Steel Pipes for Automatic Fire Sprinkler Systems from the pipe manufacturer’s point of view.

FG-sprinklerkonferansen 2015, Oslo

J. Ortner, 18.3.2015
Topics

2. The variety of standards & approvals in regard to sprinkler pipes.
3. Sprinkler steel pipes on the test bench (e.g. FM, UL and LPCB).
4. Quality management & control in the production process.
5. The \textit{WGalweld} pipe from Wuppermann compared to a traditional galvanized pipe.
The Wuppermann Group

- Wuppermann AG (*)
  Leverkusen / DE

  - Business Unit Technical Products
  - Business Unit Flat Products
  - Business Unit Service & Consulting

(*) 100% family owned
Product Overview
Business Unit Flat Products

Commercial flats & specialities

- Pickled hot-rolled flat products
- Hot-dip galvanized strips
- Zinc-magnesium coated strips
- Polyolefin-film-coated galvanized strips
- Pre-punched strip with zinc-coated edges
- Cold re-rolled & edge-dressed strips
Product Overview (small excerpt)
Business Unit Technical Products

Steel tubes & Sheet Metal Components:

- Black & pickled tubes and profiles
- Stainless steel tubes & processing
- Perforated tubes
- Sheet metal assemblies
- Galvanized tubes & profiles

- \textit{WGalweld}, galvanized pipe with the fully galvanized inner weld
Facts and Figures of Wuppermann Group

2014
Employees: > 1,300
External Sales: 550 Mio. €

2015
Production plan:
Flat products 786,000 t
Perforated tubes 12,000 t
Unperforated tubes 102,000 t
Tube & sheet-metal components 103 Mio. €
Our Locations

Austria
Czech Republic
Germany
France
Hungary
Netherlands
Poland
Romania
Sweden
Switzerland
Turkey

Wuppermann Tube and Steel AB
Göteborg

Wuppermann Austria GmbH
Judenburg
Wuppermann Austria GmbH
Judenburg, Austria

Production
• since 1989

Figures 2014
• Employees: 140
• Delivered: 111 kto
The pipe mill
The variety of regulations
Illustrating its complexity and Interplay

National Specifics
* VdS CEA (DE)
* SBF (SE)
* others

Approvals
* FM
* UL
* others

Continental Standards
* ASTM A795 (USA)
* EN 12845 (EU)
* others

The challenge for a pipe producer:
To meet all the requirements in any country!
Steel Pipes for Automatic Fire Sprinkler Systems

**Black Steel Pipe**
- Limited to *wet* pipe sprinkler systems only (i.e. FM, UL)
- Organic coated outside surface is mandatory (i.e. EN 12845, VdS)

**Galvanized Steel Pipe**
- Permitted in *wet and dry* pipe sprinkler system (i.e. UL)
- Recommended in *dry* systems (i.e. EN12845, VdS)
- Mandatory in *dry* systems (i.e. FM)
Steel Pipe Specifications

<table>
<thead>
<tr>
<th>Steel Pipe Standard (&lt;NPS150)</th>
<th>Pipe Connection</th>
<th>Steel Pipe Schedule ASME B36.10M</th>
</tr>
</thead>
<tbody>
<tr>
<td>VdS</td>
<td>Welded</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Cut grooved</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Roll grooved</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Swaged</td>
<td>✓</td>
</tr>
<tr>
<td>ASME</td>
<td></td>
<td>40</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Swaged</td>
<td>✓</td>
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</table>
## Wall Gauges

<table>
<thead>
<tr>
<th>Sprinkler pipe NPS 50 Cut Grooved</th>
<th>Standard / Approval</th>
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<tbody>
<tr>
<td></td>
<td>VdS</td>
</tr>
<tr>
<td>Wall thickness [mm]</td>
<td>3.20</td>
</tr>
<tr>
<td></td>
<td>3.60</td>
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<td></td>
<td>3.90</td>
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<table>
<thead>
<tr>
<th>Sprinkler pipe NPS 50 Roll Grooved</th>
<th>Standard / Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FM</td>
</tr>
<tr>
<td>Wall thickness [mm]</td>
<td>1.65</td>
</tr>
<tr>
<td></td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>3.20</td>
</tr>
</tbody>
</table>
**Minimal Wall Thickness (FM)**

**Threaded Pipe:**  
\[ WD_x = \text{Wall gauge under the 1st exposed thread.} \]  
\[ WD_{x40} = 1,45 \text{ mm} \] (NPS 50; Schedule 40; ASME)

**Roll Grooved Pipe:**  
\[ WD = WD_x = 1,65 \text{ mm} \] (NPS 50; Schedule 5; ASME)
Downsizing of system components

\[
6,05 \times 10^5 \quad P = \frac{C^{1.85} \times d^{4.87}}{x \ L \ x \ Q^{1.85}}
\]

- \( P \) = Pressure loss in bar
- \( C \) = Pipe friction constant
- \( Q \) = Flow rate inside the pipe
- \( L \) = Length of the pipe net
- \( d \) = Inner diameter of the pipe

**Option 1:**
- The larger the inner diameter,
- the lower the pressure loss,
- the cheaper the hydraulic system.

**Option 2:**
- A given inside flow rate,
- implies smaller nominal pipe sizes,
- means cheaper pipe costs.
# Data sheet

<table>
<thead>
<tr>
<th>NPS [mm]</th>
<th>Outer diameter [mm]</th>
<th>Wall thickness [mm]</th>
<th>Pipe weight [kg/m]</th>
<th>Working pressure [max. bar]</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>33.7</td>
<td>1.65</td>
<td>1.3</td>
<td>12</td>
</tr>
<tr>
<td>32</td>
<td>42.2</td>
<td>1.65</td>
<td>1.6</td>
<td>12</td>
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<tr>
<td>40</td>
<td>48.3</td>
<td>1.65</td>
<td>1.9</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>60.3</td>
<td>1.65</td>
<td>2.4</td>
<td>12</td>
</tr>
<tr>
<td>65</td>
<td>73.0</td>
<td>2.01</td>
<td>3.5</td>
<td>12</td>
</tr>
<tr>
<td>65</td>
<td>76.1</td>
<td>2.01</td>
<td>3.7</td>
<td>12</td>
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<tr>
<td>80</td>
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<td>2.01</td>
<td>4.3</td>
<td>12</td>
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<tr>
<td>100</td>
<td>114.3</td>
<td>2.11</td>
<td>5.8</td>
<td>12</td>
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</table>
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<tr>
<td>25</td>
<td>33.7</td>
<td>1.65</td>
<td>1.3</td>
<td>21</td>
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<tr>
<td>32</td>
<td>42.2</td>
<td>1.65</td>
<td>1.6</td>
<td>21</td>
</tr>
<tr>
<td>40</td>
<td>48.3</td>
<td>2.01</td>
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<td>80</td>
<td>88.9</td>
<td>2.34</td>
<td>5.0</td>
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<td>100</td>
<td>114.3</td>
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<td>7.2</td>
<td>21</td>
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## Approvals

<table>
<thead>
<tr>
<th>Sprinkler Piping System</th>
<th>Wgalweld™ 7</th>
<th>Wgalweld™ 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;WET&quot; &amp; &quot;DRY&quot;</td>
<td>FM</td>
<td>FM</td>
</tr>
<tr>
<td></td>
<td>NPS 25-100 (1&quot; - 4&quot;)</td>
<td>NPS 25-50 (1&quot; - 2&quot;)</td>
</tr>
<tr>
<td>UL/Ulc</td>
<td>UL/Ulc</td>
<td>in progress</td>
</tr>
<tr>
<td></td>
<td>NPS 25-100 (1&quot; - 4&quot;)</td>
<td>in progress</td>
</tr>
<tr>
<td>LPCB</td>
<td>in progress</td>
<td>LPCB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in progress</td>
</tr>
</tbody>
</table>

"Dry" also includes "Deluge" and "Preaction" systems
<table>
<thead>
<tr>
<th>Lab Tests</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FM</td>
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<tr>
<td>Corrosion-Resist. Coating</td>
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<tr>
<td>Long Term Corrosion T.</td>
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<tr>
<td>Corrosion Resistance R.</td>
<td></td>
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<tr>
<td>Salt Spray Corrosion T.</td>
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<tr>
<td>High Temperature Aging</td>
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</tr>
<tr>
<td>Low Temperature T.</td>
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</tr>
<tr>
<td>Fire Test</td>
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<tr>
<td>Chemical Compatibility T.</td>
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<tr>
<td>Air Leakage Test</td>
<td></td>
</tr>
<tr>
<td>Leakage Test</td>
<td></td>
</tr>
<tr>
<td>(✓) under certain circumstances</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab Tests</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FM</td>
</tr>
<tr>
<td>Product Documentation</td>
<td>✓</td>
</tr>
<tr>
<td>Product Data</td>
<td>✓</td>
</tr>
<tr>
<td>Marking Durability</td>
<td>✓</td>
</tr>
<tr>
<td>Hydrostatic Strength</td>
<td>✓</td>
</tr>
<tr>
<td>Bending Moment Resist.</td>
<td>✓</td>
</tr>
<tr>
<td>Hydrost. Fluct. Pressure</td>
<td></td>
</tr>
<tr>
<td>Vibration Resistance</td>
<td>✓</td>
</tr>
<tr>
<td>Rotational Torque T.</td>
<td>✓</td>
</tr>
<tr>
<td>Water Hammer T.</td>
<td>✓</td>
</tr>
</tbody>
</table>
Hydrostatic Strength (FM)

- Each NPS is tested under four times the rated working pressure.
- Test duration of 5 minutes without cracking, rupture or permanent distortion.
Bending Moment Resistance (FM)

- Each NPS is tested under rated hydrostatic working pressure of **12 bar**.
- Leakage, fracture or coupling pull off must not happen!
Vibration Test (UL)

- After the vibration exposure, the assembly is to be subjected to the Leakage Test.
- Leakage Test: 1 Minute, two times the rated pressure, no leakage!
Quality standards at Wuppermann – taken for granted

✓ Certified according to ISO 9001:2008 and ÖNORM EN ISO 3834-3
✓ Pipe standards: EN 10.217-1 / ASTM A 795
✓ Galvanizing standards: EN 10.346 / ASTM A 53
✓ CE conformity according to EN 10.217-1
✓ Test report according to EN 10.204 - 3.1
✓ Certified welders according to ÖNORM EN ISO 14732:2013
✓ Certified NDT-personnel according to ÖNORM EN ISO 9712
Wuppermann Production Process

- Entrance data
  - * Thickness (Isotope gauge; continuously)
  - * Width (inspection plan)

Strict Process Control

- Raw material
  - pickled hot rolled wide strip

- Slitting into thin strips

- Continuous galvanising of the slit strip
  - * Regulation of the zinc layer (air knife; continuously)
  - * Total thickness of the strip (Isotope gauge; cont.)
  - * Width of the galvanized strip (inspection plan)
  - * Zinc layer (magnetic inductive; inspection plan)
    - (stripping test; inspection plan)
  - * Zinc adhesion (ball-, folding test; inspection plan)
Roll forming & high frequent welding of the galv. strip to a round pipe

Thermal post galvanizing of the weld seam (inside & outside)

Pressure Test

Roll-grooving

* Pipe geometry (diameter, lengths; insp. plan)
* Weld seam (Eddy current test; continuously)
  (Thermographic test; continuously)
* Flattening test (inspection plan)
* Zinc layer weld seam outside (insp. plan)
  inside (Cu-sulfate; insp. plan)
* Marking (inspection plan)

* 85 bar (each pipe)

* A-Gauge (inspection plan)
* Groove diameter (Pipe tape; inspection plan)
* Tool measuring (each dimension change)
Conventional Production Process

unpickled hot rolled wide strip…

slitted into thin strips…

roll formed & high frequent welded to a round pipe…

batch galvanised.
Galvanizing Technologies by comparison

Pipes roll grooved after the coating

Flaking of the zinc coating

Batch Galvanized
Batch Galvanising Technology

Degreasing

Rinsing

Pickling

Rinsing

Fluxing: \(\text{ZnCl}_2 + \text{NH}_4\text{Cl}\)

Drying

Galvanizing

Cooling

Galvanizing pipe
Continuous Galvanising Technology

- Scale breaker
- Pickling (Hydrochloride)
- Rinsing
- Drying
- Galvanizing
- Induction furnace
- Cooling System
- Air wiping
## Galvanizing technologies by comparison

<table>
<thead>
<tr>
<th>Technology</th>
<th>Prerequisite for wetting the surface of the base material</th>
<th>Dipping temperature of the galvanizing goods</th>
<th>Dipping period in the zinc-bath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch galvanising</td>
<td>Removal of oxides on the base product with fluxmedium</td>
<td>80 to 100°C</td>
<td>Several minutes</td>
</tr>
<tr>
<td>Continuous galvanising</td>
<td>Removal of oxides on the substrate under deoxidizing conditions (H$_2$-containing)</td>
<td>490 to 550°C</td>
<td>Few seconds</td>
</tr>
</tbody>
</table>
FeZn alloy versus pure zinc (Micrographs)

Batch Galvanising:
The coating consists of approx. 30% pure zinc on the surface, the rest below of a FeZn-alloy. The cracks in the brittle, iron-rich zone are typical of it.

Continuous Galvanising:
The coating is almost 100% pure zinc. The very thin intermetallic layer FeₓAlᵧ acts as a bonding agent and prevents the forming of a FeZn-alloy.

Source: WE, R&D
Thin wall gauges affect low weight of pipes.

Light & straight pipes are easier to install.

Larger pipe inner diameter make down-sized system components possible.

A smooth coating surface ensures a safe seal seat of the coupling and the sprinkler outlet fitting.

The high quality of the outside surface makes a powder coating finish cheaper.

A subsequent roll-grooving on site works without any loss of corrosion resistance.

All in all high grade WGalweld quality pipes are very cost-effective.
Thank you for your attention!