to deploy today in response to risk assessment and regulatory challenges:

- *Twelve individual and comprehensive molybdenum substance risk assessment dossiers* (each more than 300 pages), containing scientifically robust molybdate effects data, hazard identification, fate and exposure data, risk assessment, hazard classification and risk management measures. All the effects data is stored electronically in the MoCon IUCLID database, and includes GLP studies conducted in compliance with current OECD protocols.
- *Very few classified hazards across the twelve substances.* Only two, molybdenum trioxide and roasted molybdenite concentrates (RMC) are hazard classified. Industry also developed an IT tool, MeCLAS, to assist in deriving hazard classifications for complex substances, such as RMC, termed an unknown or variable composition, complex reaction products or biological (UVCB) substance.

Classification & Labelling – EU CLP (using GHS hazard classification)

EC Substance Name	EINECS No.	SIEF agreed Classification July 2010
Molybdenum Sulfide (MoS ₂), roasted	289-178-0	Hazard classification & category code: Carcinogenicity Category 2 Hazard Statement: H351 = suspected of causing cancer via inhalation
Molybdenum Trioxide	215-204-7	Hazard classification & category code: Carc. 2; Eye Irrit.2; STOT SE3, Hazard Statements: H351 = suspected of causing cancer via inhalation, H319 = causes serious eye irritation, H335 = may cause respiratory irritation
Molybdenum	231-107-2	No classification
Disodium Molybdate	231-551-7 & 231-551-7	No classification
Diammonium Dimolybdate	248-517-2	No classification
Hexaammonium Heptamolybdate	234-722-4 & 234-320-9	No classification
Tetraammonium Hexamolybdate	235-650-6	No classification
Slags, Ferromolybdenum	282-217-2	No classification
Molybdenum Dioxide	242-637-9	No classification
Calcium Molybdate	232-192-9	No classification
Diiron Trimolybdenum Dodecaoxide	237-389-3	No classification
Molybdenum Sulfide (chemically produced MoS ₂)	235-721-1	No classification



- *Extensive arable and grazing soils data for EU regional risk assessment*, via our participation in the GEMAS soil mapping project. A Predicted No Effect Concentration soils calculator has also been developed using the terrestrial molybdate effects dataset to calculate safe threshold values for Mo in soils.
- *Peer-reviewed journal publications of the molybdate effects datasets* for the various environmental compartments and for human health endpoints.
- *eSDS templates in 17 EU languages* for our hazard classified substances.
- *Enhanced contacts with important downstream users* of molybdenum substances, such as the catalyst industry.
- *Profile, visibility and credibility with the European Chemicals Agency (ECHA)*, from our presentations at their REACH workshops and seminars.
- *Enhanced awareness about IMOA* due to the Letter of Access service for non-MoCon members.

Currently MoCon remains on a care and maintenance basis, to conserve its remaining operational funding until at least the last REACH registration deadline in May 2018. The Technical Working Group meets once a year to review dossier status and tackle any issues raised by ECHA. We have researched and responded to three technical challenges this year:

Extended substance identity compliance check on Ferromolybdenum Slags:

In a second round of communication on this topic, the Lead Registrant (Sadaci NV), co-registrant (Climax Molybdenum BV) and the MoCon Secretariat worked to satisfy ECHA's highly detailed data requirements about the exact composition of FeMo slags and how they are manufactured, including feedstock inputs, process parameters and accounting for compositional variability within this UVCB substance.

Molybdenum Trioxide (CAS No. 1313-27-5) added to ECHA's PACT List:

Within the last year, ECHA introduced its PACT (Public Advisory Communication Tool) List. EU member states can nominate a substance for inclusion in this list when they believe a further examination of intrinsic hazard and risk management is warranted. In February 2015, Denmark put molybdenum trioxide on the PACT List, as it was already on the Danish List of Undesirable Substances, known as the LOUS List, for reasons of use volumes and its Category 2 carcinogenicity hazard classification. MoCon commented extensively upon draft reports and engaged with the Danish authorities, seeking to ensure scientifically accurate content. At the time of writing, the outcome of the Danish assessment is that molybdenum trioxide does not pose an unacceptable risk to human health and the environment, and no further regulatory action is proposed.

Copper species in roasted molybdenite concentrates (RMC):

Given the current ECHA Risk Assessment Committee proposals to increase the EU hazard classification status of some copper compounds, it became imperative to conduct investigative work to extend our understanding of precisely which copper species are contained as minor constituents of RMC. Speciation studies (XRD and Quemsan) determined that it is present in the form of copper molybdates, and not as copper species for which ECHA is proposing increased hazard classification. Had the result been different, the impact would have been a lowering of the hazard classification threshold for copper content in RMC.



Peer-reviewed publication of all the scientific data generated for REACH is an important milestone in securing the regulatory consideration of that data in future legislation. To this end, we are currently in the process of publishing the last tranche of data; the terrestrial toxicity dataset. MoCon has also worked with KTH, the laboratory which generated the bioelution data for REACH, to achieve recent publication of a study investigating the release of molybdenum and iron from powder particles in different synthetic body fluids.

The next significant REACH challenge is the recent ECHA selection of disodium molybdate for a Dossier Evaluation Compliance Check, with a focus on assessment of CMR (carcinogenic, mutagenic, reprotoxic) properties.

The MoCon Technical Working Group continues to work steadfastly for the benefit of the MoCon membership, long after the initial REACH registrations were submitted in 2010.



IMOA HSE Committee activities

Interacting with regulatory authorities, conducting targeted research and developing issue communications are the three core areas of the HSE Committee brief.

Regulatory issues

As chemicals management legislation continues to proliferate around the globe, the Committee recently introduced an Issues Management Tool to track the circa 70 areas we are working on concurrently. It will also be of interest to the wider membership to view a summary of the broad scope of issues being handled on their behalf. Entries will be updated twice yearly, one month prior to the April and September IMOA meetings. It features a section where members can individually customize their own corporate priorities within the issues listing.

Regulatory issues consistently command our attention and input. A few prime

examples since the last IMOA Annual Review are as follows:

USA Drinking Water Candidate Contaminant List 4 (CCL4): The occurrence and levels of molybdenum in drinking water is being monitored across the U.S. as a component of a regulatory initiative to determine whether it should be formally considered as a contaminant substance. IMOA has responded twice to the U.S. Office on Water during public consultations on this topic, providing data to assist in the evaluation process. IMOA would support a negative regulatory determination, meaning that the scientific data and occurrence levels were assessed and that a formal decision to not regulate its presence in drinking water by limit values was taken. The outcome of CCL4 will not be known until 2016 at the earliest.

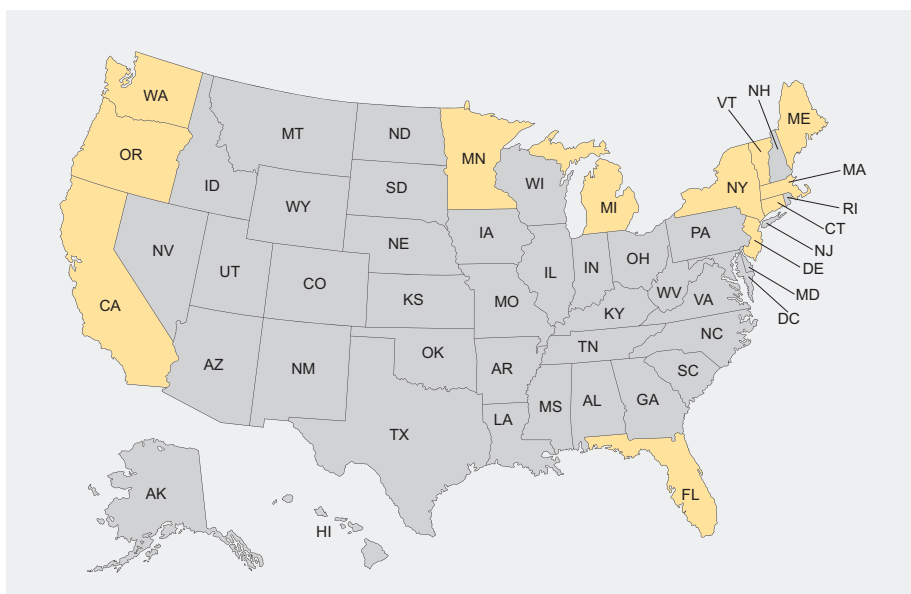
Hazard identification and classification together with risk assessment and risk management evaluation are the backbone of chemical substance regulations. Below is a selection of

current U.S. variations on this theme, all focusing on molybdenum and molybdenum compounds:

- *Agency for Toxic Substances and Disease Registry (ATSDR):* IMOA has established a dialogue with ATSDR to provide datasets to inform their development of a toxicological profile for molybdenum in human health. The profile is expected to take three years to complete.



- *Canada-USA Regulatory Cooperation Council (RCC):* This joint initiative has arisen because both countries have individually tabled molybdenum in their own national substance evaluation schemes. The RCC is a new two-nation chemical assessment program, and molybdenum is the pilot case substance for inorganics, together with four organic compounds. IMOA, via the American Chemistry Council, is now an accredited stakeholder in the process, seeking to ensure the molybdenum assessment is based on sound scientific data.
- *Children's Safe Product Rule:* Known colloquially as the 'toxic toys act', the rule aims to secure the toxic-free content of products that come into contact with children. This legislation is set to be introduced in about 12 American states this year, including New York, Vermont, Oregon, Maine, Minnesota and Florida. Very unexpectedly, molybdenum and compounds are appearing on the Priority Chemicals of Concern lists in several states.



US states intending to introduce Children's Safe Product Rule in 2015



The screenshot displays the OECD Existing Chemicals Database interface. At the top left is the OECD logo with the tagline "BETTER POLICIES FOR BETTER LIVES". The main header is "OECD Existing Chemicals Database". On the left, there is a navigation menu with sections: "Click on an item" (Home, Search, SIDS contacts, Sponsored chemicals, Category chemicals, Login, Help) and "Reports" (Overall Status, All Sponsored Substances, Publications). The main content area is titled "> Chemical Detailed Results" and is divided into several sections:

- Identity:** Cas Number(s) 7631-95-0; Chemical Name Disodium molybdate; Synonyms (Others Chemical names) (none listed).
- Available information on the chemical:** Information has only been included in the database where it has been notified to OECD by Member Countries. HPV: Yes; Recognized Low hazard: No; Existing Reports: No.
- On the ICCA List:** No. See also: [sodium molybdate \(10102-40-6\)](#).
- SIDS Relevant Information:** Sponsors: BIAC; Sponsorship Date: 10/2013; Current Status: Conclusions Agreed; Investigated in a Category Assessment Meeting (SIAM or CoCAM): [Highly soluble molybdenum salts CoCam 5, 15/10/2013, assessed](#); OECD Agreed Conclusions: [Highly-soluble-molybdenum-salts-category_SIAP_JM.pdf](#); Final Assessment Report: (none listed); Date Published: (none listed); Targeted Assessment: No; OECD-IUCLID Export File: (none listed).

At the bottom, there is a footer with "© OECD. All rights reserved. Terms & Conditions | Privacy Policy" and "Contact Us | Site Map | Help/FAQ | MyOECD".

UN Environment Programme-endorsed impact category assessment modeling tool which is incorporated into the most widely-used life cycle assessment software programs. This is an important initiative because poor quality data means inaccurate impact assessment which can dissuade product development specifiers from selecting molybdenum if it is incorrectly judged to be less environmentally friendly than another alternative constituent. Whenever feasible, IMO A participates in multi-metal initiatives, whether regulatory or research-based, to maximize cost-effectiveness and streamline information for the membership.

Targeted Research

Three diverse issues have been the focus of recent HSE Committee-directed research:

- *Determination of bioaccessible lead in molybdenite concentrates:* The driver for this research is a current EU Commission proposal to reduce a hazard classification threshold, known as the specific concentration limit for lead for reproductive toxicity, down tenfold from 0.3% to 0.03%. Complying with such a low level of lead in molybdenite concentrates would be a considerable challenge for the industry. The research project tested four molybdenite concentrate samples for dissolution of molybdenum, lead, arsenic and copper content in three different synthetic bodily fluids to simulate inhalation or ingestion. The negligible dissolution of molybdenum was as expected, at < 0.05% of total molybdenum. Lead exhibited dissolution values of up to 48%, in acidic synthetic gastric juice. The bioaccessibility test data generated by this forward-looking IMO A pilot research project potentially offers a scientific basis for demonstrating that

The rule requires listed substances to be reported annually to the State, and frequently includes a phase-out period after which it is banned from the products. In response, IMO A is intervening to address this significant misconception of the toxicology of molybdenum.

- *U.S. Toxic Substances Control Act (TSCA):* Molybdenum and compounds are listed for review from 2017 onwards. Since it is the same U.S. Government agency leading on this initiative as mentioned in a previous bullet, the RCC should at the very least facilitate the ramp-up for this TSCA assessment, or at best prepare the ground for IMO A to seek substance delisting.

In our previous Annual Report 2013–14, we shared the welcome news that the OECD had awarded Mutual Acceptance of Data (MAD) status to our molybdate effects dataset, meaning that it should be the starting point for new or revised

legislation in OECD member countries. IMO A has since successfully argued that the dataset's MAD status should be taken into account by the authors of a molybdenum trioxide assessment report being prepared by consultants for an EU member state country (see the MoCon section above for more details).

We continue our work on life cycle related initiatives, the latest of which was the preparation and submission of a paper about IMO A's life cycle data to the International Journal of Life Cycle Assessment (IJLCA). It is one of several papers submitted for a special edition of the IJLCA by the metals associations that participated in the multi-metal LCA methodology alignment project which we successfully concluded last year.

Also in the field of life cycle assessment, and likewise as a member of a multi-metal initiative, we are working via Eurometaux to secure the inclusion of more accurate ecotoxicological data into USETox, the

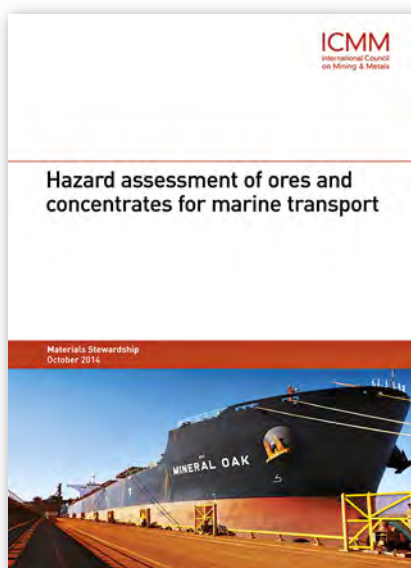
the bioaccessible *lead fraction* able to cause a toxic effect is significantly less than the *total lead content* in molybdenite concentrates. Such data may be influential in arguing against hazard classification in the future, as the concept of bioaccessibility becomes more accepted by the regulatory community.

- **Worker exposure to molybdenum assessed by bio-monitoring:** This project was launched in 2012 involving six IMO member companies currently at varying stages of the process, although a preliminary assessment of results is expected towards the end of 2015. Participating companies represent different areas

We commission peer-reviewed research and engage in dialogue with regulators to support an evidence-based approach for molybdenum

- **Testing for corrosivity to metals:** This is both a UN Globally Harmonized System and Transport Regulations endpoint that seeks to determine whether a substance (in this case molybdenite concentrates), should be hazard classified as corrosive to metals. After initial testing of five concentrates, each with an intentionally diverse characterization of constituents, the project is currently on hold as the validity of the UN-prescribed testing methodology is under review. The copper industry, via the International Council on Mining and Metals (ICMM), is spearheading this methodology issue, with test data support from IMO. We are conducting the testing because it is a GHS endpoint requiring data to make the relevant SDS section entry. For the copper concentrates industry however, the primary driver is that it is a required test for compliance with the latest version of the International Maritime Organization's (IMO) code for bulk solids loaded directly into the ships hold. Molybdenite concentrates are shipped as packaged goods in super sacs under the IMO's Dangerous Goods code.

of the value chain, from mining to conversion and use in the production of stainless steel, molybdenum metal and extrusions. The broad aim is to generate an initial set of data about the range of molybdenum levels in worker biological fluids (blood/urine), and what relationships may exist between those levels and concurrently-obtained personal airborne inhalable and respirable exposures.



Issue communications

The APEC Metals Risk Assessment Training Workshop is targeted towards the Asian regulatory community and companies in that geographic region. IMO is a co-sponsor of this multi-metal initiative coordinated by ICMM, to raise awareness and knowledge-share about the importance of risk assessing metals according to their unique specificities, such as essentiality, valency states, speciation, bioaccessibility, etc. For accurate assessment, inorganic substances should not be assessed



Asia-Pacific Economic Cooperation

within more general frameworks designed for organic substances. The APEC workshop is conveying that message and metal-specific testing methodologies to Asia as the region strengthens its chemicals management regulations.

All MoCon and HSE technical activities are managed and driven forward by the corporate member of the respective HSE Committee and MoCon Technical Working Group, the HSE Executive staff member and our consultants. We express our sincere gratitude for their dedication and professionalism.

Market Development



Dr. Nicole Kinsman
IMOA Technical Director



Market Development

Key activities and achievements in 2014/2015

Carbon steels

Our engagement program with the carbon steel sector continued, with participation in more than 30 conferences, events and customer visits over the year. A considerable effort has been directed towards providing metallurgical consulting to steel mills.

A seminar on lightweighting of heavy commercial vehicles held in Beijing, China, in November 2014 attracted over 90 participants and enabled various steelmakers and truck producers to discuss the production and use of modern high-strength steels. Four Chinese steelmakers reported their chemistries for producing the S700MC grade, all containing about 0.2% molybdenum – in line with the suggestion issued as part of IMOA's market development program in recent years.

Based on the seminar, two papers highlighting the benefits of molybdenum-alloyed steels in heavy vehicle construction have been published in the Springer journal 'Advances in Manufacturing'. Both are available under an open access license allowing free distribution and reproduction.

'Fundamentals and Applications of Mo and Nb Alloying in High Performance Steels – Volume 2', the proceedings of the joint IMOA-CBMM symposium

held in Jeju Island, South Korea in spring 2013, have been printed and distributed to industry contacts.

The IMOA-sponsored project on the development of better carburizing steels concluded last year, with one of the investigated alloys clearly outperforming all European and several overseas gear steels. We continue to disseminate these results in technical papers and at conferences. German special steel producer BGH has now produced a heat of this grade for customer trials. The material will also be included in a new project by the German VDA-FVA, where globally available gear grades are benchmarked under severe loading conditions. Caterpillar and Brazilian miner Samarco are among the companies interested in trying out the new grade and

we continue to share the findings of the project with special steel and truck producers in Europe, the U.S., China, Korea and Brazil.

To further publicize the outstanding results, we have prepared two detailed papers. The first was presented at the recent symposium on wear resistant alloys in Brazil. The second was presented in the Association of Iron and Steel Technology Long Products Conference in Colorado, U.S. in July. Two more papers will be presented at Material Science & Technology 2015 in Columbus, U.S., in October, and HSLA 2015 in Hangzhou, China, in November.

The low-carbon mainstream DP800 alloy concept for automotive applications proposed by IMOA, with around 0.15%



added molybdenum, is gaining popularity in the Chinese market with several steelmakers now producing this grade. It is expected that other companies will copy this concept, in line with our experience with the S700MC truck-frame grade.

Several projects developing molybdenum-containing 1800–2000 MPa press hardening steel grades are underway at steelmakers in Germany, China, Taiwan, Korea and Japan.

The ‘International Symposium on Wear Resistant Alloys for the Mining and Processing Industry’, was held in Campinas, Brazil, in May 2015. The event, organized by Companhia Brasileira de Metalurgia e Mineração (CBMM) saw some 170 participants attend to listen to 32 presentations on the importance of molybdenum and niobium alloying. Codelco and Minera Los Pelambres, both IMOA members, highlighted the needs for better materials in the mining industry in symposium presentations.

The research project ‘HAZ-Simulation of Modern Line Pipe Steels’ carried out by Voestalpine has concluded. Contrary to claims in several literature sources, molybdenum appears to have no negative effect on the heat affected zone when welded. Molybdenum improves the toughness of the coarse grain zone and reduces the trend to post-weld heat treatment embrittlement, especially in presence of increased niobium content. Thus molybdenum can enhance the alloying limits for weldable low-carbon steels.

Architecture, Building and Construction (ABC)

Workshops

In North America, IMOA and the Nickel Institute (NI) jointly sponsored building and construction workshops at some of the world’s most prestigious architecture



and engineering firms in New York and Chicago. A webinar was held for the American Institute of Architects (AIA) chapter in the Virgin Islands, and two workshops on grade and finish selection for corrosive environments were hosted at Gehry Partners in Los Angeles. In total, we attracted more than 400 attendees from 18 companies. IMOA now has eight courses accredited by the AIA for both instructor-led face-to-face and distance learning.

The U.S. Federal Highway Administration (FHWA) sponsors one-day workshops on corrosion resistant concrete reinforcement for the transportation departments of different states. IMOA and the NI have developed a 30-minute stainless steel presentation which was given to several states over the year, at the request of the FHWA.

We also ran a series of workshops in Beijing and Shanghai in conjunction with the NI.

Conferences and symposia

Jointly sponsored by the NI, IMOA’s consultant gave presentations at several events in North America during the year. A stainless steel presentation for architects and fabricators was given during the AIA Roofing and Building Exterior Solutions

Sheet Metal Symposium in Fort Worth, Texas, U.S. A plenary session paper was presented at the Mid-Century Modern Structures 2015 Symposium in St. Louis, Missouri, U.S., discussing the Gateway Arch and subsequent molybdenum-containing stainless steel memorial applications. Stainless Steel World published an article based on the paper and Corrosion and Materials (a publication of the Australasian Corrosion Association and Asian and Pacific Materials and Corrosion Association) will reprint it later in 2015.

Publications and new ABC content on the IMOA website

IMO A has been publishing monthly issues of the e-newsletter Stainless Solutions since August 2014. Each issue covers a technical topic of interest to the 600+ distribution of architects, engineers and fabricators. One issue was dedicated to our stainless steel library of more than 250 individual publications and resources, which can be downloaded directly from our website. To support the e-newsletter, new website content related to finishes, sustainability, structural applications, grade selection, austenitic stainless steels and applications has been added, and website traffic and downloads have increased substantially.



A feature article entitled 'Duplex Stainless Steel Revolutionizes Structural Design' was published in the May issue of The Construction Specifier (circulation 52,000), North America's leading building and construction industry technical journal. It highlighted the new AISC steel Design Guide, the unique design characteristics of duplex stainless steels and numerous current innovative global projects. It is also being circulated to editors of other magazines who may be interested in republication.

We were able to attract leading global architecture firms and senior industry experts to speak about the sustainability advantages of stainless steel in architectural façade design, including Skidmore Owings & Merrill (SOM), Kohn Pedersen Fox (KPF), and Coop Himmelb(l)au (CHBL).

Stephen Selkowitz, Director of the U.S. Department of Energy's Building Technology and Urban Systems Department, gave a joint presentation

Other efforts

IMO A and the NI sponsored workshops in December for the Chinese offices of large curtain wall fabricators Permasteelisa, Jangho and Meinhardt. Attracting 126 attendees, the workshops focused on the selection and fabrication of stainless steel. Similar sessions were held at the Shanghai offices of SOM and Pelli Clark Pelli.

We have started the research work on the Stainless Steel Performance Atlas, which we are carrying out in association with CISRI, China's national preeminent iron and steel research institute. Co-sponsored by the International Stainless Steel Forum (ISSF), the NI and Outokumpu, the atlas will list performance data for stainless steel installations in eight Chinese cities, as a useful reference for architects when specifying future projects.

We sponsor a range of research projects to discover and develop new or expanded uses for molybdenum

Market development in China

Rapid economic growth means that China remains an important target for our market development activities. Over the year, we have continued to promote molybdenum-containing stainless steel in the ABC sector while assessing opportunities in the developing market of solar water heaters.

ABC activities

11th International Conference on Green and Energy Efficient Buildings

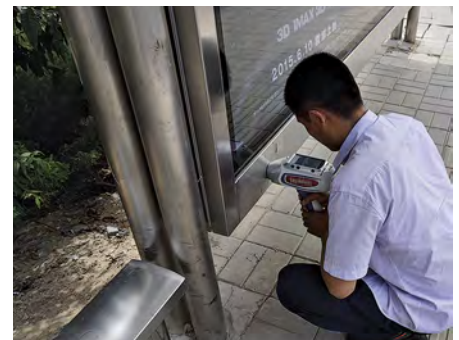
We co-founded the China Stainless Steel Cooperative Promotion Group (CSCPG) last year, with the China Stainless Steel Council (CSSC), NI, the International Chromium Development Association (ICDA) and CITIC Metal Co. Ltd, to encourage the appropriate use of stainless steel in China. Led by IMO A, its first major project was the organization of a session dedicated to stainless steel at this conference, the leading sustainable building event in China, which drew some 4,000 delegates, including all key Chinese property developers.

with the session moderator, our North American consultant, specifically on sunscreen energy analysis. Several local stainless steel suppliers presented their offerings to the ABC market.

Project support

Since early 2014, IMO A has assisted some of the key contractors working on the Type 316 stainless steel curtain wall enveloping the Ping An Financial Center, an iconic 660 m high building under construction in Shenzhen.

We have also provided significant support to the Museum of Contemporary Art and Planning Exhibition (MOCAPPE) project. Originally, the building's façade was to be aluminum, contrary to the vision of the architect, CHBL. However, after several meetings, glass bead-blasted Type 316 stainless steel was selected for the façade. Since then IMO A has also assisted in the fabrication and installation phase. We are keen to improve our understanding of façade material specification in China (currently almost always aluminum) and to strengthen our relationships with the supply chain.



Solar Water Heaters

A potentially very large market, solar collectors manufactured from molybdenum-containing ferritic stainless steel are becoming more attractive to consumers. We have been actively promoting this grade, giving presentations at solar water heating seminars and hosting workshops for manufacturers in Dezhou and Shandong, including Sangle-Yazaki's plant in Jinan. A new dedicated production line at this plant will produce 100,000 units per year.

Duplex stainless steel

We issued the third significantly revised edition of the duplex brochure in English in time for distribution at the Duplex Stainless Steel Seminar and Summit in Stresa, Italy, in September 2014; and at Stainless Steel World Americas, in Houston, U.S., in November 2014.

The brochure is available in English, Chinese, German, Japanese, French, Italian, Portuguese and Spanish. Over the last year, 44,000 copies were downloaded, bringing the total to almost 200,000 copies since 2009.

We have also revised and updated the series of technical information leaflets or 'shop sheets' focusing on working with duplex. Extracted from the duplex brochure, the shop sheets on forming, machining and welding different duplex grades are routinely amongst the most popular downloads.

IMOA held the position of vice-chair at the 'Experiences with austenitic and duplex stainless steels' symposium at the NACE Corrosion 2015 conference in Dallas, U.S., in March. We also continued to chair the highly-attended meeting of the NACE 114X technical exchange group on duplex and ferritic stainless steels.



The relationship between stainless steel piping, leakage rates and repair cases in Tokyo's water system since 1983.

Stainless steel service piping

The city of Tokyo has replaced all lead piping between water mains and dwellings with Type 316 stainless steel, to reduce water leakage and for health reasons. Since the project began in the early 1980s, leakage has dropped from 15% to 2.2% in 2013, with pipe repairs falling from 58,000 to less than 10,000 annually, despite seismic conditions (see figure above).

In a new project started last fall in association with the NI, we are aiming to disseminate this technology in the U.S., Europe, China and other parts of Asia, focusing our efforts on areas with regular seismic activity, high water leakage or water shortage.

Research

We sponsor research to discover and develop new or expanded uses for molybdenum. In addition to those with Voestalpine and CISRI mentioned earlier, we have six other projects at various stages:

The corrosion of stainless steel rebar in concrete is being studied by Ugitech and the French Institute of Science and Technology for Transport, Development and Network (IFSTTAR). In the first phase, accelerated corrosion tests were carried out on stainless steel-reinforced mortar samples, contaminated with chloride levels from 3% to 8%, for 5 days at 40°C. Duplex stainless steel (2205) did not show any corrosion under these conditions. In the second phase, 2205 duplex stainless steel reinforced concrete samples were contaminated with 8% chloride and long-term exposed in a climatic chamber with controlled humidity and temperature. After 18 months of exposure, current measurements indicate no corrosion despite the high chloride content and the elevated temperature.

A project with Ugitech and the University of Grenoble is designed to deepen our understanding of the corrosion resistance synergies between molybdenum and nitrogen in austenitic stainless steels. We have confirmed a significant increase in the protective effects of molybdenum

and nitrogen when added together, compared to their individual effects when added alone, for acidic and neutral solutions. However, this effect diminishes with increasing pH and disappears in high pH alkaline (basic) solutions. This may be due to molybdenum disappearing from the outer layer of the passive film after aging in alkaline solution.

IMOA is sponsoring the role of The Steel Construction Institute (SCI) in HILONG, a three-year European collaborative research project seeking to maximize the benefit of high-strength steels (HSS), particularly in long-span applications such as stadia, arenas and exhibition halls. Ground-breaking laboratory tests on HSS columns and trusses have been performed and design guidance is being developed.

IMOA is also sponsoring the SCI's role in BIOGASS, another three-year European collaborative project, designed to develop guidance for duplex and ferritic stainless steel biodigesters and storage tanks. Field trials in two biodigesters clearly demonstrated the superior corrosion resistance of

molybdenum-containing grades. Workshops and practical guidelines are being prepared, and amendments to the Eurocode for structural tank design will be proposed.

The first year report from the stainless steel atmospheric corrosion testing project that we embarked on in early 2013 with the Kuwait Institute of Scientific Research (KISR) has been completed. Half of the samples were removed from the five test sites and examined after about one year of exposure in spring 2014. The remaining samples were removed earlier this year and are under examination at the moment. The final report is due this fall and is expected to inform grade selection in the Middle East region.

We have also begun a new project with SSAB to examine the role of molybdenum in modern direct quenched (DQ) and tempered steels, in order to recommend optimal molybdenum levels for industrial scale trials. We expect these grades to offer significantly improved toughness compared with existing DQ steels that contain little or no molybdenum.



Team Stainless

IMOA is a member of Team Stainless, formed from the trade associations of the stainless steel and alloying element industries to promote the benefits of stainless steel. The Team Stainless partners jointly sponsor carefully selected projects which are of mutual interest.



The Swedish Royal Institute of Technology, KTH, were commissioned to test a variety of stainless steel grades using a new procedure simulating food contact. The study showed that metal release from all tested grades was well below the EU specific release limits, confirming the safety of stainless steel for food use.

A study commissioned from the Paris Institute of Technology for Life, Food and Environmental Sciences and Manchester Metropolitan University in the UK, looked at best practice in cleaning stainless steel surfaces for hygienic applications. The results are being published in a booklet in the fall.

Other efforts

We have now published 'Practical Guidelines for the Fabrication of High Performance Austenitic Stainless Steels' in Italian as well as English. The 72-page brochure explains the metallurgy and alloying of austenitic stainless steel and its mechanical, physical and corrosion-resistance properties. We hope to publish in further languages where there is sufficient demand.

Financial Report 2014

Income and expenditure account

For the year ended 31 December 2014

IMOA/Molybdenum Consortium

	2014 \$	2013 \$
Turnover	2,789,485	3,481,542
Operating and administrative expenses	3,480,009	3,406,214
Operating surplus/(deficit)	(690,524)	75,328
Other interest receivable and similar income	1,954	4,014
Surplus/(deficit) on ordinary activities before taxation	(688,570)	79,341
Tax on surplus/(deficit) on ordinary activities	488	1,157
Surplus/(deficit) on ordinary activities after taxation	(689,058)	78,184

Balance sheet

For the year ended 31 December 2014

IMO A/Molybdenum Consortium

	2014		2013
	\$	\$	\$
			\$
Fixed assets			
Tangible assets		51,416	16,530
Current assets			
Debtors	68,209		340,699
Cash at bank and in hand	4,502,889		5,089,412
	4,571,098		5,430,111
Creditors – amounts falling due within one year	(740,939)		(876,009)
Net current assets		3,830,159	4,554,102
Total assets less current liabilities		3,881,575	4,570,632
Reserves			
Profit and loss account		3,881,575	4,570,632
Accumulated funds		3,881,575	4,570,632

Financial Commentary

The 2014 audited accounts presented here are consolidated figures for IMO A and the Molybdenum Consortium and are subject to approval at the 2015 AGM. Income from subscriptions and levies amounted to US\$2,789,485. After expenses of US\$3,480,009 a deficit (after taxation) of US\$689,058 was carried forward bringing the combined accumulated funds to US\$3,881,575. Of this US\$2,626,487 was attributable to IMO A and US\$1,255,088 to the Consortium.

In the case of IMO A, budgeted expenditure was higher than subscription income and the year end balance fell below the Executive Committee's benchmark of approximately one year's expenditure. The Molybdenum Consortium reserves will contribute to the funding of the Consortium until at least 2018.



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