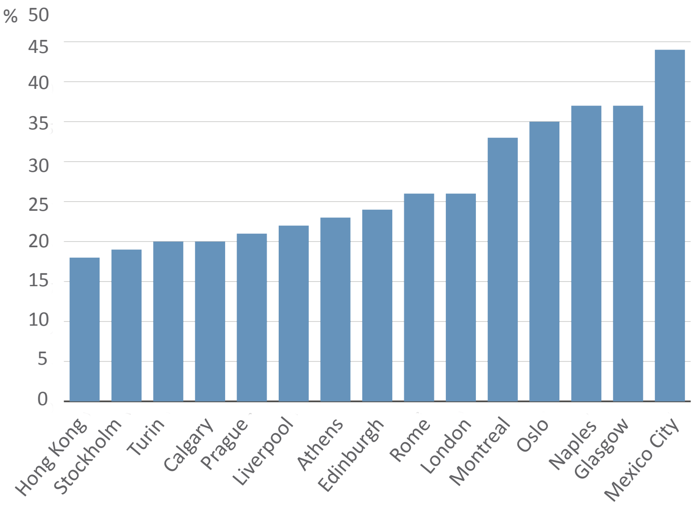
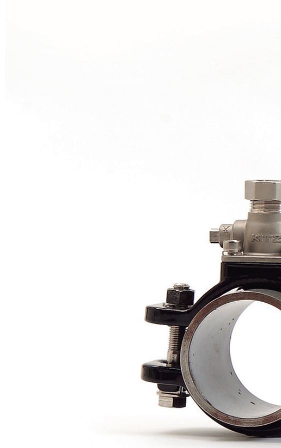
Técnica

A workable, lasting solution for water losses through leaking water pipes

Water loss through leaking water pipes is a problem for cities all over the world. Some of them are losing water at upwards 40% per year, and this is all water which has already been treated. A recent study by the OECD has shown that it is not only the under developed or even the developing cities that are so affected – even the capital cities of major economies are losing far more water than is sustainable or even viable, as the table on this page illustrates. Source: OECD 2014





Stainless steel water pipes

Material benefits

Stainless steel has high strength and is a very durable material. It is corrosion resistant, with no need for painting other protective layers.

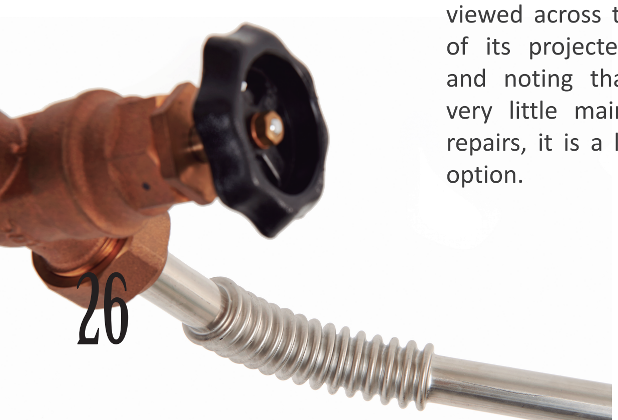
Stainless steel is exceptionally wear resistant. It has a hard, smooth surface, making it more difficult for bacteria to adhere and grow. Stainless steel has played a key role in the production, preparation and transport of food and drink for 100 years. It is chemically inert. The introduction of corrugated pipes minimises the risk of leaks by reducing the number of welded joints that would otherwise be necessary. A secondary benefit is that the corrugations make the pipes easier to bend on site, thus making bending in inaccessible places easier. These pipes improve productivity and are also resistant to seismic shocks.

Environmental Benefits

Over its entire life cycle, stainless steel has one of the lightest environmental impacts of all known engineering materials. At the end of its long life, it is capable of being 100% recycled to create new stainless that will be as strong and long-lasting as the original product.

Life Cycle Costing

Stainless Steel has a higher initial investment cost than many of its competing materials. However, when viewed across the full extent of its projected useful life, and noting that it requires very little maintenance and repairs, it is a less expensive option.



Stainless Steel Corrugated Water Pipes

A flexible stainless steel corrugated piping system:

- avoids leaking at joints,
- reduces the number of joints and
- resists seismic shocks.

The 3 following actions to managing leaking pipes are:

1º To replace the existing pipes with stainless steel ones.

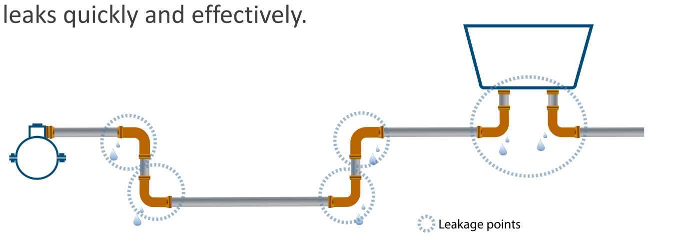
2º To introduce a secondary management system, improving the rate of detection of recurring leaks.

3º There must be a rapid response team that works around the clock repairing the leaks quickly and effectively.

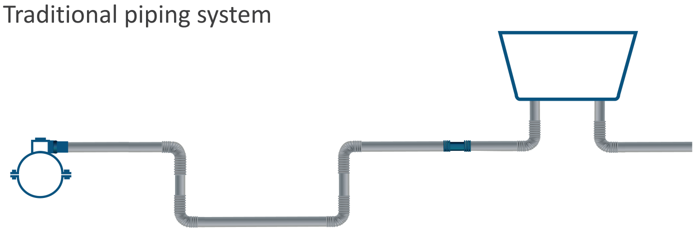
Métodos utilizados de detección y reparación mejorada para evitar fugas

- Planificación de la detección: cada área de servicio se divide en bloques y cada bloque se inspecciona sistemáticamente.

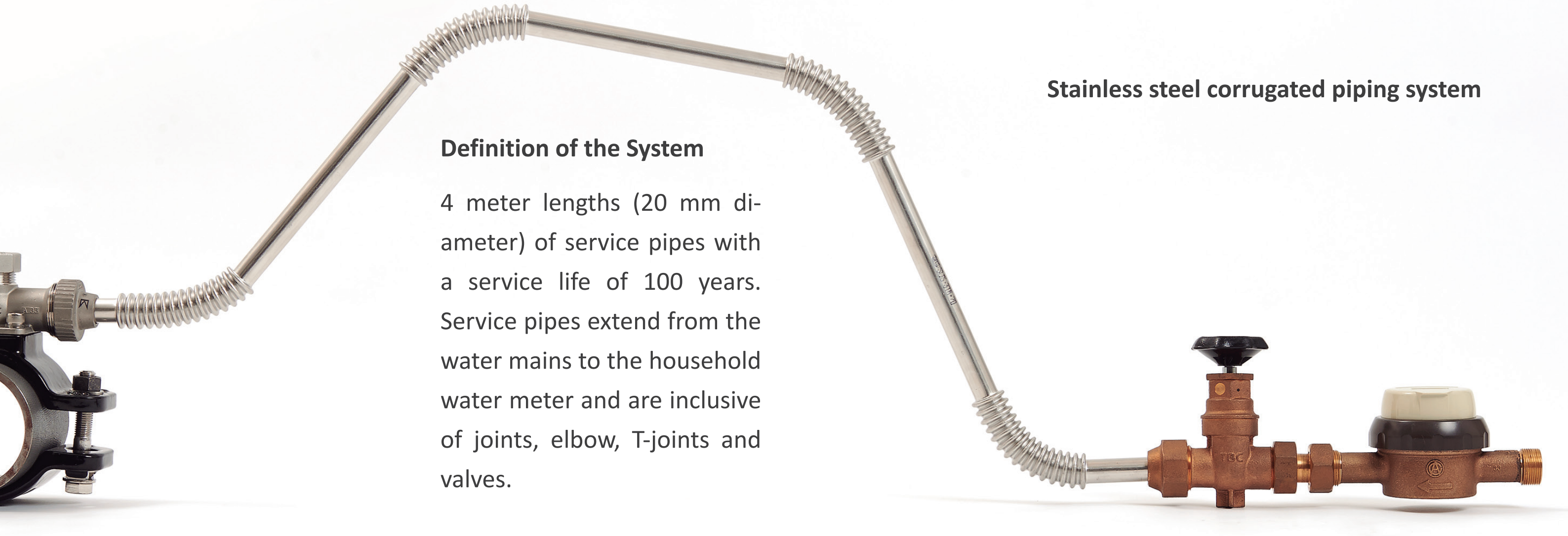
- Planificación de reparación: la respuesta a un informe de escape es inmediata. Equipos listos 24 horas, 365 días del año.



Traditional piping system



Stainless steel corrugated pipes

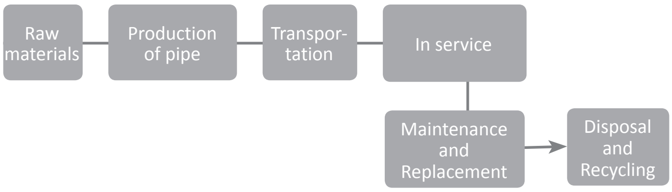


Stainless steel corrugated piping system

Definition of the System

4 meter lengths (20 mm diameter) of service pipes with a service life of 100 years. Service pipes extend from the water mains to the household water meter and are inclusive of joints, elbow, T-joints and valves.

The LCC analysis was calculated from cradle to grave:



Assumptions	AISI 316	PVC	PE
1. Service life (years)	100	20[1]	20[1]
2. Real interest rate (%)	0.27[2]		
3. AC ($) for a 4 m corrugated pipe (included parts)	297[3]	89[3]	67[3]
4. IC[3] ($) incl. labour costs	1,683		
5. OC	Assumed to be 0 (but maintenance and downtown costs exits in practice. Minimising that disruption is important)		
6. LP			
7. RC[3] ($)	1,981 $/ 100 years	1,772 $/ 20 years	1,750 $/ 20 years
8. Residual value (recycled scrap)[4]	100 $/ 100 years	0 ($)	0 ($)

(1) from Seoul Waterworks

(2) from IHS Markit

(3) from Incheon (South Korea) example

(4) Stainless steel is capable of 100% recycling

Life Cycle Cost Formula

All Costs Are at Present Value

Total life cycle cost (LCC)	Initial materials acquisition costs (AC)	Initial materials installation & fabrication costs(IC)	Operating & maintenance costs (OC)	Lost production costs during downtime (LP)	Replacement materials costs (RC)
LCC	AC	IC	$\sum_{n=1}^{N} \frac{OC}{(1+i)^n}$	$\sum_{n=1}^{N} \frac{LP}{(1+i)^n}$	$\sum_{n=1}^{N} \frac{RC}{(1+i)^n}$

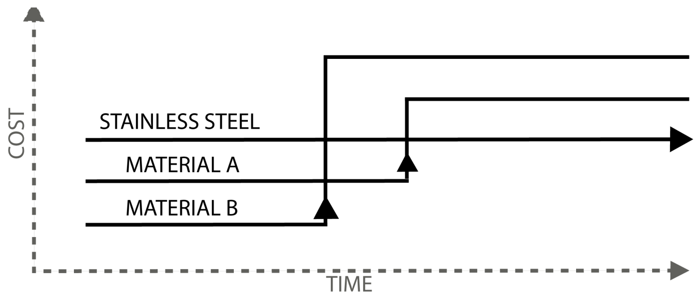
Where: N = Actual Service Life, i = Real interest rate, n= Year of the event

Cost diagram for each material

The analysis of the Life Cycle Cost for grade 316 stainless steel illustrates that it is a less expensive product when viewed over its useful life.

Alternatives which were tested by the Tokyo Water Board are shown to have a shorter life cycle and therefore a higher cost.

Duration	Stainless steel	PVC	PE
100 years	1,932 $	7,978 $	7,878 $



Schematic representation showing the cost of alternate materials A and B substantially increases over time while the cost of stainless steel remains constant.

FUENTE / *SOURCE*:

www.worldstainless.org

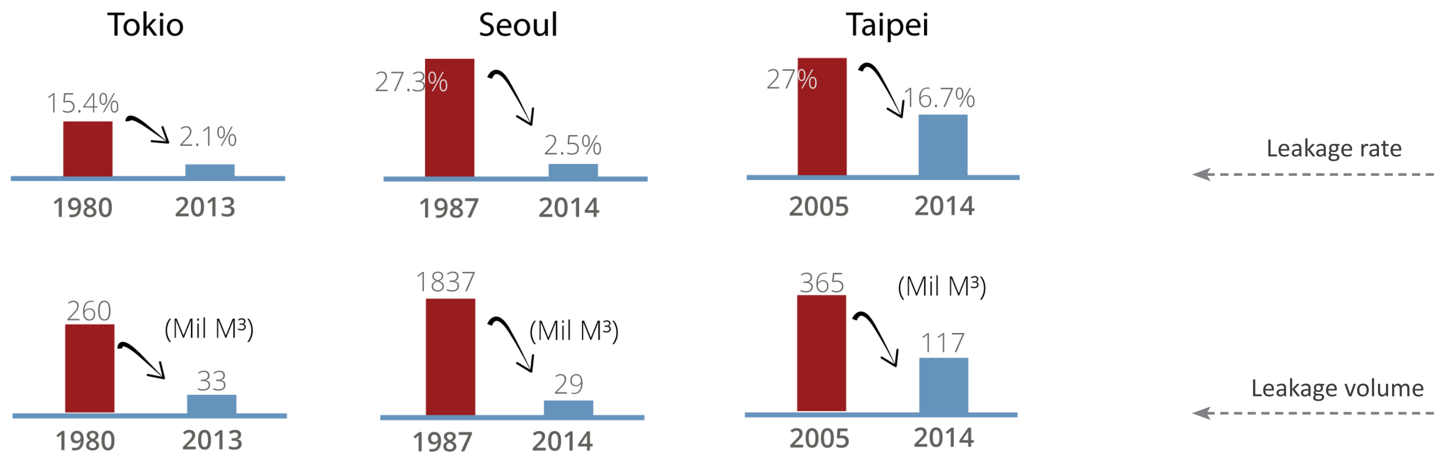
www.cedinox.es

PDF:

A Workable, Lasting Solution for water- Losses through Leaking Water Pipes

(only English)

Results of the projects in Tokyo, Seoul and Taipei



Stainless Steel Water Pipes in Tokyo

Tokyo	1980	2013
Population (mil)	11.6	13.3
Distributed volume (mil/m³)	1,692	1,523
Leakage (mil/m³)	260 15.4%	33 2.2%

Major Challenges:

- Critical water shortages.
- Leaking water pipes.
- High chloride ion content in the soil.
- Concerns about maintaining a good waterquality.
- Susceptible to severe seismic shocks.
- Severe localised flooding around the area of leaks, even causing some roads to collapse.

Why was 316 chosen over 304?

The Tokyo Water Board chose the higher alloyed grade 316 stainless steel for its improved corrosion resistance following extensive ground testing.

They said that it was selected because they wanted the best available material. The cost of the material was less important than strength and durability because security of water supplies was the most important consideration.

Underground burial tests

To check the corrosion behaviour of the pipes and to collect data on their corrosion resistance, the Tokyo Water Board commissioned tests using pipes made from a number of competing products, by burying them underground at 10 different sites, for a period of 10 years.

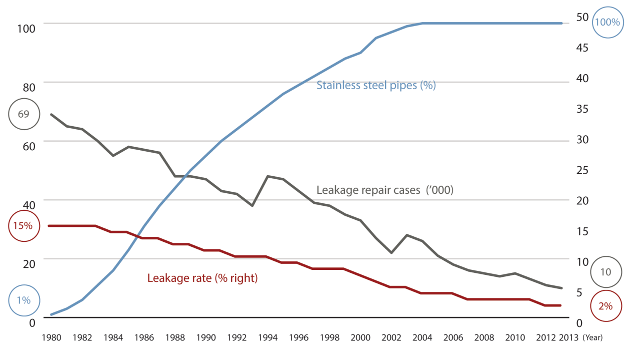
The tests showed that stainless steel had performed better in terms of strength and corrosion resistance with grade 316 performing better than 304. The Cl^- and SO^2 concentrations in the soil were very high. The tests showed no evidence of pitting corrosion on the 316 samples.

316 is a higher alloyed grade and therefore more expensive than 304, but the Tokyo Water Board decided that the greater cost is the cost of laying the pipes and that the risk of failure could not be tolerated because of a potential water shortage. The difference was economically justifiable.

Corrugated Stainless Steel Pipes

The Tokyo Water Board discovered that many of their leaks had occurred at joints. The use of corrugated pipes allowed the installers to bend the pipes to the required shapes, thus reducing the need for joints and elbows, but it also allowed the pipes to remain more flexible after installation, and therefore more capable of resisting seismic shocks.

This point was well proven after the Great Sendai Earthquake which struck the Northeast Coast of Honshu Island on 11 March 2011, with a magnitude of 9.0, which made it one of the strongest earthquakes ever recorded. Tokyo City lies on the boundary between the areas demarcated as having a strong to very strong This point was well proven after the Great Sendai Earthquake which struck the Northeast Coast of Honshu Island on 11 March 2011, with a magnitude of 9.0, which made it one of the strongest earthquakes ever recorded. Tokyo City lies on the boundary between the areas demarcated as having a strong to very strong impact (the earthquake was felt as far away as Beijing). After this incident inspections revealed that only 5% of the stainless steel pipes which had been installed were damaged. Tokyo tested corrugated stainless steel pipes from 1991 to 1998, before introducing them for all installations from 1998. In the early stages of testing, they used bronze fittings and discovered a risk of corrosion in the area of the joints. They therefore specified stainless steel for all joints, elbows, T-sections, valves and other fittings. The advantages provided by the use of stainless steel pipes were a reduction in the number of leaks; reduced maintenance; improved water quality; and a proven resistance to seismic activity. The Tokyo Water Board has found no evidence of chemical residue deposits inside the pipes they have inspected.



Reduction of leakage in Tokyo

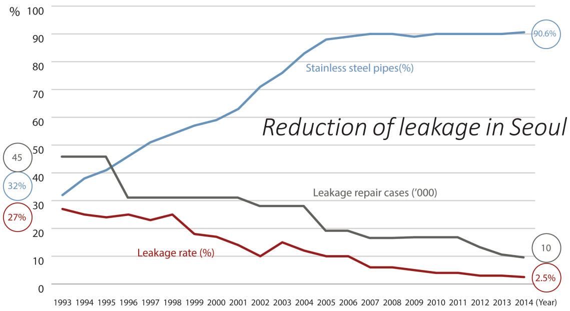
Stainless Steel Water Pipes in Seoul

Seoul Waterworks in Figures (2014)
Service population: 10.3 million
Annual distribution volume: 1,169 million m³
Water leakage rate: 2.5%

Seoul began to replace its water pipe lines in 1984. 95.6% of the pipes have been replaced so far. The total replacement (13,720 km) will be finished by 2018.

Stainless steel was used to reduce corrosion, improve water quality and to reduce water losses through leakage because of its superior strength. From 1987 to 1993 stainless steel and copper pipes were used together, but from 1993 only stainless steel has been used. From 2001 corrugated pipes were introduced to reduce joints and to make assembly easier on site. Seoul discovered that the reduction of water losses, together with the improvement in water quality meant they could reduce the number of water treatment plants from ten to six. Even though the project still has one year left to run. This has enabled the city to reduce the number of repairs from 60,000 to 10,000 cases per year. It has also allowed the city to reduce its total water production from 7.3 mil m^3/day to 4.5 mil m^3.

Seoul considered alternative materials, but their tests demonstrated that stainless steel was the preferred option. Contrary to the experience of their mentors, the Tokyo Water Board, Seoul decided to specify grade 304 stainless steel. First, because their soils were shown to be less aggressive than those in Tokyo and second because 304 is a less expensive material. Following the example of the capital, other Korean cities like Daegu, Incheon, Daejeon and Ulsan have also started to use stainless steel for their service pipes.



Stainless Steel Water Pipes in Taipei

Service Population: 3.88 million
Daily Distribution Volume: 2.26 million m³
Daily Supply to Service Area: 1.97 million m³
Leakage rate: 28.4% (2002)

In 2002 the level of water supplies to Taipei became dangerously low. With a 28.4% leakage rate in the pipelines, plus only half of the average rainfall, it resulted in a 49-day intermittent water supply. Taipei originally wanted only to expand the water supply, instead of controlling the water losses. This resulted in a complicated pipeline system, which had aged and was leaking.

A leakage management project was planned to be finished in 4 phases within 20 years. This should improve the performance of the pipelines, reduce the water loss and prevent water shortages like the one in 2002.

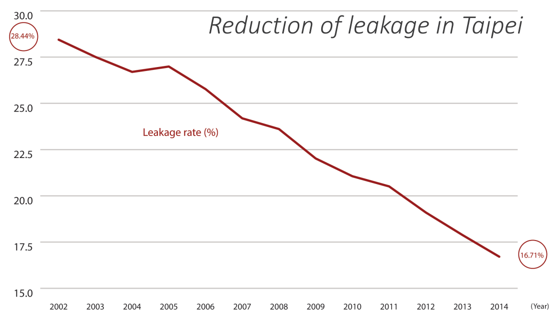
Year	Rain fall over Feitsui Reservoir (mm)	Fetsui Reservoir Storage (%)	Leakage rate of TWD's* network (%)	Annual Water Supply to TWD* (x100 mil/m³)	Annual Water Supply to TWC* (x100 mil/m³)
2002	1377	+58	+28.44	8.78	0.74
2014	1201	+92	+16.70	6.99	1.23
Difference	-176	+34	-11.74	-1.79	+0.49

*TWD: Taipei Water Department
**TWC: Taipei Water Corporation

Results

Even though only 35% of the pipes have been replaced so far, an excellent result already became apparent during the 2014 drought. That year had 13% less rainfall than during the previous drought in 2002, but there was no interruption to the water supply, thanks to the vast improvement in the leakage rates.

With the leakage rates reduced by more than 10% already, the water savings have been 1.79 billion m³ per year. Water losses were at 365 million m³ in 2005 and were down to 219 million m³ in 2014. The target leakage rate of 10% should be reached by 2025.



A model South African Case Study

Drakenstein Municipality in the Western Cape is a frontrunner in the use of stainless steel water piping. It uses grade 316 stainless steel in its underground network and grade 304 in above-ground applications. It has chosen to do this as it believes it is illogical to place pipes in the ground that will need constant maintenance due to corrosion.

It currently has a 13.4% water loss figure, as compared to other municipalities' average water loss of 39% and says its figure will only improve as it continues replacing inferior fittings over the years.

Many cities and municipalities discount the use of stainless steel for water pipes due to the initial cost, however, a full analysis proves that not only is it the best material of choice, but when factoring in the total life of the project it is also a very cost effective solution. A sensitivity analysis was done over a duration of time with regards to interest rate fluctations. These showed that stainless steel has the cheapest LCC using net present values up to a maximum real interest rate of 11.93%. Furthermore, even if the plastic pipes lasted 50 years, rather than 20, they would still be 1.7 times more expensive than 316 stainless steel.