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From rails, to ruins, to rebirth

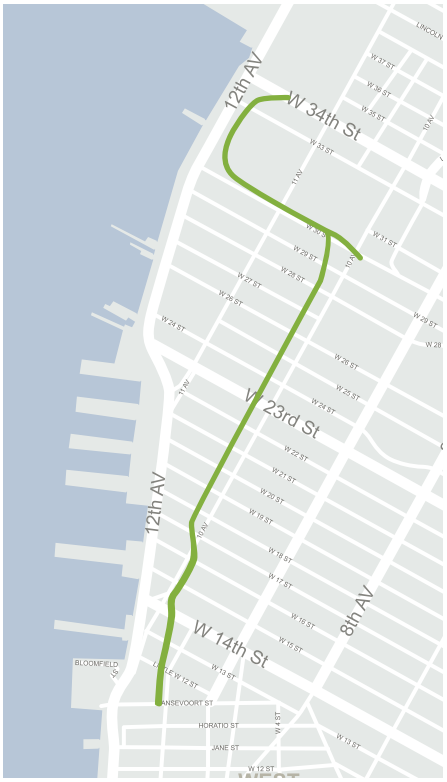
The High Line, a truly unique New York City park, started life as a railway thoroughfare from one end of the city to the other, transporting goods high above the congested streets. After years of neglect and deterioration, the High Line has been reinvented as a dazzling, elevated public space, thanks in no small part to molybdenum-containing stainless steel used in its reconstruction.

Slated for demolition, the once bustling New York City High Line railway had not seen a train in almost two decades. Despite the lack of attention, under tangles of wild grasses and poison sumac its steel bones gleamed – still sound after three-quarters of a century. Revitalized with Type 316 stainless steel cables, nets, staircases and railings, the High Line began its second life as an elevated public park in 2014. Today the High Line attracts more than five million visitors a year. By juxtaposing the original steel beams with new molybdenum-alloyed stainless steel additions, the High Line is a testimony to both the flexibility and longevity of steel. Furthermore, it exemplifies the importance of molybdenum-alloyed stainless steel in a new chapter of industrial history: reimagining the remains of yesterday's infrastructure as material for tomorrow's public spaces.

The High Line: past and present

The High Line, located in Manhattan's West Side, runs from Gansevoort Street in the Meatpacking District to West 34th Street, between 10th and 12th Avenues. The 2.3 kilometer-long elevated park features art displays, scenic overlooks, shopping, green spaces, and activities. A monthly calendar lists events for families, couples, and individuals of all ages, ranging from Tai-Chi to stargazing. Along the High Line trail itself, railroad trestles peek through butterfly gardens. Children attend nature-based summer camp, and teens train for jobs in urban revitalization. Families lean over stainless-steel railings to take in sweeping views of Manhattan.Today the High Line is a happy place: a bustling, but also peaceful public space.

Yet, less than twenty years ago the High Line was an eyesore; an untended industrial gravesite. Long gone were its days as a vital railway carrying goods through Manhattan's largest industrial neighborhood. Originally completed in 1934, the High Line railway started life as part of the largest transportation infrastructure project in New York ›



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City's history. It replaced a grade-level railroad along the center of 10th Avenue, where so many accidents had occurred over the years that the road was nicknamed "Death Avenue." The High Line signified hope for commercial activity and renewed prosperity during the Great Depression. Carrying food and other goods, the railway became known as the "lifeline of New York". After decades of national highway expansion, however, the High Line gradually became irrelevant in a trucking-dominated industry. Carrying just three cars of frozen turkey breasts, the final train made its way down the track in 1980 and the "lifeline of New York City" fell silent. In the absence of activity, its steel skeleton concealed itself among the grasses; rusted edges obscured a still-sound foundation.

From wreckage to reconciliation

Indeed, it was the well-preserved steel beams that signaled hope for the High Line in spite of pushes for its demolition. In 1999, Manhattan residents Joshua David and Robert Hammond started a community group called "Friends of the High Line." Galvanized by the efforts of local railroad enthusiast and activist Peter Obletz, the group aimed to protect the existing High Line from impending demolition. Their vision was an ambitious one: to transform the defunct railway into an elevated park-greenway, inspired by the beautiful Promenade Plantée in Paris. In 2004, the New York City government committed $50 million to create a railbanked trail on the High Line site. "Railbanking" allows a railroad to "bank" a corridor for future rail use if necessary. During the interim other uses are considered viable. In 2005, the federal Surface Transportation Board granted a Certificate of Interim Trail Use, legitimizing city funding. The High Line was finally ready to begin a nine-year transformation, with stainless steel to play a critical role. ›

The elevated High Line park is embedded in the neighborhood. Some stretches are flanked by buildings on either side and new ones are added every year. © Jakob Rope Systems

The park invites visitors to relax and take in the views of the city and nature. © Jakob Rope Systems

Stainless steel netting is very versatile. It ensures the safety of visitors and can also be visually adapted to the environment where it is installed. On the left it protects existing steel railings and has therefore been colored black to better blend in. On the right, where it is used on a newly installed stainless steel staircase, it has has been left in its shiny state. © Jakob Rope Systems

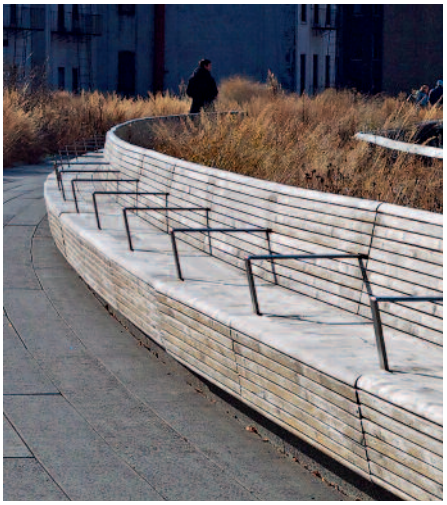
Stainless steel fulfills a dream

Construction of the High Line was funded by Friends of the Highline in partnership with the New York City Department of Parks and Recreation, and work commenced in 2006. The design team included architects and landscape architects, as well as a planting designer. Wanting to play up the colossal under-beams as much as possible, the team used structural steel to reinforce the existing infrastructure. Due to high population density and traffic in the West Side, all steel work had to be managed meticulously in order to minimize road closures and other disturbances. Type 316 stainless steel with 2% molybdenum was chosen for its durability, corrosion resistance and low maintenance costs to help bring the High Line into the 21st century. This stainless steel minimizes the need for continued maintenance in such a high-traffic area and provides the durability required to stand up to millions of visitors annually. Molybdenum imparts excellent resistance to atmospheric corrosion, a problem for some metals in environments like New York City that are near the ocean or subject to deicing salts.

Some of the High Line's most visible elements are made of Type 316 stainless steel. For the railing of the High Line, the architects chose a stainless-steel net and cable system. This railing and net system is used throughout the park and functions as both a design and a safety element. The netting used with stainless steel railings, for example around the staircases, displays stainless steel's bright finish. Other netting that utilizes existing steel railings is made of black-oxide coated Type 316 to blend in with the architecture. Stainless steel hardware also beautifully accents the wooden furniture which provides opportunities to relax and contemplate throughout the park. Fully accessible Type 316 stainless-steel staircases lead the public from the busy streets below to the peaceful promenade above. Perforated to allow excellent drainage and plasma-sprayed with a proprietary slip- and corrosion-resistant coating, they allow the public, including the mobility impaired, to have safe access to the High Line. Stainless steel even provides a moment of drama: the "30th Street Cutout," where the existing floor of the High Line has been excised and replaced with a glass-floored viewing platform running diagonally across the route, uses stainless steel grating as a support structure to assure pedestrians' safety. The tri-functionality of structure, safety, and design underscore the flexibility of Type 316 stainless steel.

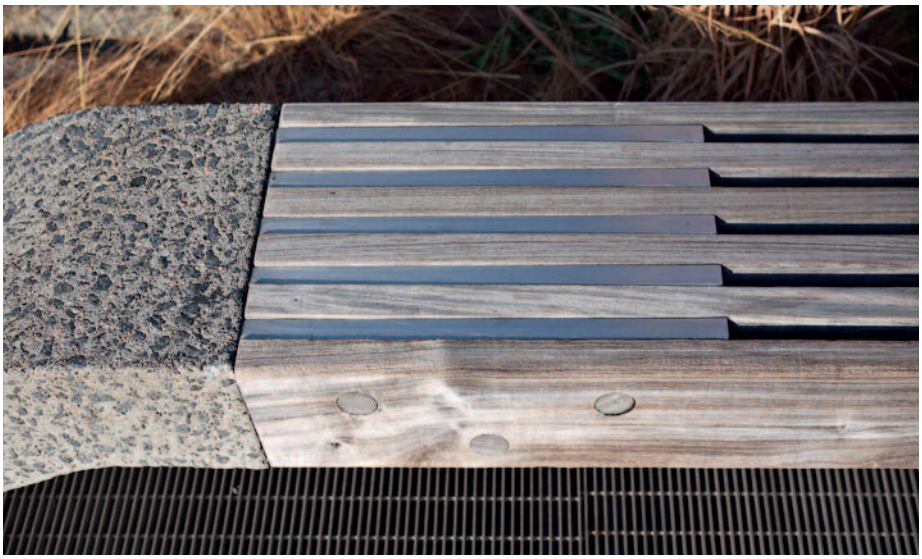
A model for the future

The High Line is the first park of its kind in the United States. It runs for nearly 22 blocks between the neighborhoods of the West Side and provides a unique ›



The wooden street furniture is complemented with stainless steel arm rests and other hardware.

horizontal experience in an otherwise vertical landscape. By updating the original steel elements with modern stainless steel, those who played a role in restoring the High Line successfully transformed an important piece of New York City history without disturbing the surrounding area in the process. The success of the High Line speaks to the enduring legacy of steel in history; one where the industrial bones of the past flower with the innovation of the future. Durable, corrosion-resistant and easy to maintain, molybdenum-alloyed stainless steel has the potential to outfit countless re-imaginings of forgotten places throughout the world. (KW)



Stainless steel details on a park bench are both decorative and functional. The grating below is also made of stainless steel.

PHS – strong, tough and safe

Auto bodies are designed to prevent injuries and save lives when an accident occurs. To protect passengers, while keeping weight to a minimum, requires materials of construction that have both high strength and toughness. Press-hardened steel (PHS) provides these properties and has therefore become the backbone of today's auto body crash structure. As manufacturers push the limits of protection and lightweighting, they are interested in the benefits of molybdenum alloying in this class of steel.

Automotive vehicle crash safety is an extremely important issue and, thanks to its dramatic improvement over the last few decades, accident-related casualties have declined substantially. Even occupants of a tiny compact car struck by a monstrous SUV have good chances of survival today. While crash design must fulfill minimum legal requirements, it is also an important point of consideration for car buyers. To help consumers with their purchasing decision, all cars are rated based on standardized crash-testing procedures, defined and performed by organizations such as the European New Car Assessment Program (NCAP), Germany's Allgemeiner Deutscher Automobil Club (ADAC), the US National Highway Traffic Safety Administration (NHTSA) and others.

The best performing cars receive a 5-star rating in these tests, whereas legal standards usually require at least a 3-star rating. Auto makers are torn because designs that increase crash safety tend to add weight to the car body, conflicting with goals of improved fuel economy and reduced CO_2 emissions. Stronger materials that add less weight to the structure allow designers to achieve both objectives.

Critical crash conditions and protective components

The most difficult situation to design for is the side impact crash. The center pillar (the post between front and rear door) is in close proximity to an occupant's pelvis and shoulder, so if a crash causes the center pillar to intrude too far into the passenger compartment, severe injuries are more likely. Therefore, the center pillar and other components in the side structure of the car body should deform as little as possible without breaking. Instead, they must reroute the kinetic energy of the crash to areas of the car body that can safely deform and absorb that energy.

Traditionally, critical components in the vehicle's side structure have been reinforced with one or two extra shells stamped from relatively thick medium-strength steel sheet. However, this adds weight and consumes space needed for airbags and sensors inside the pillar. Using stronger steel would eliminate the need for additional reinforcements, but ›

The side impact crash test reveals the behavior of a vehicle in this type of accident. © Volvo Car Group

such steels are difficult to form into the shapes required. To further complicate the problem, there seems to be a "natural law" for steels that says increased strength correlates with decreased formability.

Development of the modern side component

In the early 1980s, the Swedish company Hardtech developed a process that heats a steel sheet to around 900 °C prior to forming it into complex shapes. The cold forming die quickly absorbs the workpiece heat, quenching the formed part. Steel with the right chemical composition transforms during quenching into the extremely strong "martensite" phase, producing a workpiece with very high strength. The process is now known as press-hardening. Although it was well known that alloying steel with molybdenum promotes martensite transformation upon quenching, the original process used a very small alloy addition of boron instead. Accordingly, steel used for press-hardening is also widely known as "boron steel".

The Swedish automaker Saab used the first press-hardened components to reinforce the doors of their 9000 model. However, the process was slow to develop because it required more complex, costly and less productive equipment than conventional stamping. It saw only limited use for some time. A breakthrough occurred in 2004 when Volkswagen made major improvements in process efficiency and designed seven press-hardened components for its high-volume Passat model. Press-hardening technology then progressed quickly, and virtually all of today's cars contain press-hardened parts. In 2014, Volvo took the technology to an unprecedented level in its second-generation XC90 SUV model. Nearly 40% of its body structure is made from press-hardened steel, creating a virtually indestructible safety cage around the passengers.

Refining safety and efficiency with the help of molybdenum

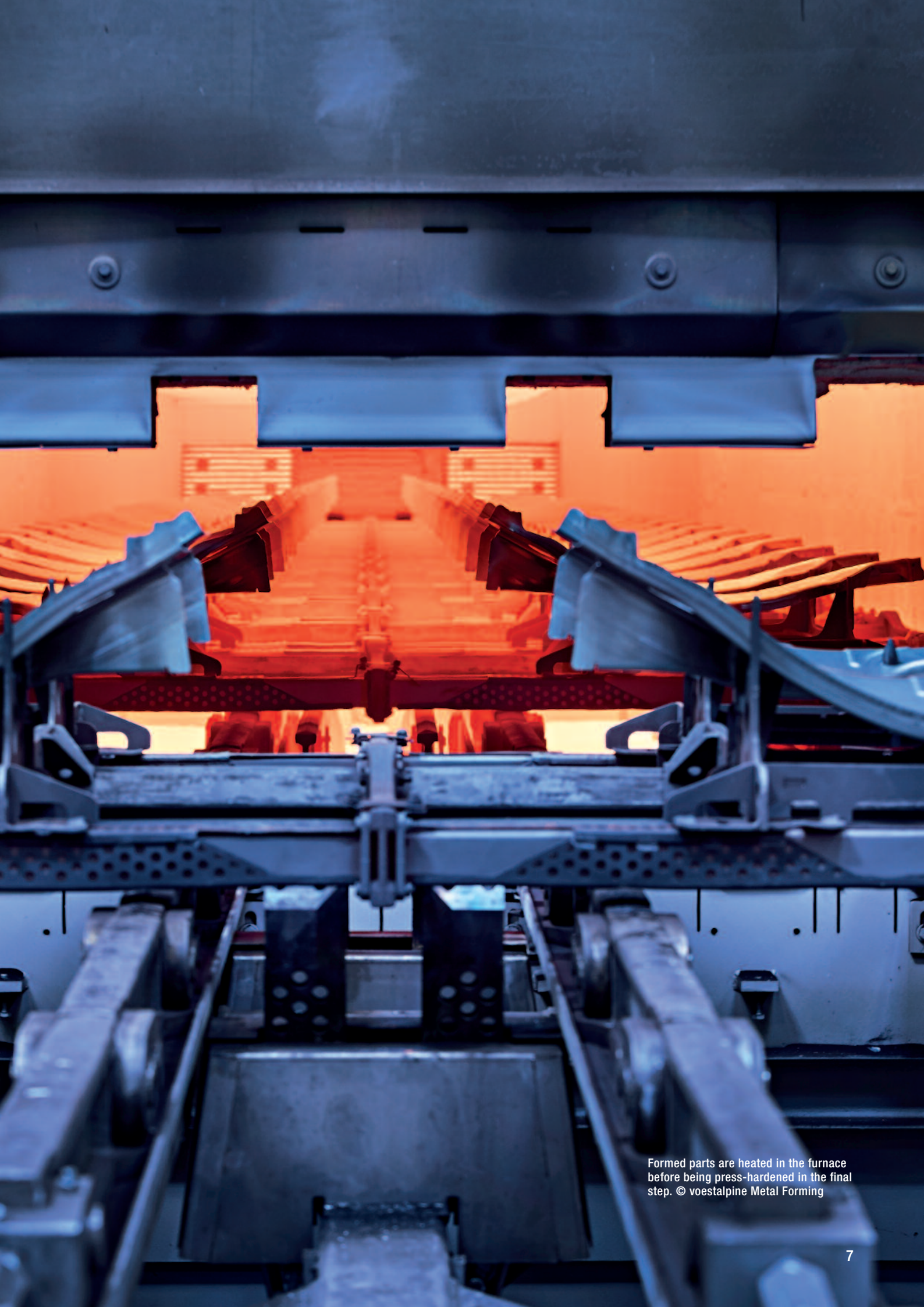
During the first 15 years of press-hardening technology the major focus of development was on process efficiency. Now however, material improvement is increasingly important. The original press-hardening steel, known as grade 22MnB5, was not specifically designed for use in car bodies, but could reach a tensile strength of 1500 MPa. For cars, impact resistance, represented by the property called "toughness", is highly relevant. Higher toughness means that the steel can absorb more energy in a crash before failing. Unfortunately, many steels suffer a loss in toughness as strength increases.

As car makers are now interested in increasing the tensile strength of press-hardening steel towards 2000 MPa, in order to further reduce weight, the interaction between strength and toughness has become increasingly important. Projects supported by IMOA have clearly established that molybdenum additions to such steels can provide a good combination of strength and toughness. Molybdenum acts much like a "glue" between the microstructural features within the steel, holding them together under extreme loads. Furthermore, it helps to reduce the deleterious effect of hydrogen, termed hydrogen embrittlement, by limiting its mobility within the material.

Newly developed press-hardening steel grades are already making use of molybdenum in the alloy. The first commercially available 2000 MPa press-hardening steel (34MnB5) contains 0.15 to 0.20% molybdenum. A recently developed 1500 MPa grade (a molybdenum-modified variant of 22MnB5) is intended for thicker sections needed by heavy-truck components. Although it still uses boron, the co-addition of moly boosts its hardenability and permits hardening of the thicker truck sections.

Molybdenum continues to be a part of the future

Experience in this area shows that there are still things to learn about molybdenum's beneficial effects on steel properties. IMOA plays a key role in identifying and promoting these effects in steel applications. The resulting increase in the understanding of how molybdenum benefits users will widen its use. Press-hardened steel in cars and trucks is just one example that shows that molybdenum can even improve existing steel grades. And as demand for lighter and safer cars increases, the demand for molybdenum will most likely increase with it. (HM)



Formed parts are heated in the furnace before being press-hardened in the final step. © voestalpine Metal Forming

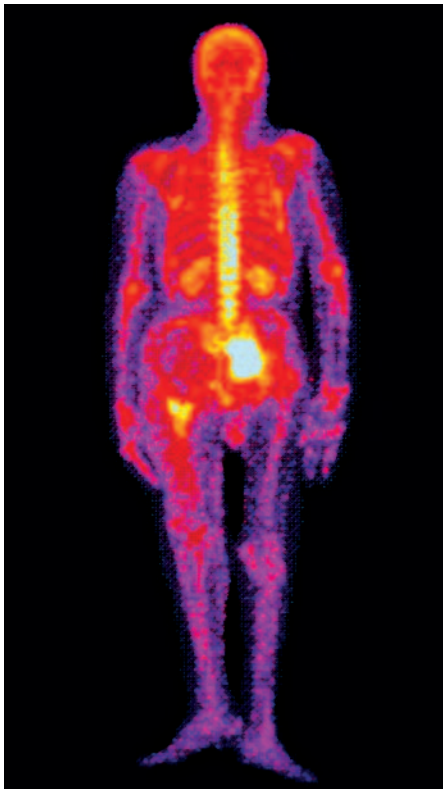
New moly-99 sources wanted

Molybdenum-99 is a vital radioactive isotope used to diagnose and detect a range of diseases, including cardiovascular problems and cancer. Millions of patients benefit from nuclear medical imaging technology every year. However, only a few, mostly very old nuclear research reactors worldwide can produce the isotope, so the reliability of its availability causes some concerns. Therefore, a number of new projects are underway to secure safe and stable long-term supply.

The moly-99 atomic nucleus contains the 42 protons common to all molybdenum atoms along with 57 neutrons. It is unstable with a "half-life" of 66 hours, decaying to the metastable technetium-99m isotope. This means that half of the moly-99 atoms will decay to technetium-99m in that time. Technetium-99m then decays with a half-life of six hours emitting a gamma ray, similar to a high-energy x-ray, that a standard medical “gamma camera” can detect. Thus, it is important for many medical diagnostic procedures. Because of its short half-life, the imaging agent cannot be stockpiled and starts to disappear as soon as it is produced. Therefore, “just-in-time” is a way of life for the isotope’s tenuous supply chain. Any flight delays or traffic jams on the race from the reactor where it is produced to the clinic where it is used can become existential threats, rendering moly-99 and technetium-99m shipments useless and endangering patients who are waiting for a diagnosis.

Importance of technetium-99m in modern medicine

Technetium atoms bind to pharmacological agents that concentrate in various parts of the human body, including the bones, heart, brain, and kidneys. Gamma cameras collect the technetium’s gamma radiation, a technique analogous to an x-ray CAT scan. The result is a picture of the organ that has two significant advantages over a CAT scan: the patient receives a greatly reduced radiation dose and the image contains much more detail since the signal comes directly from the organ itself. Technetium-99m is used in over 30 million tests each year throughout the world in more than 30 different medical procedures, making it by far the most important medical radioisotope.



The technetium-99m tracer reveals metastatic thyroid cancer in a colored gamma scan.
© GJLP/SCIENCE PHOTO LIBRARY

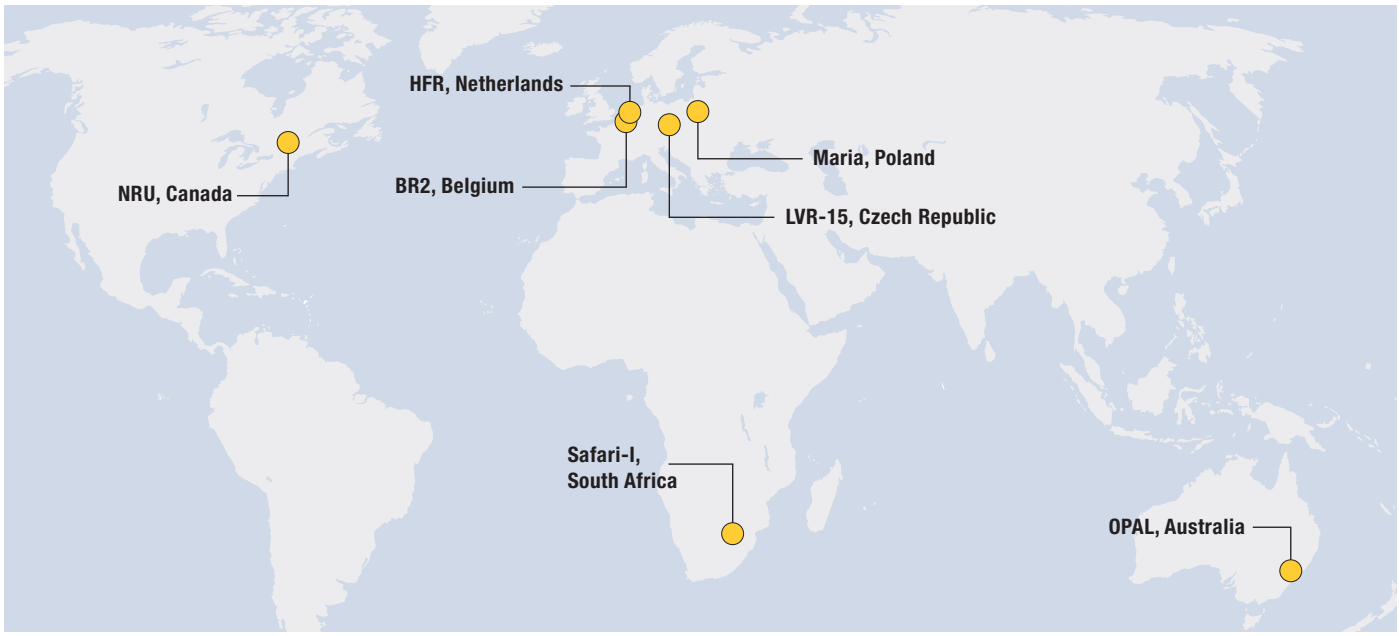
The supply problem

The problem is that the moly-99 supply chain needs to be bolstered. Nearly all the moly-99 in the Western world is produced in seven nuclear research reactors located in the Netherlands, Poland, Belgium, the Czech Republic, South Africa, Canada, and Australia. A few more produce small amounts for local distribution, and four in Russia serve primarily domestic consumption. Until recently, all but one of the reactors produced moly-99 from highly enriched uranium (HEU), a material that can be used to make a simple nuclear weapon. The international community has been trying to eliminate the use of such uranium in reactors for safety reasons.

To add to the concerns, five of the reactors are now more than 50 years old and are susceptible to lost production time due to greater maintenance needs and unexpected shutdowns. Such unplanned shutdowns of two reactors in 2009–2010 caused a critical shortage of moly-99. Canada’s Chalk River reactor, which provides 20% of the world’s moly-99 supply and about 40% of U.S. requirements, was shut down in 2016 after expiration of its operating license. It was reopened only in March 2018 after receiving an extension to operate until March 2028. This has provided a sense of stability for the moly-99 and technetium-99m world, but the long-term viability of the supply chain is still in question.

Path to solving the problem

In 2013 President Obama signed legislation offering federal grants to encourage American companies to develop alternative technologies to produce the crucial moly-99. SHINE (Subcritical Hybrid Intense Neutron Emitter) Medical Technologies proposed a completely new technique using a particle accelerator to produce moly-99 from low-level enriched uranium targets. In 2016, it became the first project since 1985 to receive Nuclear Regulatory Commission (NRC) approval. The company estimates that ›



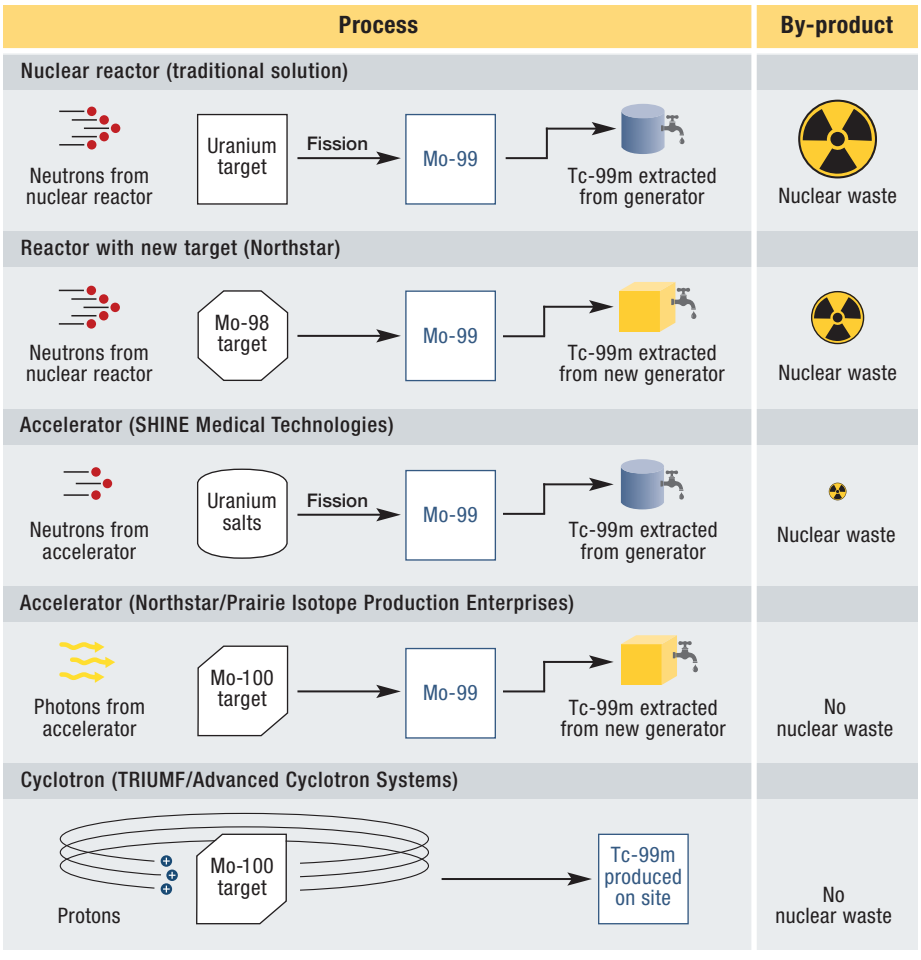
Locations of the seven research reactors which supply 95% of the world's Mo-99. Source: Molybdenum-99 for Medical Imaging, National Academy of Sciences, 2016

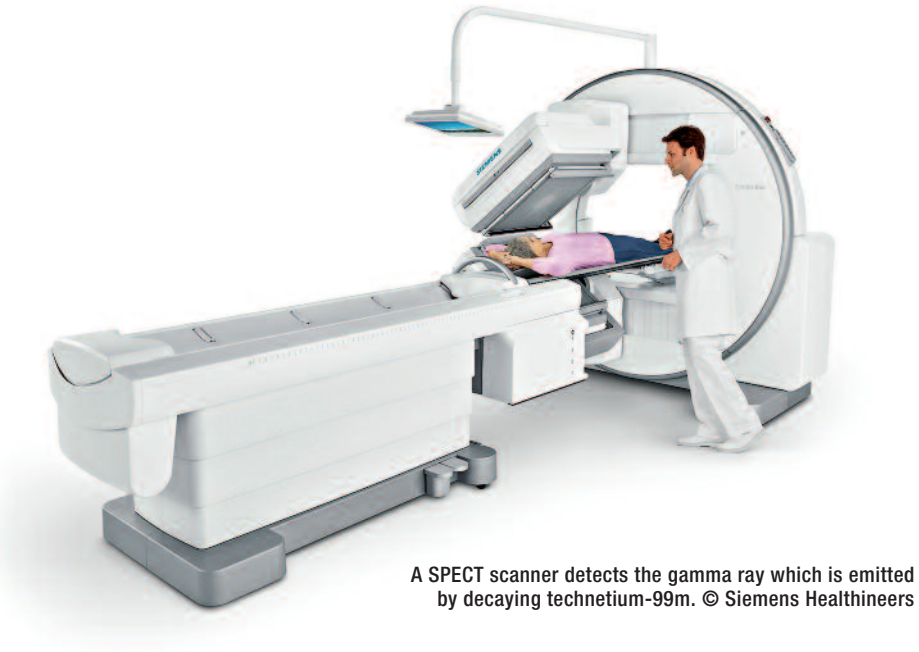
the facility will be able to produce 50,000 doses of moly-99 each week. The $25 million in federal funds covered part of the project's estimated $100 million cost, but the company has had difficulty raising the remaining funds. As a result, the project's start date has slipped to 2020 and some experts feel its startup could take longer.

NorthStar Medical Radioisotopes, located near the SHINE facility, is pursuing two technologies to produce moly-99 and has received $50 million in federal grants for their projects. One is a neutron-capture technology which irradiates molybdenum targets in an existing research reactor. The process then harvests the moly-99 created from the Mo-98 isotope which is 24% of naturally occurring molybdenum. The company is optimistic about this approach, since the U.S. Food and Drug Administration has already approved the process to extract moly-99 from the irradiated material.

NorthStar's second project uses an electron accelerator to produce Mo-99 from a target that uses the Mo-100 isotope, but it has not yet received its ❯

Traditional process and the proposed new technologies to generate Mo-99 and extract technetium-99m (Tc-99m). Adapted from Nature [10.1038/504202a], source: NEA/OECD





A SPECT scanner detects the gamma ray which is emitted by decaying technetium-99m. © Siemens Healthineers

initial NRC approval. Prairie Isotope Production Enterprises (PIPE), a Canadian non-profit consortium, is pursuing a similar methodology. This approach creates no nuclear waste, an advantage in comparison with the technologies using a uranium target.

Two other Canadian organizations CycloMed99, a consortium led by Canada's particle accelerator center TRIUMF, and Advanced Cyclotron Systems, a manufacturer of cyclotrons used to create other medical isotopes, are working on yet another technology which uses proton beams produced by hospital cyclotrons to create technetium-99m directly from a molybdenum target enriched in the Mo-100 isotope. Neither organization appears yet to have a commercially viable project, but since the technology is designed around existing equipment, their path may be less obstacle-strewn. Like the electron-accelerator approach, the proposed technology produces no nuclear waste.

In addition to all of these players, BWX Technologies recently announced a method to produce Mo-99 from a patent-pending neutron capture process. The former Babcock-Wilcox Company has years of experience in building commercial and naval nuclear reactors, but they have not released much detail about their process to make moly-99. They have acquired the Canadian firm Nordion, who have process technology that extracts technetium-99m from moly-99, so they are serious contenders.

Uncertain future

Because of the importance of moly-99 for modern medicine, many ideas and plans are in the works to solve the supply problem. While none of the projects seem to promise a quick solution, the fact that so many companies are working on new approaches increases the likelihood of developing additional capacity in the medium term. In the meantime, the world remains dependent on the reliability of seven nuclear reactors scattered about the globe, and the ultimate solution to the molybdenum-99 problem remains in the future. (TF, JS)

Wine improves with moly and time

Acid-resistant molybdenum-grade stainless steel vats and related equipment are essential in the production of many alcoholic beverages. They are used in alcoholic fermentation, vinification, aging, storage and transport. Hygienic and easy to clean, they help producers from high end to mass market, creating refined and well-crafted libations.

As the world's population has grown, global alcohol consumption has risen to its highest level ever. The annual per-capita consumption has remained relatively level in recent years at 4.3–4.7 liters of pure alcohol. Spirits account for approximately half the total, followed by beer (35%) and wine (8%). Although the beverages and their processes are very different from one another, they all require hygienic, specialized equipment for their production.

Stainless steel at the intersection of tradition and innovation

Alcoholic beverages have many sources. Wines are made from grapes, and sakes from rice, while gins are infused with juniper berries. Artisans who make the beverages strive for the highest quality while maintaining consistency from batch to batch and vintage to vintage. Each beverage's raw ingredients and processing steps dictate the optimal material for the process equipment. Stainless steels offer excellent hygienic properties, corrosion resistance, cleanability, durability and lightness of weight. Furthermore, they do not taint the product's taste or color. As a result, stainless steels dominate the alcoholic beverage equipment market. ›

Alcoholic fermentation – where it all plays out
In alcoholic fermentation, yeasts break down sugars contained in plants or obtained by conversion from starches. The yeasts transform sugars into ethanol (alcohol) and carbon dioxide (CO_2), raising the temperature in the vat. Temperature strongly affects the fermentation rate of yeasts. Below 10°C, the yeasts are unable to multiply; above 35°C, their activity decreases rapidly and fermentation may stop. Between those limits, the fermentation rate doubles for every 10°C increase in temperature. Depending on the end product, it may take several hours to several days to produce the initial alcoholic beverage.

A barrier to chemical attack

Alcoholic beverage production starts with musts, mashes or worts – mixtures resulting from pressing, boiling or malting of raw ingredients. Their chemical properties, in particular their acidity, dictate the optimal choice of the stainless steel grade, although alcohol itself is not corrosive. The starting musts and mashes are fermented to produce the alcohol, a process typically carried out in stainless steel vats. The vat material must resist chemical attack and satisfy the specific requirements of the alcohol produced. The same is true for the other stages of production before and after fermentation. These differ for each type of beverage, but wine requires the most complex and most delicate processes of all.

White wines: protecting the aging process

Wine is made by fermenting a "must" obtained from pressed grapes, and is often matured in vats or barrels. White wines are usually made from white grapes and red wines are made from red grapes, though the grape juice of both types of grapes is clear. For red wines grapes are macerated and fermented with their skins and seeds, giving them color and flavor.

White wines require more care at every stage of production than red wines, because they are more fragile and sensitive to oxidation. In fact, the best wineries even harvest white grapes at night to protect their subtle flavors. The pressing should be slow and gentle, typically in a pneumatic Type 316L stainless steel wine press. This way crushing of the skins and seeds, which could release bitter tannins, can be avoided. Only the juice of the grapes is fermented for most white wines. The 10 to 14 day fermentation at 18–20°C is cooler than for red wines in order to preserve the aromas of the fruit. Fermentation at 12–13°C for up to one month yields more delicate, well-balanced wines. Heat regulation systems, integrated into the vats, allow the winemaker to precisely control the fermentation temperature.

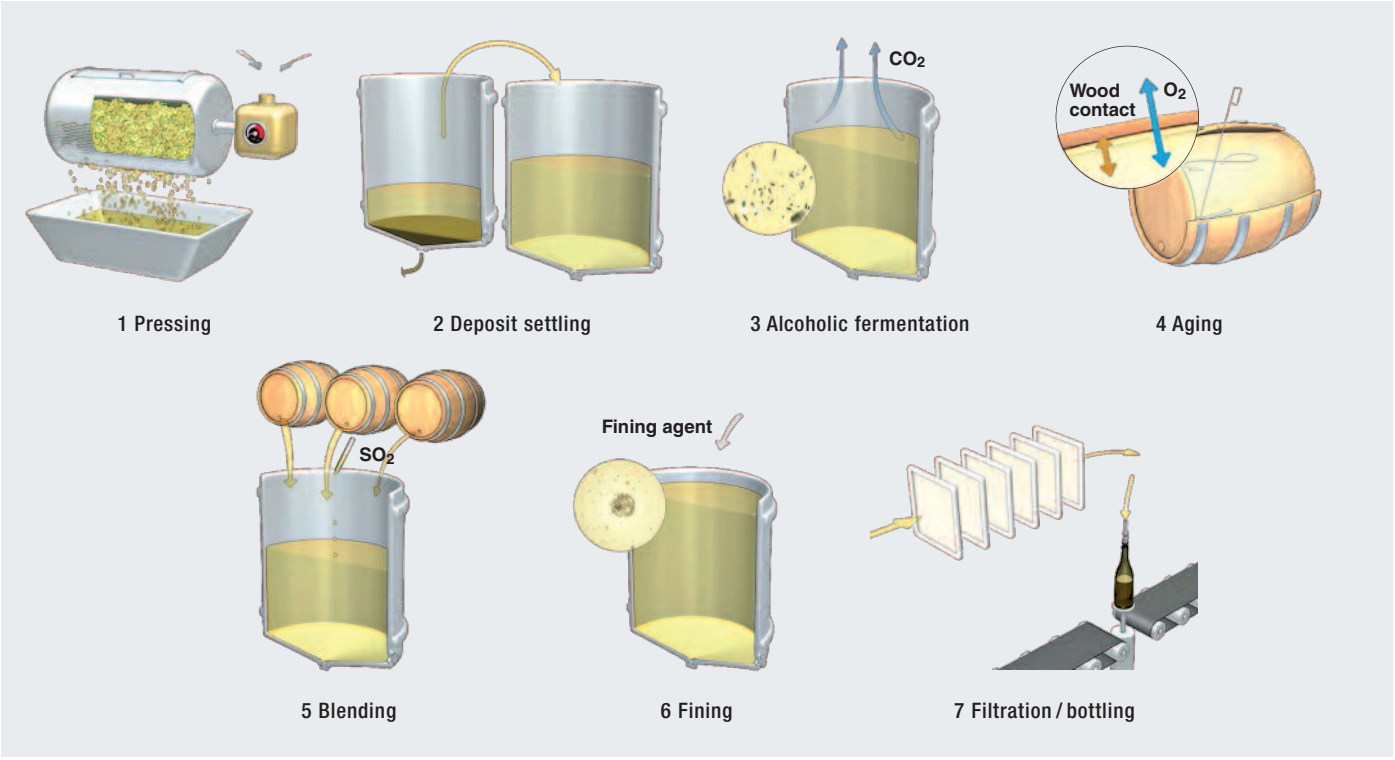
Stainless steel tanks are hygienic, facilitating high-quality wine production. © Domaine Etienne Simonis / photo Benoît Facchi

White wines' natural acidity is much higher than that of red wines. Furthermore, white wines are more sensitive to oxidation, which can occur when the must is exposed to air while it is pumped from one container to another. They therefore require the addition of sulfur dioxide (SO_2) to prevent oxidation. Besides being an important antioxidant, SO_2 is also a good antiseptic against certain micro-organisms and is therefore used throughout the winemaking process.

The combination of high acidity and SO_2 increases the corrosiveness of the must and wine. Therefore, Types 316 and 316L stainless steel, with 2% molybdenum for improved corrosion resistance, are preferred for making white wines, including champagnes and dessert wines, fortified wines and rosés. As red wines are less corrosive, Type 304 stainless steel is usually sufficient for the vats and is most widely used. ❯

Typical stainless steels used for different alcoholic products

Product	Process step	Material
Spirits	Fermentation/aging/storage	304L, 316L
Beers, ales	Fermentation/storage/water tanks	304L (316L, 2205 in special cases)
White, rosé and fortified wines	Pressing/maceration/fermentation/ blending/aging/filtering/storage	316L
Red wines	Fermentation	304L (316L, 2205 for vat covers)



Main steps in the production of white wines. Wood barrels are typically used for aging of Burgundian-style wines. Most other white wines use stainless steel equipment throughout. © Courtesy of Comité Interprofessionnel des Vins de Bourgogne / www.bourgogne-wines.com

However, Type 316L is utilized for fermentation vat lids where the CO_2 gases from the process concentrate.

Even long-term exposure to acids and SO_2 during storage and aging has no effect on the stainless-steel vats. This means nothing can leach from the tanks into the wine, allowing the wines to improve on their own. And because the tanks can be hermetically sealed, they also prevent unwanted oxidization of the wine during aging.

The easily-cleaned and sterilized stainless steel vats improve food safety and prevent defects in the wine more effectively than competing materials such as wood, concrete or resin, and at a lower cost. Before bottling the wine even passes through 316L stainless steel mesh filters or beads that retain residual impurities without altering the wine's taste.

Type 316 stainless steel barrels help preserve the freshness and fruitiness of wine while aging. © Maison S.Delafont

Spirits: corrosion-resistant vats for unadulterated products

Virtually any plant can be fermented and distilled to produce alcohol. Grains, vegetables, fruit, sugar cane and agave are all well-known starting materials. The basic steps in the production of spirits are fermentation of the raw plant material, usually through the addition of yeast, followed by distillation of the fermented mash to obtain ethanol. Type 316L stainless steel vats are used in spirit production for high acidity mashes. They enable rigorous control of the fermentation process and provide ease of handling and cleaning.

Fermentation vats used for whiskey can have capacities varying from 1,000 to over 50,000 liters. Vats were traditionally made from woods, but stainless steel ›

Champagne wineries use 316L vats for storage before bottling, and for the delicate gasification process that follows. © Champagne Laurent Perrier, photo Didier Boy de la Tour

vats are more cost-effective, and easier to empty, maintain and clean. They also protect against the “bad yeasts,” bacteria, and molds that can plague wooden vessels, because the mirror-polished interior of stainless steel vats can be meticulously cleaned and hermetically sealed.

Fruit and aromatic plant brandies and gin also sometimes use Type 316L vats for maceration, a process that infuses flavors to the product, and for storage. For example, brandy produced in Alsace, France, after six to eight weeks of maceration, is aged outdoors in Type 316L stainless steel vats for at least six years to allow the brandy to mellow. There the brandy is subject to variations in the Alsatian microclimate, increasing its complexity. Some Japanese sakes are aged similarly for up to ten years.

Beer: barring air and contaminants

Beer is the most widely consumed alcoholic beverage in the world. It is produced from wort (a mixture of water and germinated barley called malt, boiled together with hops). The wort is sown with yeast and fermented in stirred vats in an oxygen-free environment within strict temperature ranges, according to the type of beer being produced. After fermentation and until consumption, the beer has no contact with air, so the equipment has to be hermetically sealed. In some cases, it is aged after fermentation for three to six weeks at 0°C, allowing it to mature and produce carbon dioxide. The standard grade used in breweries is Type 304 stainless steel. However, Type 316 stainless steel and even 2205 duplex stainless steel are sometimes used for applications requiring higher corrosion resistance.

Beer production also benefits from the hygienic properties of stainless steel. © shutterstock.com/ Viacheslav Nikolaenko

Alcoholic beverages have been produced for thousands of years. The results in terms of taste have often been unpredictable. Only very few producers had the wealth and knowledge to make high quality beverages in materials that were prone to bacteria growth and other contamination. However, with the broad introduction of stainless steel processing equipment, many of the potential problems have been eliminated. Today well-made, high-quality alcoholic beverages are available at almost any price point, thanks in part to molybdenum-containing stainless steels. (TP)

Wood, concrete or stainless steel vats – which material is best?

- Wooden vats have been used to produce alcoholic beverages for centuries. Wood can enhance color and subtle flavors in both wines and spirits. It remains necessary when aging in casks is essential, but this is one of the few uses left for wood today. Wood is sensitive to contamination by micro-organisms, is not completely leak-tight, and incurs high-maintenance costs.
- The 20th century brought concrete vats to the production of spirits and wines. Concrete is thermally stable, inexpensive, and easily shaped into nearly any form. However, concrete vats are difficult to maintain; they often require an inert epoxy resin coating or even stainless steel cladding to resist chemical reactions. Once installed and sealed, a concrete vat is almost impossible to move, a significant disadvantage.
- In recent years stainless steel alloys have replaced nearly all competitors in alcoholic-beverage production because they offer great advantages in installation, operation, and maintenance. The manufacturing flexibility of stainless steel allows for a variety of customized vat shapes (e.g. cylindrical, curved, squared, tapered or even subdivided). Stainless steel vats may be installed on legs, on a slab, or suspended from the ceiling. They are light and easily moved to optimize the layout of a production area. Integrated external coils or jackets allow precise temperature control during the critical fermentation stage. They can be hermetically sealed to avoid oxidation of the product. They are neutral and hygienic in contact with food, easy to sanitize and offer numerous options for modular stainless steel add-ons such as pumps, thermostats, tubing, and valves. Finally, stainless steel allows designers to create spectacular production sites that attract visitors from near and far.

Supporting communication cables

Stainless steel lashing wire plays an important part in telecommunication. It keeps aerial cables firmly in place and reduces the risk of cable breaks and service interruptions. Molybdenum-containing stainless steel lashing wire is used particularly in coastal areas to avoid premature corrosion failure of this essential support structure.

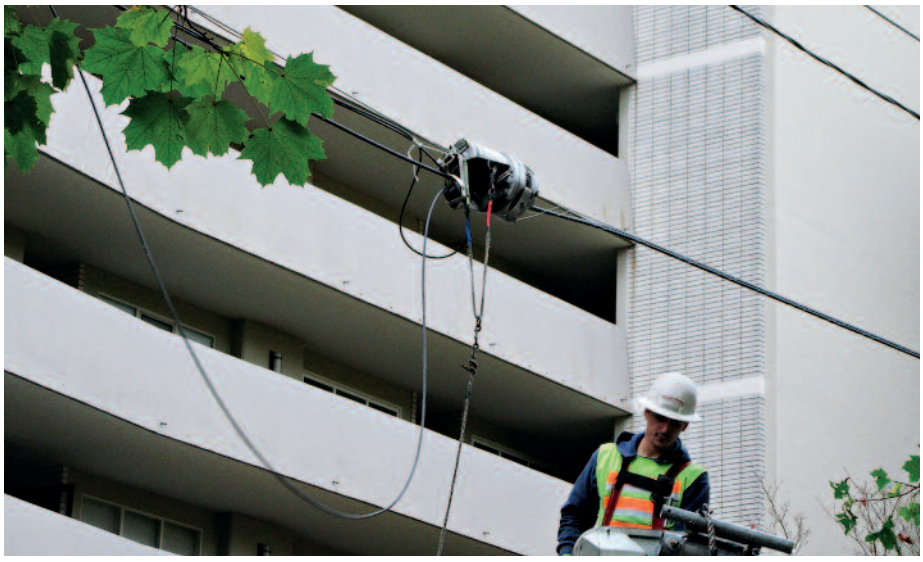
Aerial cables are an essential part of our communications systems where underground cabling is not feasible. These cables carry phone, internet and fiber-optic lines that do not have sufficient strength to support themselves. Installers, therefore, first string a robust, galvanized steel messenger cable, and then run the telecommunication cables alongside it. To secure them firmly in place the cables are lashed together with a thin lashing wire. Fiber-optic cables are filled with many individual micron-sized optical-glass transmission strands and need particularly careful handling and stable support. Otherwise the extremely pure and brittle glass could break due to loads imposed during installation and repair, or due to stresses from severe weather.

Lashing wire is almost always made of stainless steel, usually Types 430, 302, or 304. Type 316 stainless steel, containing 2% molybdenum, is typically used for its improved resistance to corrosion in coastal regions that have air-carried sea salt in their atmosphere.

Installing cables and their supporting lashing wire seems straightforward: simply wrap the lashing wire around the cable and messenger wire. However, this requires some sophisticated machinery to manage the wires without creating a tangled mess of cables. The task is made more difficult because it must be carried out high above ground and sometimes over rough terrain without compromising the safety of the installation crew.

Installers use a cable-lashing machine designed to wind the lashing wire around the messenger wire and communication cables as the cable is being strung between two poles. An entire industry exists to develop and manufacture various kinds of cable-lashing machines. They are designed to be used on the ground or raised in the air; some stay stable as they ride along the line, while others spiral around the cables. They are available in a range of sizes to accommodate different weights and gages of cable. Machine manufacturers also supply the lashing wire and a variety of auxiliary fasteners and other components necessary to complete the installation. Although the basic method is similar throughout the industry, there is competition among machine manufacturers to supply the most trouble-free and long-lasting machine, and a wire that flows freely without kinking or breaking.

Communication cables firmly lashed to messenger wires strung along the side of a building.



Lashing wire being installed with a machine suspended high above the ground on the messenger wire.

Lashing wire is one of those little-known but essential molybdenum applications that is hiding in plain sight. It ensures that above-ground, high-speed internet and telephone services reach the consumer at a high quality, with a minimum of interruption, even in severe weather conditions. (CK)

IMOA news

New service-water pipe brochure

Water leakage is a global problem affecting many parts of the world. More than 25% of all water produced by utilities never reaches their customers, with most of this leakage occurring in the service pipe from the mains to the consumer, which is often vulnerable to damage from corrosion, earth movement and seismic events.

Type 316 stainless steel containing molybdenum provides a hygienic, strong, shock- and corrosion-resistant, long-lasting solution of 100 years or more when manufactured into partially corrugated, flexible piping. The corrugated system minimizes potential leakage and substantially reduces repair cases. It has already helped to save millions of cubic meters of water annually in Tokyo, Seoul and Taipei, where leakage rates have been reduced to as little as 2%, as well as numerous other cities in the region.

The Nickel Institute, the International Stainless Steel Forum and IMOA are promoting the system in new developments and to replace leaking service pipe, delivering workshops, conferences and meetings with engineering firms, water authorities and suppliers in the U.S., Canada, Australia, China, India, UK.

In May we launched a new brochure, 'Stainless Steel Service Pipes: A proven solution to water loss and water quality everywhere' at the International Water Association (IWA) Water Loss Conference in Cape Town, South Africa.

The overall project continues to gather momentum with a number of water authorities now showing an interest in the system. In addition to dissemination, we are also actively encouraging the formation of new supply chains for corrugated stainless steel service pipe, supporting efforts to establish relevant standards, conducting testing, and ensuring that the right local skills are available for the new pipe material.

Online communications

IMOA's website has performed well over the year, attracting a monthly average of more than 12,000 unique visitors. Complementing the website is our social media presence on LinkedIn, Twitter and YouTube, which continues to attract new followers and provides another important communications channel. Since March we have also been active on the Chinese WeChat platform.

Over the last year, we have increased followers on LinkedIn and Twitter by an average of more than 40%, while the 'A World with Molybdenum' video has been viewed more than 1,300 times.

IMOA's social media presence includes pages on LinkedIn and Twitter

Steel symposium in China

In association with the Chinese Society for Metals and Shanghai University, IMOA is hosting the '2018 Molybdenum and Steel Symposium' in Shanghai on 28–29 November 2018.

Sponsored by the China Molybdenum Application Promotion Group (CMAPG), co-founded by IMOA in 2017, the symposium will bring together experts from all over the world to discuss the very latest advances in molybdenum alloying and the results of several Chinese and international research projects.

The program includes a round table discussion on the current molybdenum market and future trends, and a visit to the laboratory of the Shanghai University Advanced Solidification Technology Center (CAST), which is organizing the event. Further details and the final program will be available in the autumn.