The Evolution of Pipe Couplings

Repair Market
The Need

In the 19th century long pipe lines were installed as part of the industrial revolution, in order to transmit water from reservoirs to cities. Most pipes were made of wood. They needed frequent maintenance.
What is a coupling?

**Oxford Dictionary:** *(technology)* a thing that joins together two parts of something, two vehicles, or two pieces of equipment.

A **coupling** *(or coupler)* is a very short length of pipe or tube, with a socket at one or both ends, that allows two pipes or tubes to be joined, welded, brazed or soldered together.

Wood, 1812, Philadelphia USA  
Cast Iron, France 19th century  
Lead, roman empire
Pipe Repair is an SOS Business!
It requires special skills
And professional knowledge
It is done under harsh conditions
And must be completed fast to minimize suffering
History: First pipe coupling patent – 1888*

The first coupling US patent was introduced in 1885 filed in 1888 by Dresser

*Source: US patent Office
Evolution of couplings

Multi-component
Dedicated Coupling

• Designed for ONE type of pipe size & material
• Steel

Multi-bolt Dedicated Coupling

• Designed for One pipe size & material
• Ductile Iron

Wide Range Coupling
Rigid joint

• Designed for different pipe sizes & materials
• Rigid joint
• Multi-bolt

Wide Range Flexible joint

• Wide-range
• 2-bolt
• Dual sealing
• Flexible Joint – dynamic deflection

Restrained Coupling

• Wide-range
• Prevents axial movement & pipe pullout
• Internal restraint

Multi-purpose Wide range Coupling

• Advanced openable coupling
• Stainless Steel
• Dynamic deflection
Dresser’s first pipe coupling

- Introduced in 1888 by Solomon Dresser
- Features:
  - Made of Steel
  - Used for Gas in oil fields
  - Rubber sealing
  - Provided the basis for the pipe repair industry

1908 version
Common water and wastewater pipe materials

- CAST IRON
- DUCTILE IRON
- STEEL
- COPPER
- HDPE
- PVC
- GRP
- ASBESTOS CEMENT
COMMON PIPE FAILURE BY PIPE TYPES
## Pipe Materials and Typical Problems*

<table>
<thead>
<tr>
<th></th>
<th>Corrosion</th>
<th>Circular Breaks</th>
<th>Leaking Joint</th>
<th>Longitudinal Cracks</th>
<th>Surface Softening</th>
<th>Perforation (Holes)</th>
<th>Pipe Wall Rupture</th>
<th>Delamination</th>
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<td>ASBESTOS CEMENT</td>
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</table>

*Source: water association of Australia
Percent of failures as a function of age and pipe material

% of failures for each material

AC | Steel | CPP | PVC | D1 | C1

80+yr | 61-80 yr | 41-60 yr | 21-40 yr | 0-20 yr

SOURCE: April 2012 Utah State University Buried Structures Laboratory
# Failure data over a 12-month period

<table>
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<tr>
<th>PIPE MATERIAL</th>
<th>LENGTH MILES</th>
<th>NUMBER OF FAILURES</th>
<th>FAILURE RATE #/((100\text{mi})/(\text{year}))</th>
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<tr>
<td>CI</td>
<td>33,611</td>
<td>8,204</td>
<td>24</td>
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<tr>
<td>DI</td>
<td>33,238</td>
<td>1,620</td>
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<td>PVC</td>
<td>26,840</td>
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<tr>
<td>CPP</td>
<td>2,355</td>
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<td>Steel</td>
<td>4,300</td>
<td>581</td>
<td>13</td>
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<tr>
<td>AC</td>
<td>13,502</td>
<td>954</td>
<td>7</td>
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<tr>
<td>Other</td>
<td>3,755</td>
<td>787</td>
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<td><strong>TOTAL</strong></td>
<td><strong>117,603</strong></td>
<td><strong>12,963</strong></td>
<td><strong>77</strong></td>
</tr>
</tbody>
</table>

**SOURCE:** April 2012 Utah State University Buried Structures Laboratory
Most common failures - breakdown

% of Respondents

- Circ. Crack: 50%
- Corrosion: 28.30%
- Long. Crack: 13.00%
- Leak: 4.30%
- Fatigue: 2.20%
- Other: 2.20%

SOURCE: April 2012 Utah State University Buried Structures Laboratory
Pipe failure types in water systems

Common failures:
- Corrosion
- Longitudinal cracks
- Circular Break
- Leaking joint

Holes
Pipe failure types in water systems

Common failures:
- Corrosion
- Pipe wall rupture
- Leaking joint
- Holes
Pipe failure types in water systems

Common failures:
- Surface softening
- Pipe wall rupture
- Leaking joint

**ASBESTOS CEMENT**

Longitudinal Crack  Circular Break
Pipe failure types in water systems

Common failures:
- Pipe pullout due to Smooth surface
- Cracks
- Pipe wall rupture
Pipe failure types in water systems

Common failure:
- Holes
- Leaking joint
- Delamination

STEEL
Pipe failure types in water systems

**Common failure:**
- Pipe wall rupture
- Leaking joint
- Rapid Crack Propagation

**Polyethylene (HDPE)**
Pipe failure types in water systems

**Common failures:**
- Joint leaks
- Fiberglass delamination
PIPE REPAIR METHODS IN WATER SYSTEMS
Pipe Repair in water systems

Asbestos Cement

OLD

Original asbestos coupling

NEW

Hydraulic wide-range openable Coupling in a repair function

Hydraulic wide-range openable Coupling in a joining function
Pipe Repair in water systems

GRP pipe

OLD

Glued GRP Coupling

NEW

Wide-range openable Coupling
Pipe Repair in water systems

PVC pipe

OLD

Dedicated coupling on PVC replacement pipe

NEW

Wide range couplings on PVC replacement pipe
Common pipe repair solutions
OLD COUPLINGS VS. NEW COUPLINGS

• Installer Interface: Multiple Bolts

• 2-bolt couplings

• Installation-ready

• Installation stages
Installer Interface - Cumbersome

OLD - Multiple Bolts

- Wide-range coupling
- Involves under-pipe work
Installer Interface - Ease of Use

NEW - 2/4 Bolts

• Wide-range coupling
• Top-facing bolts
• No under-pipe work
Installer Interface - Ease of Use

NEW - Installation-Ready Technology

• Stab-fit design
• Lighter and simpler
• 1 or 2 Top-facing Bolts
• No need for disassembly
• No need for under-pipe work
• Coupling slides easily on pipe
Installer Interface - Ease of Use

Wide-range coupling Installation

1. Installing without dismantling
2. Tightening the bolts.
TECHNOLOGICAL ADVANCEMENTS

• Gaskets
• Restraint Couplings
• New Multi-purpose Couplings
GASKETS – OLD VS. NEW

• The Cone-shaped Gasket

• The Hydraulic Pressure-Assisted Gasket

• Hydraulic Gasket Allows Continuous Dynamic Deflection

• 2-Layer Removable Gasket accommodates wide range
OLD – the Cone-shaped Gasket
(no flexibility/deflection of the pipes)

No ground shift absorption
May Lead to more breaks near the installation
NEW – The Hydraulic Pressure-Assisted Gasket
Allowing Continuous Dynamic Deflection

- **Water pressure**
- **Radial mechanical closing**
- **Hydraulic Gasket applies Pressure on pipe**
- **Self-inflating inner chamber**
- **Pipe**
NEW – Hydraulic Pressure-assisted Gasket
Allows Continuous Dynamic Deflection

• Allows several degrees of pipe shift during installation
• Absorbs ground shifts due to extreme conditions after installation
• Prevents pipe damage in the long run
NEW – 2-Layer Removable Gasket
Accommodates Variable Pipe Sizes

Insert Screwdriver  Peel Inner Layer  Remove Inner Layer

True Wide-Range Coupling replaces several dedicated-range products

Before detaching The inner layer  After detaching The inner layer
RESTRAINED COUPLINGS – OLD VS. NEW

- External restraint vs. in-product restraint
- Restraint Couplings – Ready-to-use
- Restraint Closure Mechanism – Old Vs. New
- 2 Closing Methods
- Restraint Action Shows on Pipe
- How Restraint prevents axial movement
External restraint vs. in-product restraint

Eliminating the need for external anchoring

OLD – Dedicated Coupling
With External Restraints

NEW – Wide-range Restraint Coupling
No External Restraints
Restraint Couplings – Ready-to-use

No need to disassemble before installation
Restraint Couplings - 2 Closing Methods
Multiple Bolts Vs. 2-Bolts

OLD – Axial closing method

NEW - Radial closing method
Restraint Action Shows on the Pipe
Restraint prevents axial movement

- Grip slides on slope
  Preventing pipe motion
- Pipe exerts pressure
- Teeth go deeper into the pipe
RECENT DEVELOPMENT:

Openable Multi-purpose Couplings

- Openable Coupling Structure
- Multi-purpose applications
- Wide-range gasket
- Hydraulic Gasket – side View
Openable Coupling Structure

- Stainless Steel Body
- Double layer gasket
- Bolts (S/S)
- Compression beams (S/S)
Openable Multi-purpose Couplings

APPLICATIONS:

- Joining pipes as a **coupling**
- Sealing breaks and cracks in pipes as a **clamp**
- Repairing holes as a clamp
- Allowing Dynamic Deflection (up to 3° / each end)
- Absorbing ground vibrations and temperature changes
New Wide-range gasket

Wrap-around option

Low water pressure

High water pressure
Openable Coupling - Hydraulic Gasket’s Mode of Operation

Hydraulic Gasket – side View
Openable Coupling - Installations
SUMMARY – EVOLUTION OF COUPLINGS

- Multi-component Dedicated Coupling
- Multi-bolt Dedicated Coupling
- Wide-range Rigid joint
- Wide-range Flexible joint
- Restrained Coupling
- Multi-purpose Wide-range Coupling
Relevant Standards

See appendix

- AWWA C-219
- NSF 61
- NSF 372
- EN-681
THANK YOU!
APPENDIX:

Relevant Standards
Drinking Water System Components

- NSF/ANSI 61
- NSF/ANSI 372
NSF/ANSI 61
Drinking water system components – Health effects

Purpose:
This Standard establishes minimum health effects requirements for the chemical contaminants and impurities that are indirectly imparted to drinking water from products, components, and materials used in drinking water systems. This Standard does not establish performance, taste and odor, or microbial growth support requirements for drinking water system products, components, or materials.

Scope:
This Standard is intended to cover specific materials or products that come into contact with: drinking water, drinking water treatment chemicals, or both. The focus of the Standard is evaluation of contaminants or impurities imparted indirectly to drinking water. The products and materials covered include, but are not limited to, process media (e. g., carbon, sand), protective materials (e. g., coatings, linings, liners), joining and sealing materials (e. g., solvent cements, welding materials, gaskets), pipes and related products (e. g., pipes, tanks, fittings), mechanical devices used in treatment/transmission/distribution systems (e. g., valves, chlorinators, separation membranes, point-of-entry drinking water treatment systems), and mechanical plumbing devices (e. g., faucets, endpoint control valves).
NSF/ANSI 372
Drinking Water System Components Lead Content

**Purpose:** This standard establishes procedures for the determination of lead content based on the wetted surface areas of products.

**Scope:**
This standard applies to any drinking water system component that conveys or dispenses water for human consumption through drinking or cooking.
AWWA Coupling Standards

- AWWA C219
- AWWA C227
AWWA C219-11
Bolted, Sleeve-Type Couplings for Plain-End Pipe

- **Scope**: This standard describes bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters used to join plain-end pipe. Couplings may be manufactured from carbon steel, stainless steel, ductile iron, or malleable iron, and are intended for use in systems conveying water. This standard covers nominal pipe sizes from 1/2 in. (12.5 mm) through 144 in. (3,600 mm).

- **Purpose**: The purpose of this standard is to provide the minimum requirements for couplings of plain-end pipe, including requirements for materials, design, testing and inspection, installation, and shipping.
AWWA C227-11
Bolted, Split-Sleeve Restrained and Non-restrained Couplings for Plain-End Pipe

- **Scope**: This standard describes bolted, split-sleeve couplings (couplings) used to join plain-end pipe of similar outside diameter. Couplings may be manufactured from carbon steel or stainless steel and are intended for use in systems conveying water, wastewater, or air used in water treatment. The standard covers nominal coupling sizes from 3/4 in. (20 mm) through 144 in. (3,600 mm).

- **Purpose**: The purpose of this standard is to provide the minimum requirements for bolted, split-sleeve couplings for plain-end pipe, including requirements for materials, design, testing and inspection, installation, marking, and shipping.
AWWA - Repair clamp Standard

- AWWA C230

This standard provides minimum requirements for fabricated full-encirclement stainless-steel band clamps for use in the repair or service connection of potable water, wastewater, and reclaimed water piping systems.

They are intended for pipe sizes 2 in. (50 mm) through 12 in. (300 mm). This standard does not cover stainless-steel tapping saddles whose seal is not fully circumferential.

Covered requirements include materials of construction, design, manufacturing, and installation instructions. The standard also covers inspection, quality assurance, test procedures, marking, packing, shipping, and affidavit of compliance.