INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Drinking water – Saving every drop

Most people take drinking water for granted, largely unaware of the vast network of pipes connecting the reservoir and treatment plant to the faucet. Life seems unimaginable without it, yet on average more than a quarter of the water distributed by utility companies never reaches a single customer.

Leaks and bursts from old pipes and loose or corroded fittings are mostly to blame. Worldwide, 25–30% of water is lost in distribution. In Europe, an average of 26% of water is lost; in other parts of the world, NRW rates of up to 70% have been recorded. In the U.S., two-thirds of a $384 million, 20-year capital investment program for public water systems has been earmarked for improvements in water distribution systems.

Tokyo, part of the largest metropolitan area in the world with over 30 million inhabitants, has replaced all service pipe with Type 316 stainless steel and virtually eliminated water loss.
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Molybdenum-containing stainless steel is an ideal replacement material for older pipes made from lead, iron or plastics. It can dramatically reduce the number of repair cases and overall water loss, especially in seismic areas where the risk of damage to underground piping is greater.

The loss of treated water to leakage before it reaches the customer is not just wasteful, it is costly. It requires extra water processing plants and more treatment chemicals as well as more energy to pump the water to where it needs to go. Add to that the unnecessary depletion of water resources and the destruction of natural habitats to build new catchment facilities, such as dams and reservoirs, and there is a very compelling case for addressing losses, which goes far beyond saving money.

Durable and resilient service piping

Upgrading aging steel, lead or plastic water pipes can dramatically reduce water leakage, particularly in the service pipe connecting the water main to a property, where some 95% of leaks are typically found. Problems often go undetected for months or years, meaning that even small leaks can be responsible for the loss of millions of liters.

Replacing old pipes is the obvious solution, but with what? To provide hygienic drinking water over a long service life, pipes must be manufactured from a material offering several distinct advantages over the steel, iron and plastics versions. Corrugated stainless steel piping dispenses with the numerous elbows and fittings needed in traditional pipes to connect the water main to the meter. Joints are vulnerable to the aging of gaskets, earth movement, vibration from traffic above and seismic events, all of which can cause them to leak over time. Using corrugated stainless steel piping has been shown to reduce the potential for leaking by 75–80%.

Non Revenue Water (NRW) can be defined as the water that a utility produces (or purchases) and distributes but which generates no income, essentially system input minus billed consumption. Unbilled or unauthorized consumption and meter inaccuracies account for a small proportion of NRW, but the biggest contributor is physical losses due to bursts and leaks.

Molybdenum-containing stainless steel also provides other benefits:

- **Durability** – Corrugated stainless steel piping is designed to last for 100 years or more without replacement or repair.
- **Strength and ductility** – Strong pipes which are capable of withstanding great pressure from the surrounding soil and heavy trucks passing on the road above and which will 'bend before breaking', even during seismic events. The high strength also allows for a stronger connection to the fittings at either end.
- **Fitting** – Corrugated stainless steel pipe can be simply bent to fit and can be easily and quickly installed, saving time and money.
- **Resilience** – Strength and flexibility combine to protect the pipes even from accidental mechanical damage, for example by a digger.

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- **Corrosion resistance and protection** – greater resistance to corrosion and aging from the water itself, from treatment chemicals and from the surrounding soil.
- **Hygiene** – Stainless steel is essentially inert in water, with negligible leaching of alloying components, and therefore not affecting the quality of the drinking water.
- **Recyclable** – Stainless steel is 100% recyclable, further reducing environmental impact and enabling a proportion of the original cost to be recovered at the end of service life.

Installation of corrugated Type 316 stainless steel service pipe in Tokyo. © Tokyo Waterworks

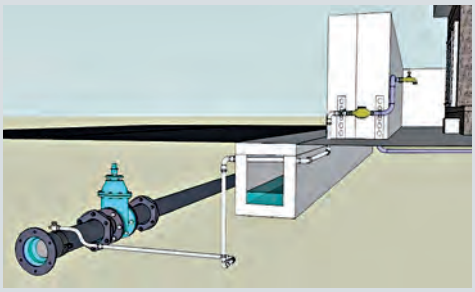
Near-zero leakage in Tokyo

Like any city, Tokyo uses a lot of water. Rapid economic growth in the second half of the 20th century greatly increased water demand as an influx of population and industries swelled the metropolitan area. Even though demand has slowed thanks to new water-saving technologies, the City still has an incredible thirst, with more than 1.5 billion cubic meters of water distributed in 2013.

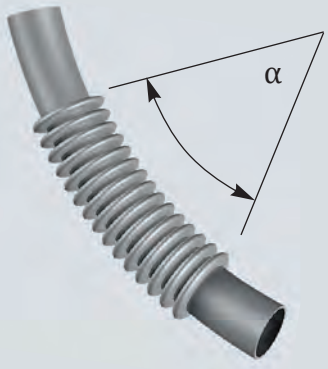
The potential for leakage in a network with more than two million connections in one of the seismic hotbeds of the world is massive, yet water loss is only a little over 2%. The reason is that in the early 1980s, the water authority began a water-loss reduction program to replace all the lead service piping in the network with Type 316L stainless steel, and since 1998, with corrugated Type 316L stainless steel pipe. They also replaced the cast iron water mains with seismic-resistant ductile iron piping, reducing the vulnerability of the transmission infrastructure to earthquakes.

The authority furthermore introduced a comprehensive leak detection and fast repair regime, using a variety of new technologies to detect and fix leaks ›

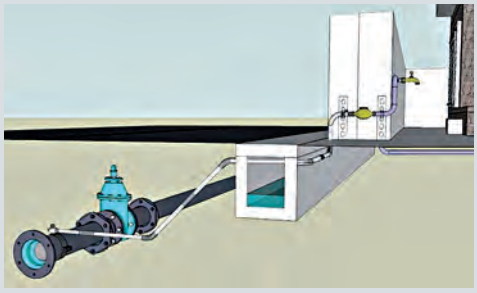
Traditional connections
- each elbow has two joints
- joints are prone to leakage or can fall off during earthquakes



Taipei example: With elbows – 15 connections between the water main and the meter



Corrugated pipes
- reduce number of connections
- reduce the rate of leaks
- are bendable or deflectable during an earthquake



With corrugated pipes – 3 connections
The potential for leakage is down to 20% of the traditional system.

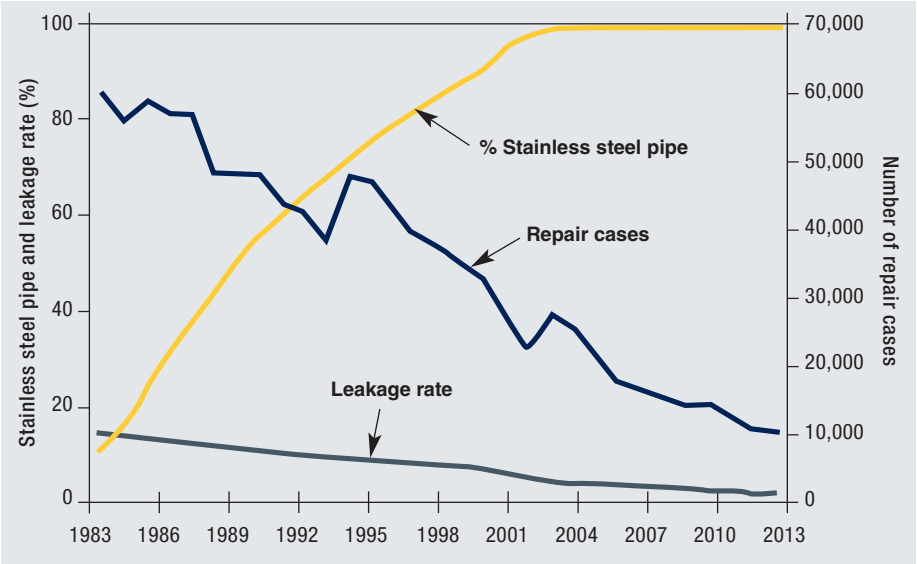
very quickly, often before they become apparent. This increased vigilance, coupled with the replacement program, saw Tokyo's NRW fall from 17% in 1983 to 2.2% in 2013.

To put this into context, Tokyo has reduced annual water leakage by nearly 150 million cubic meters since the early 1990s. The cost savings associated with the reduced water loss combined with the savings due to the drop in repair cases amounts to hundreds of million dollars per year for the Tokyo Waterworks.

Drought averted in Taiwan

A similar program to replace service piping and cast iron mains was undertaken in Taipei, where the water department distributed 0.8 billion cubic meters of water in 2013, over a network with some 310,000 connections. The program began in 2003 after a severe drought in the previous year which brought intermittent water supplies to the Taiwanese capital over a 49-day period.

Leakage rates were analyzed in 450 district metering areas within the city, revealing that 40% of the areas were losing half of their water or more before it reached consumers. A detailed analysis of the repair cases showed that while polybutylene pipe accounted for only 3% of the network it had 28% of all leaks.



The relationship between percentage of service pipe replaced with stainless steel (yellow), leakage rates and number of repair cases in Tokyo's water system since 1983.

Some 90% of all problems occurred in plastic pipes, with the vast majority (83%) caused by cracking. As in Tokyo, an enhanced regime of leakage detection and swift repair was introduced.

The ongoing program has so far replaced 35% of service piping of various materials with corrugated Type 316L stainless steel pipe. The result was a 10-percentage points drop in water loss, from 27% in 2003 to 17% in 2014. In terms of water volume, losses in Taipei were even greater than in Tokyo, at 365 million cubic meters in 2005. In 2014, with the replacement program less than half complete, leakages had already been reduced to 219 million cubic meters, a reduction of 146 million cubic meters, resulting in significant cost savings.

More importantly, a drought more extreme than the 2002 event which precipitated the pipe replacement program occurred in 2014, with 13% less rainfall than during the previous drought.

However, the vast improvement in leakage rates achieved since 2003 meant that there was no interruption to the water supply. In fact, more water reached the customers even though less was distributed in total.

Water is a fundamental human need which can't be substituted with anything else. On average, we drink four liters a day in one form or another, and use much more in our everyday lives. Security of supply is a prerequisite for the sustainable growth of our towns and cities. Replacing leaking service piping with molybdenum-containing stainless steel is an investment in the future. This also makes economic and environmental sense in the present day, as these examples clearly demonstrate. (Alan Hughes)

People lining up to collect water from tank truck in Kolkata, India. © istockphoto.com/ookpiks