Hydrogen in sprinkler systems

Experiences from a field study

Fire Sprinkler International in London, 1st June 2022

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Presentation

01 Introduction …

- 2014: First investigations because of high pressure increases in sprinkler systems (> 25 bar / > 360 psi)
- Deflagrations and explosions in Northern Europe
- Incidents in Germany
- International bans for internally galvanized pipes in sprinkler systems

All currently known and investigated incidents happened on wet sprinkler systems with internally galvanized pipes during maintenance or modifications

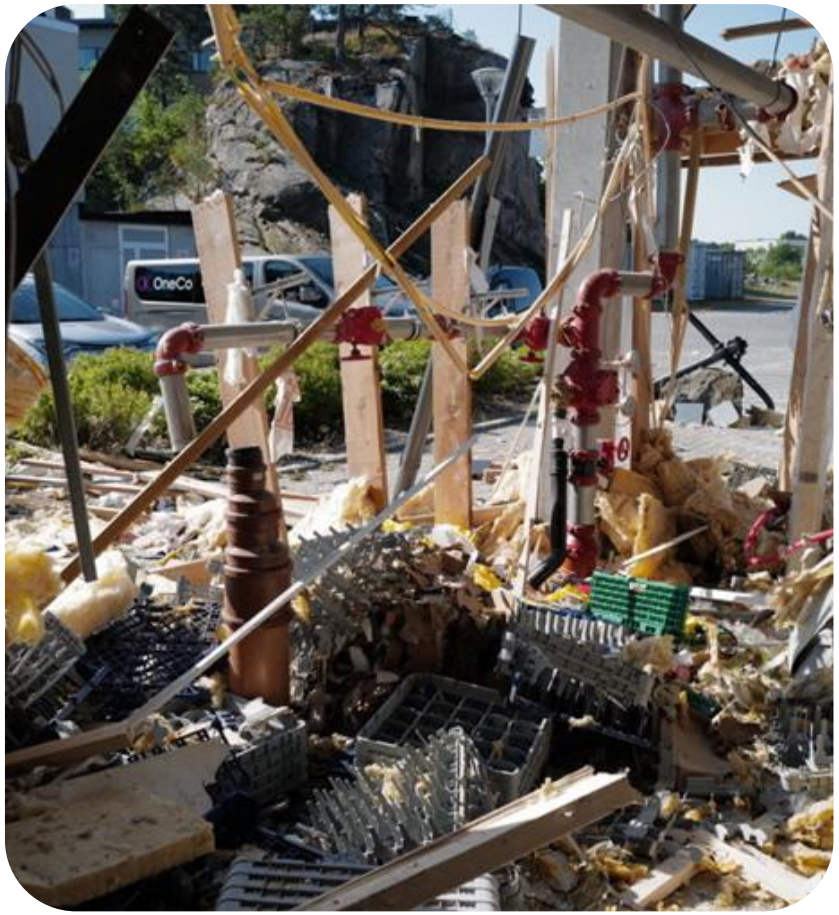
2.2.1.3 Use Schedule 40 (or equivalent thickness) pipe for wet, dry, and pre-action systems installed over occupancies deemed sensitive to leaks.

2.2.1.4 **Do not** install steel pipe that has been internally galvanized in a wet-pipe sprinkler system. See Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, for additional recommendations regarding discharge through a sprinkler system's main drain and its inspector's test connection.

2.2.1.5 Check sprinkler systems that exhibit pinhole leaks or show other signs of corrosion (scale, tubercles, or other deposits) for obstructed waterways in pipes, valves, and sprinklers in accordance with Data Sheet

Source: FM Global Property Loss Prevention Data Sheet 2-1 October 2021, page 3

01 … & Motivation



Source: Brennaktuelt.no: Brann-brannsikkerhet-eksplosjon, Kristiansand (Accident happened on June 15th, 2020)

Could this happen in Germany, too?

02 What we know

Hydrogen can form in black pipes, too.

Problem with zinc is its higher reactivity.

$$Zn \rightarrow Zn^{2+} + 2e^- \quad (1)$$

$$O_2 + H_2O + 4e^- \rightarrow 4OH^- \quad (2)$$

$$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2 \quad (3)$$

$$2H_2O + 2e^- \rightarrow H_2(g) + 2OH^- \quad (4)$$

Environmental influences

Temperature

Potential equalization / grounding

Water quality

pH value

Hardness

Impurities

Salinity

Dissolved CO_2

Patina

Zinc carbonate $ZnCO_3$ and zinc oxide ZnO

Exposure time

02 Theory – Why problems now?

Maintenance valves

Sprinkler water remains longer in pipes

→ Hydrogen corrosion takes over

Quality of zinc coating

Electrochemical-

vs.

Hot dip galvanzied

→ Intermetallic phase

Media

Digital age

Social networks

→ Fast and global distribution of information

03 Measurements during „25 Year Inspection“

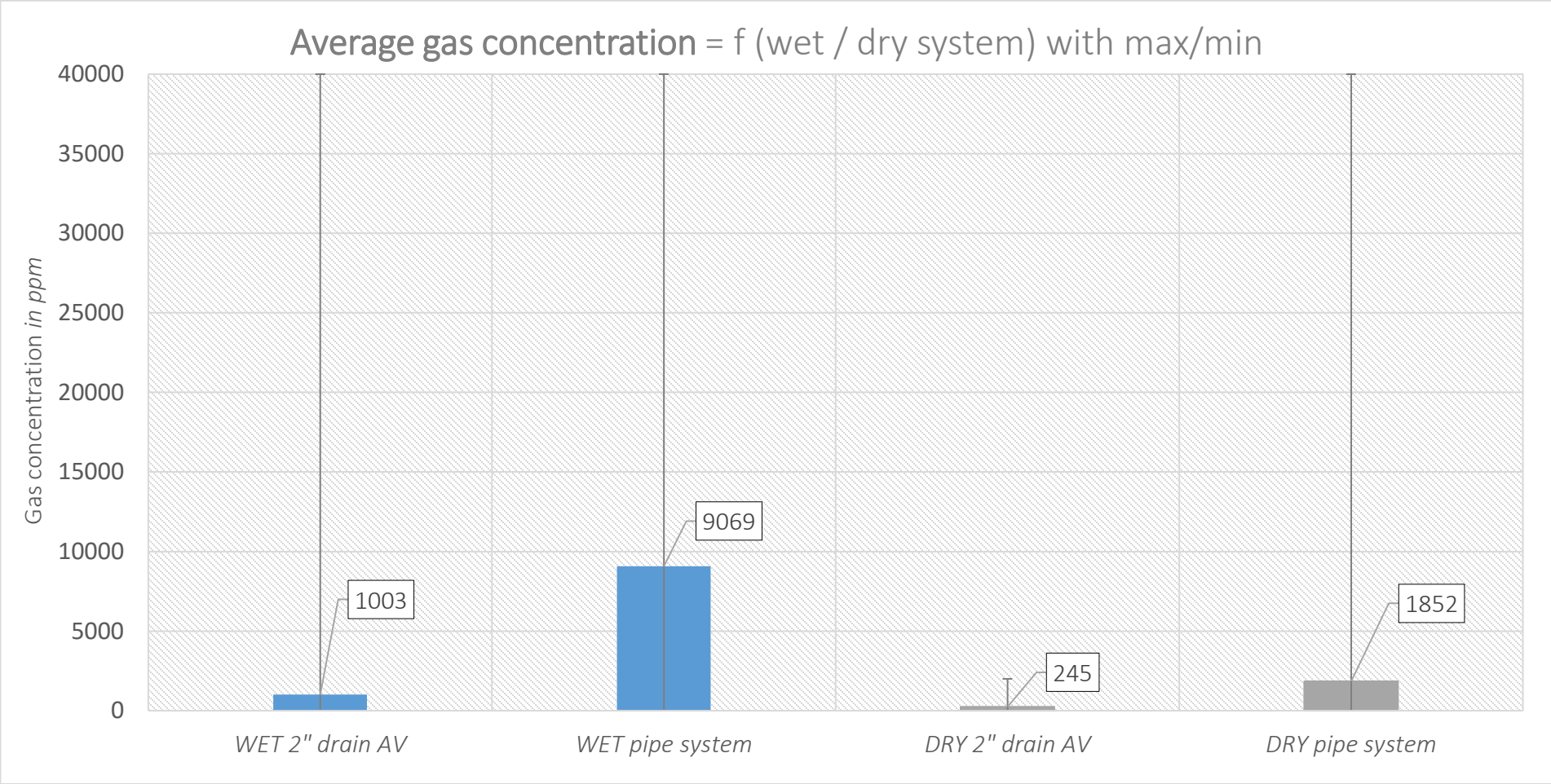
Problem: Corrosion itself is very complex

Idea: Measure a lot – minimize mistakes

- Evaluating amount of zinc pipes in the system
- Measure pH
- Measure gas concentration (Alarm valve + ceiling)
- Technical gas analysis (depends on concentration)

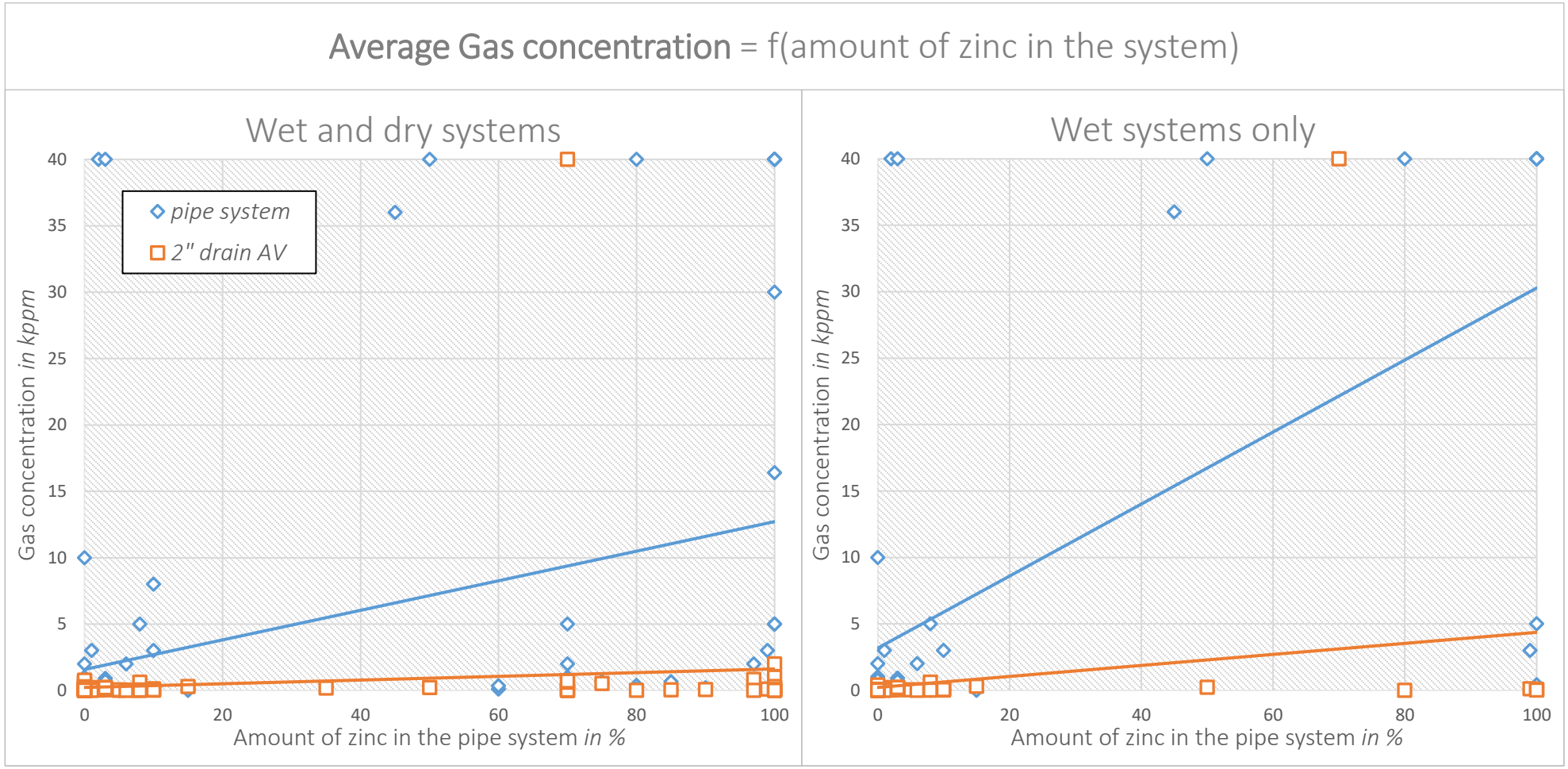
Thank you to my colleagues at VdS and to bvfa BUNDESVERBAND TECHNISCHER BRANDSCHUTZ e.V. for helping to collect data.

04 Results (1/4)



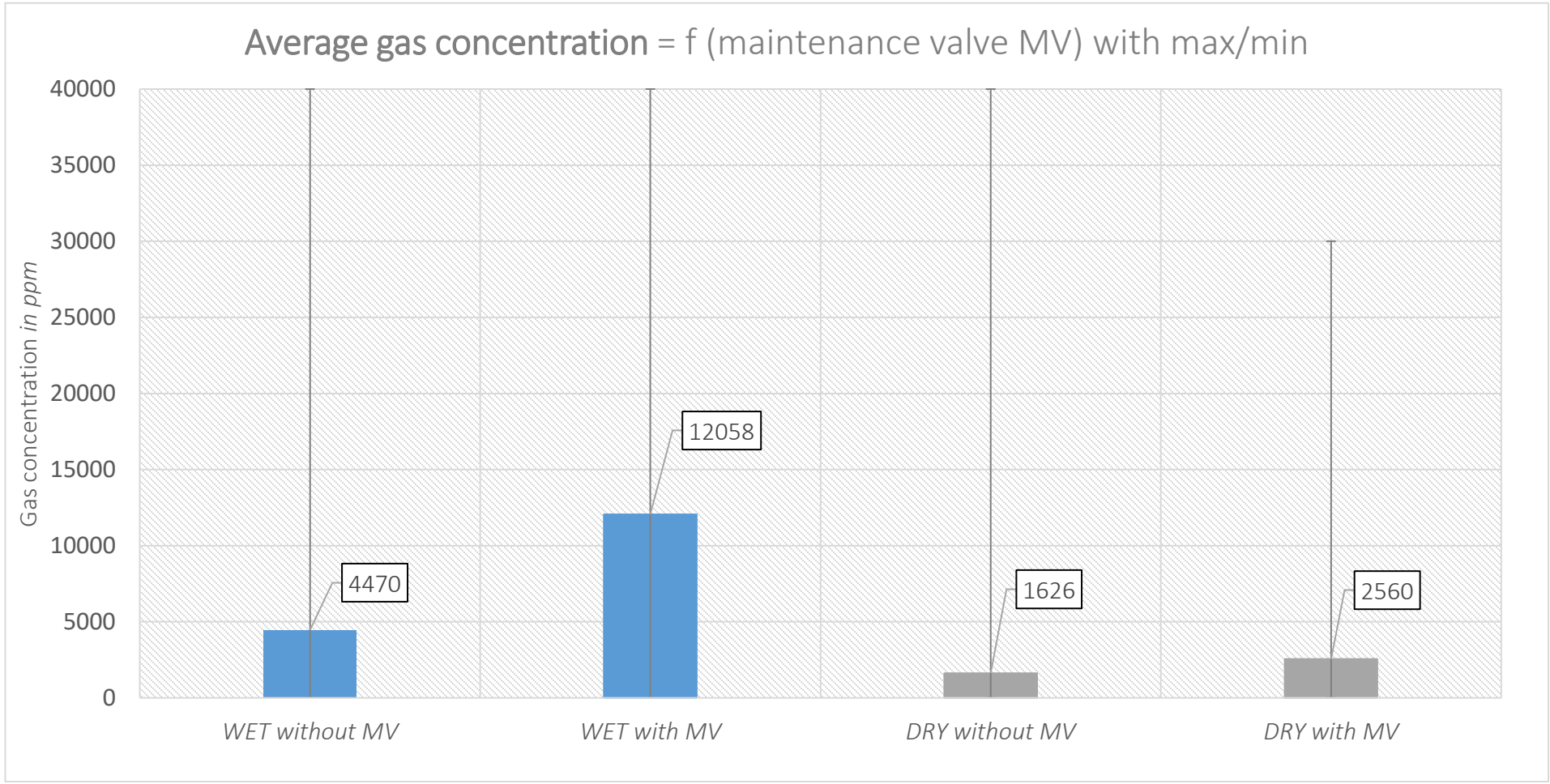
1 Vol.-% = 10.000 ppm // LEL H_2 in Air = 4,0 Vol.-% = 40.000 ppm

04 Results (2/4)



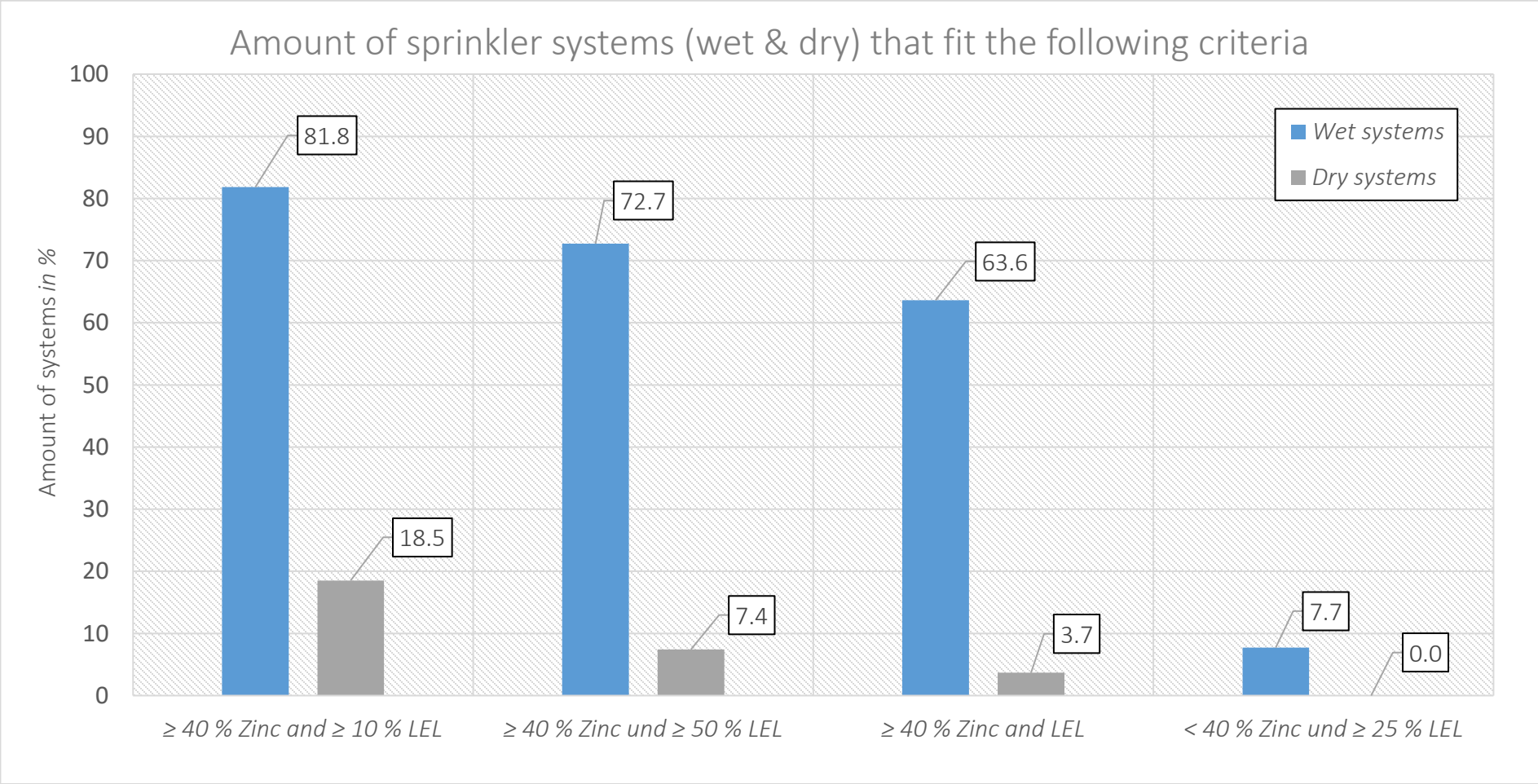
1 Vol.-% = 10.000 ppm // LEL H_2 in Air = 4,0 Vol.-% = 40.000 ppm

04 Results (3/4)



1 Vol.-% = 10.000 ppm // LEL H_2 in Air = 4,0 Vol.-% = 40.000 ppm

04 Results (4/4)



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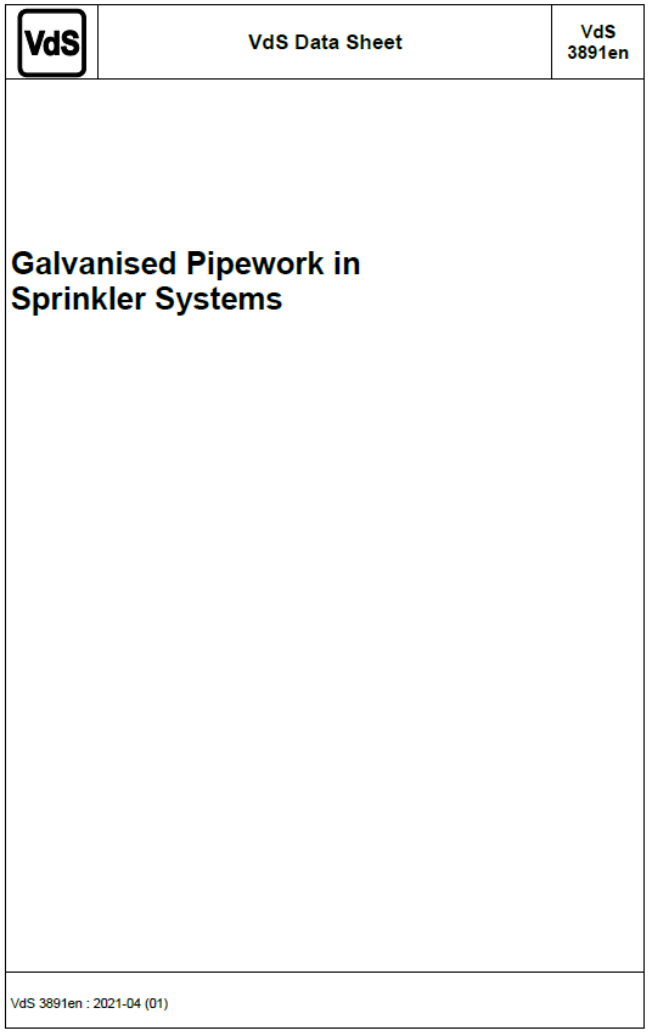
05 Summary

- Very critical measurements directly on / in sprinkler pipes
- Indipendent from sprinkler system: Higher gas concentrations in systems with zinc coated pipes
- Max. concentrations usually at the highest points (e.g. ceiling)
- In dry systems with higer concentrations we also found high amounts of residual water
- Maintenance valves seem to have an influence on gas evolution

Zinc is one piece of the puzzle.

06 Outlook

- Continue field tests
- More technical gas analysis on interesting sprinkler systems
- Testing / experiments based on recents findings
- Intensify international exchange since we are all still learning
- Improve our publications



Source: https://shop.vds.de/publikation/vds-3891en

Thank you very much for listening.

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