

A corrosion study of the effects of copper and silver ionisation on galvanised pipes.

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Introduction

- Copper and silver ionisation (CSI) used in drinking water, cooling towers and process waters, primarily for Legionella control
- As a biocidal concept it has been in existence since the 60's
- Originally developed by NASA for sanitising water in space for the Apollo missions

Holland Water

- Copper and silver ionisation since – 2003
- Uses separate electrodes and patented electronics which are unique in the industry to deliver accurate dosing of 400 µg/l Cu and 40 µg/l Ag
- Remote online monitoring
- Active R&D and innovation (Silco sensor, Cosirec, miniturised dosing equipment)
- Approx. 400 installations in NL, BE, IT, PL, UAE

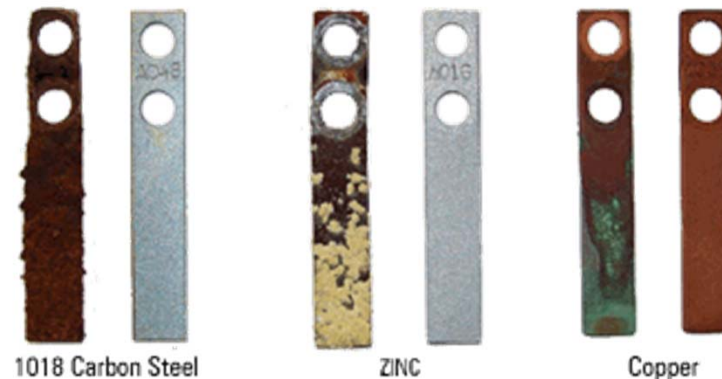
Corrosion in Zn galvanised water pipes



- Many different types of corrosion
- Common major types: galvanic, localised (pitting/crevice etc), biological, mechanical
- Copper known to cause galvanic corrosion, normally when joining galvanised pipes.

Problem?

- Suggested that CSI causes corrosion in galvanised pipes of drinking water networks*
- Deposited Cu on the coupons caused extensive corrosion, especially after shut down.



- × Not a dedicated corrosion study but focused on Legionella control
- × Outdated technology used in lab circulation loop
- × Used alloy electrodes, shown to be less accurate⁺
- × Cu concentrations not measured using a standard method and Ag not measured.
- × Uncontrolled dosing, leading to Cu concentrations ~ 2000 ppb

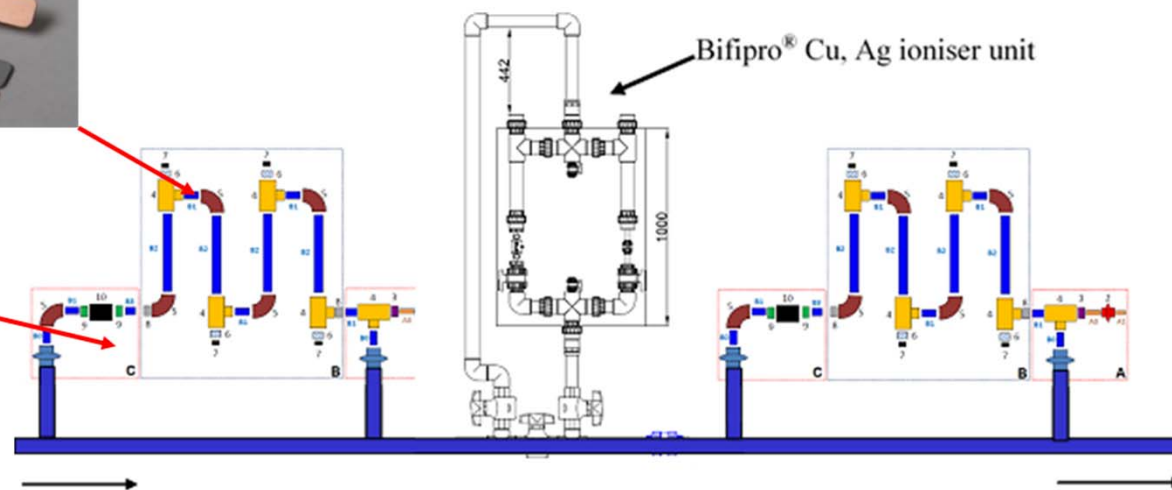
* Loret *et al*, Journal of Water and Health, 2005.

⁺ Walraven *et al*, Journal of Water Process Engineering, 2015

Solution!

- Create a setup to investigate the reported problem in a real-life scenario
- Careful design to equalise all types of corrosion except for CSI on the coupons

CC1



- Data logger recording the flow and temperature every 5mins from both racks.

*Performance
for life*

Dia 5

CC1

Do we have a real picture of our coupons?

Conrad Chapman; 27-7-2017



Bifipro® (CSI) installation for 30,000
m³/year



Corrosion racks with hot dipped galvanised steel coupons
(UNS G10100 and ASTM D7091)



Flow data

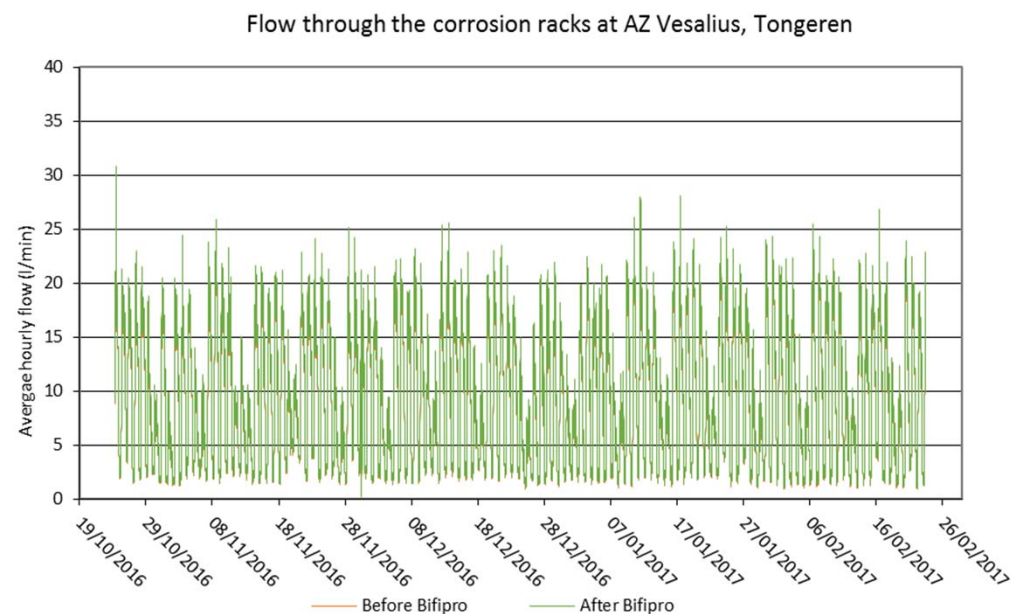
Start date: 19/10/2016

End date set 1: 16/12/2016

End date set 2: 23/2/2017

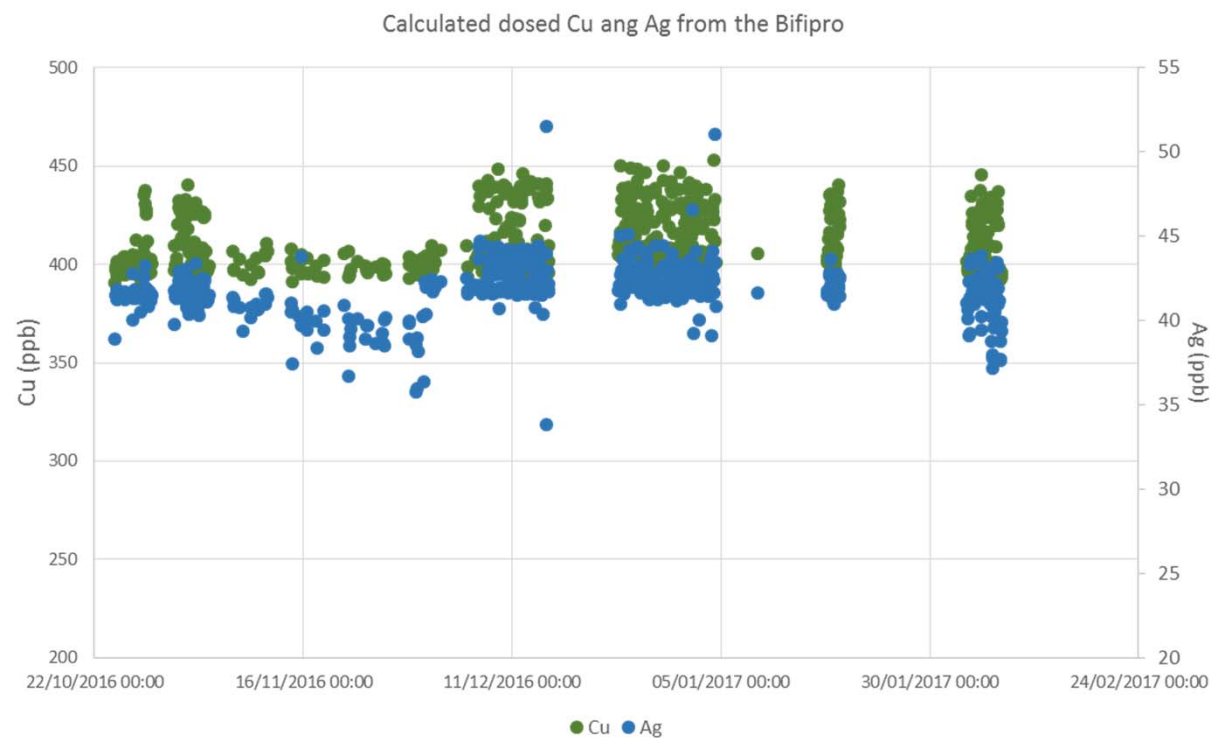
Test duration: 122 days

Rack before Bifipro®	Rack after Bifipro®	Bifipro®	Unit
9.2	9.4	57.1	l/min average
1613.7	1651.6	10436	m³ total passed
44.6	52.9	233	l/min top flow



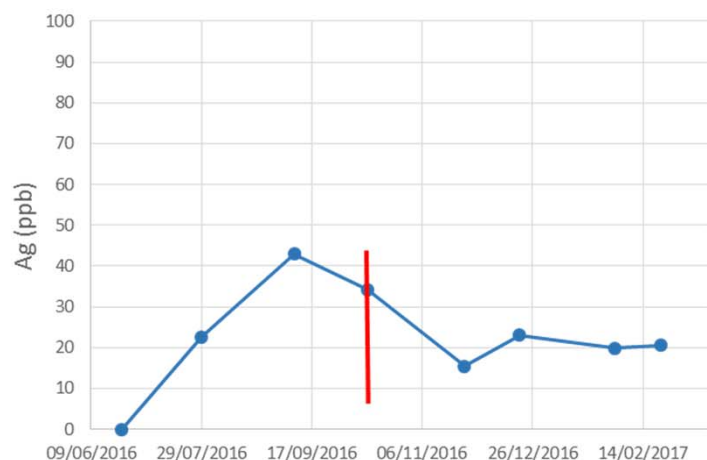
CSI output

CSI turned on:
24/6/17

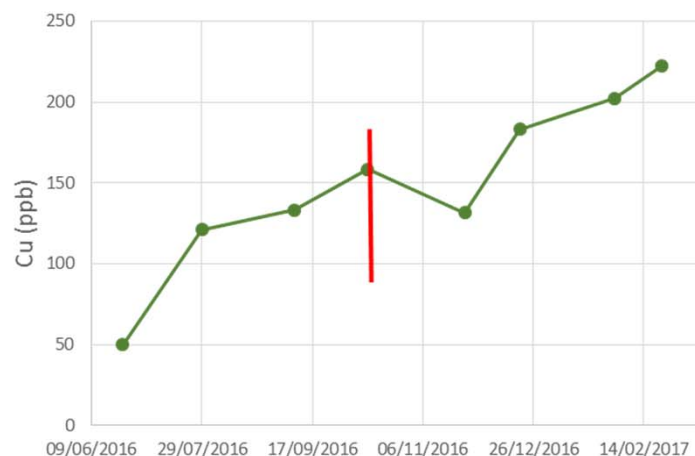


Lab data from building tap points

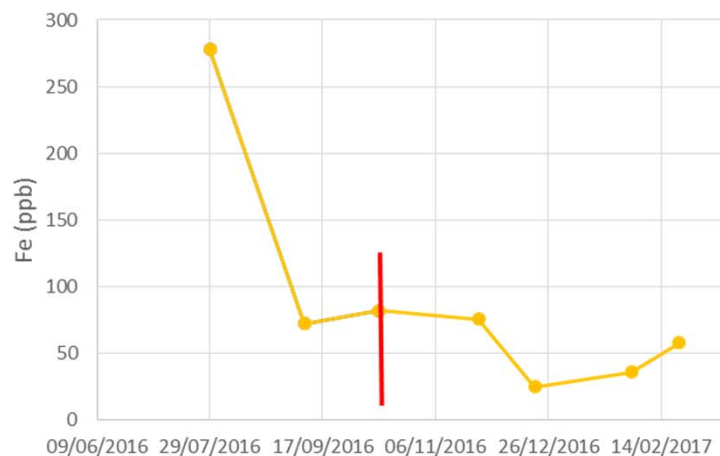
Ag concentrations from lab samples




Cu concentrations from lab samples



Fe concentrations from lab samples



 = Start date

The coupons



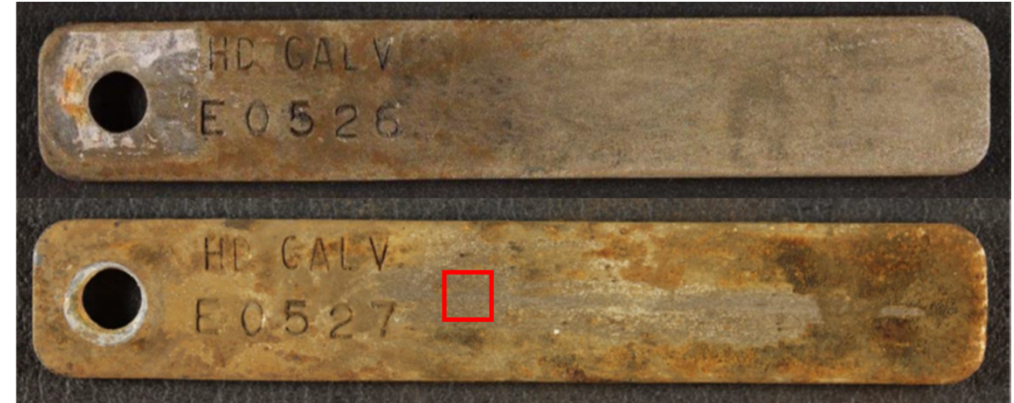
Before CSI unit

Top: after 58 days

- Red iron rust 70% coverage
- Corrosion rate (after chemical cleaning) **0.11 mm/year**

Bottom: after 127 days

- 80% red iron rust coverage
- Corrosion rate (after chemical cleaning) **0.08 mm/year**
- Corrosion rate (after mechanical cleaning) **0.11 mm/year**
- Rust layer was extensive which could not be cleaned off with chemicals
- Localised loss of Zn layer



After CSI unit

Top: after 58 days,

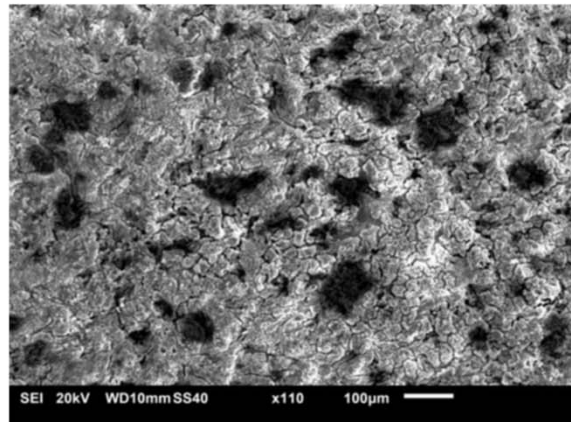
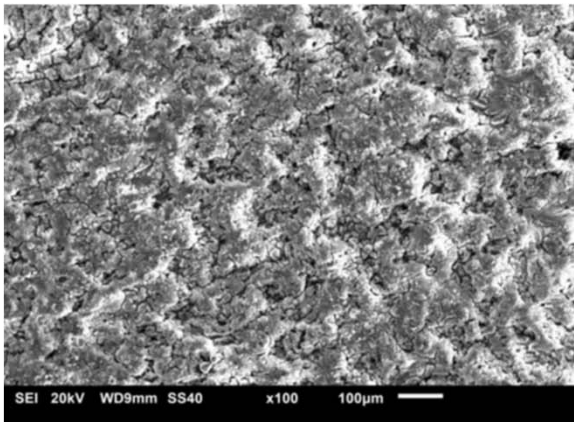
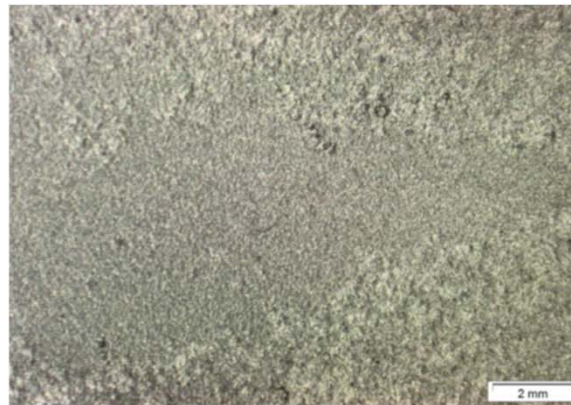
- Red iron rust 20%, 7% Ag
- Corrosion rate (after chemical cleaning) **0.14 mm/year**

Bottom: after 127 days,

- 60% red iron rust, 20% Ag
- Corrosion rate (after mechanical cleaning) **0.11 mm/year**
- More uniform corrosion layer
- Corrosion layer more superficial

*Performance
for life*

Microscopy after 127 days

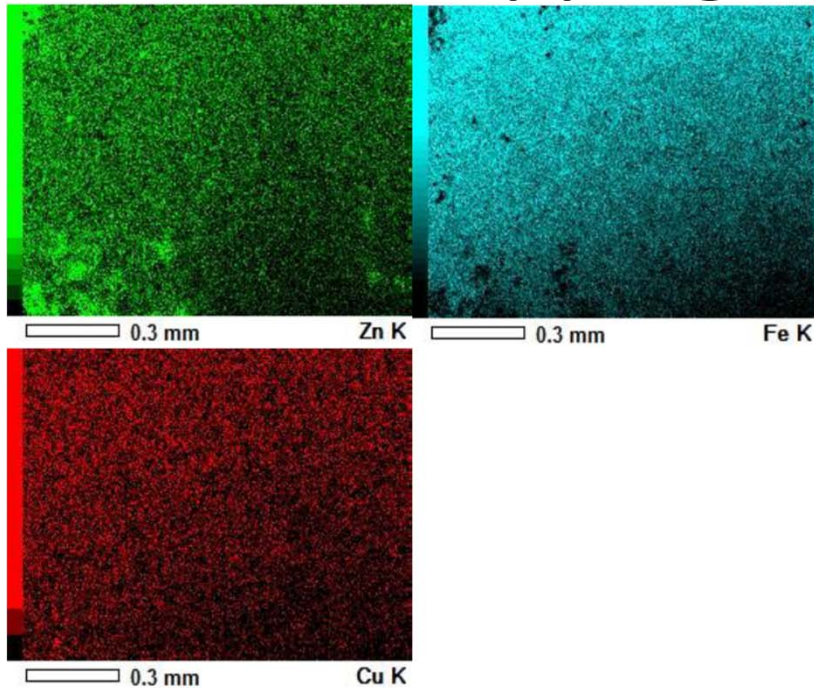


Before CSI

After CSI

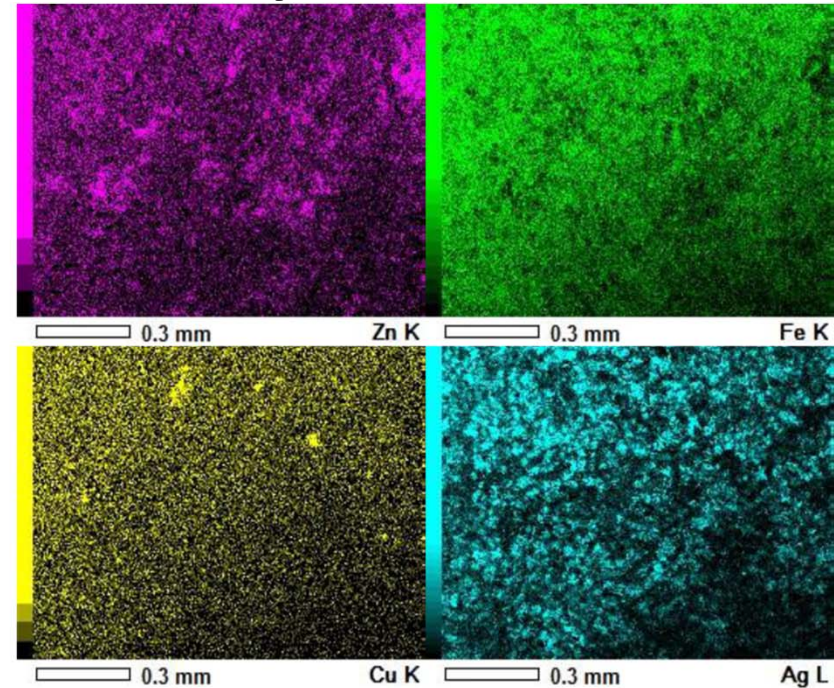
- More localised pitting on the before coupons
- Visual evidence of the Ag build up using SEM

EDX mapping after 127 days



Before CSI:

- Cu <0.5 ms%
- Fe 36 ms%
- Zn 8 ms%



After CSI:

- Cu 4 ms%
- Ag 20 ms%
- Fe 23 ms%
- Zn 6 ms%

Conclusions

- The equipment provided the correct amount of Cu and Ag
- Corrosion setup was successful at:
 1. Allowing a detailed study on the effects of CSI in drinking water on galvanised steel pipes
 2. Providing stable, well defined conditions for the experiment.
 3. Neutralised any significant effects from other corrosion types.
- Corrosion rates the same after 127 days (11 mm/year)
- Minimal coverage (4%) of pipes with Cu
- ✓ Strong signs of corrosion abatement from the Ag coating the pipes.
- ✓ CSI using the Bifipro's® unique combination of separate electrodes and sophisticated electronic control does not enhance the natural corrosion rate



ctgb

