CRAFT BREWERS CONFERENCE
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#CraftBrewersCon

Soft Hoses vs. Hard Pipe

Process applications, safe & sanitary design, and limitations of both to consider

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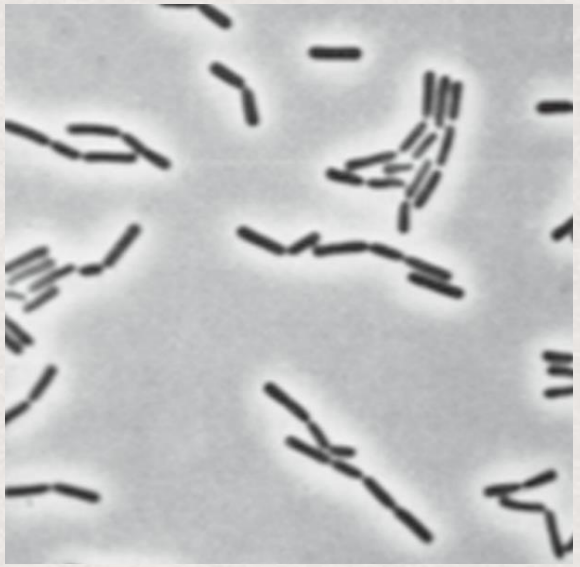
Sanitary Piping

Matt Bailey – Odell Brewing Company

Stainless Tubing Pro/Cons

- **Pros:**
  - Cleanability (internal and external)
  - No hoses on floors
  - Cost of ownership
  - Lifespan
  - Safety (pressure rating)
  - Convenience
- **Cons:**
  - Initial Cost
  - Installation disruption
- Quick example:
  - Cost of a 40’ hose (~$1000)
  - 40’ SS pipe ($300-$500 for tubing, $115 fittings, $400 - Wall/Ceiling mounts, 8 Welding hours $650=$1665)
  - Replacement frequency of hose



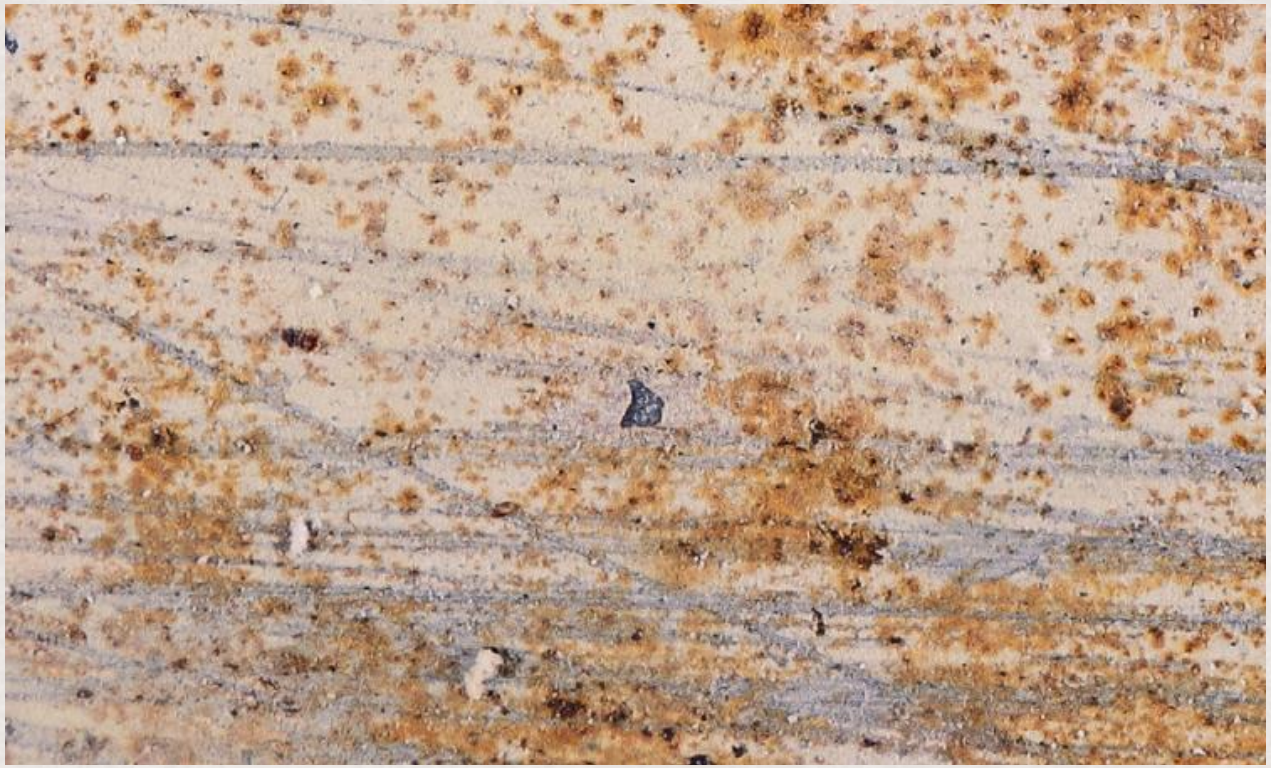
304 SS vs 316 SS

- Ashton Lewis presentation
- 316 SS is more resistant to chlorides
  *the presence of chlorides can cause corrosion in either type
- 304 SS is susceptible to chloride pitting

https://www.brewersassociation.org/seminars/stainless-steel-201/

Corrosion (chlorides)

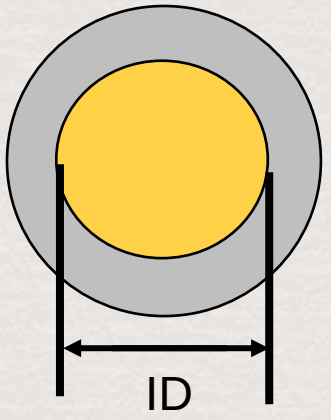
- What has chlorides?
  - Chlorinated Caustic
  - Insulation
  - Road Chemicals in snow climates
    - Transportation risk

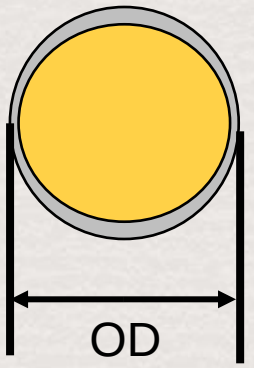


Corrosion of Stainless Steel: Test Methods and Proper Expectations, October 1st, 2017, www.assemblymag.com

Nomenclature: Piping and Tubing

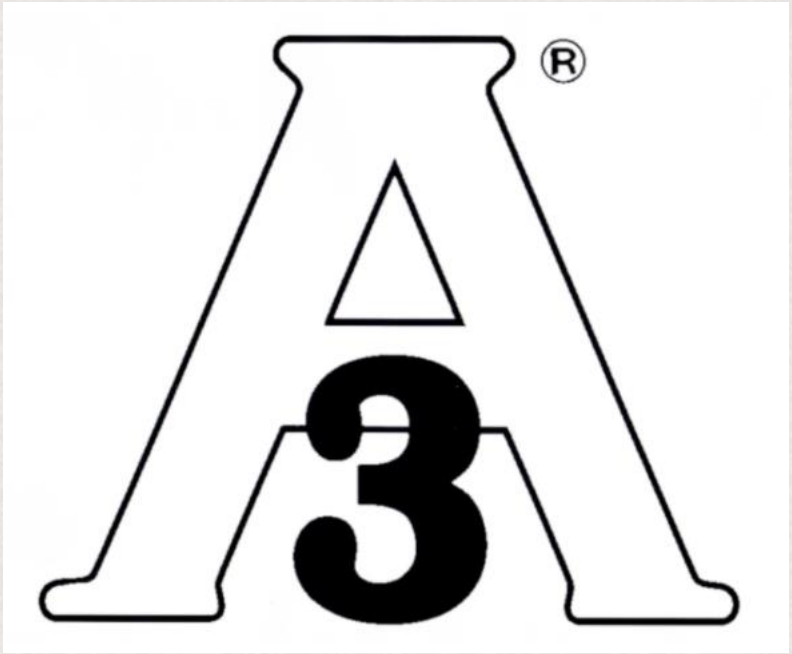
- “Pipe” is measured by ID (internal diameter)
  - Stainless Steel, Copper, PVC, Carbon steel (black pipe)
  - Higher pressure rating (thicker wall)
  - Typically not sanitary polished like sanitary stainless tube
- “Tube” is measured by OD (outer diameter)
  - Lower pressure rating
  - Food and Beverage process piping





What is 3-A?

- Standard for hygienic fitting and tubing
- Ensures suppliers adhere to hygienic design and manufacturing
- Look for the 3-A symbol on your fittings
- http://www.3-a.org/About/Mission



Sanitary welds

- Contiguous on surface with little discoloration
- Fully penetrates inside of pipe work
  - No gaps, holes, or rough in appearance
  - No lips or ridges
  - No pipe threads
- Shiny and smooth
- Qualify your welders with a “coupon”
- Random inspection
- Include in contract

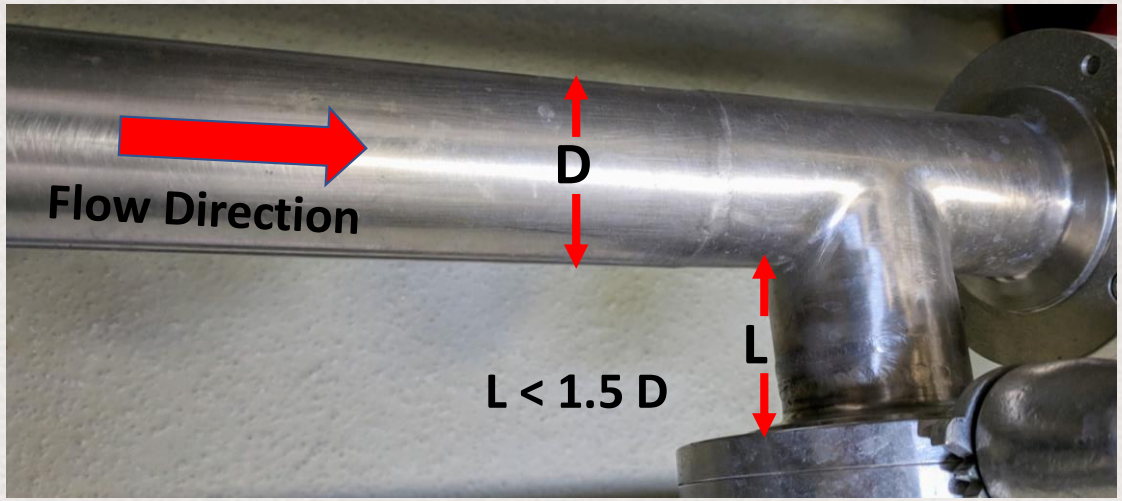
Example of a bad weld seam

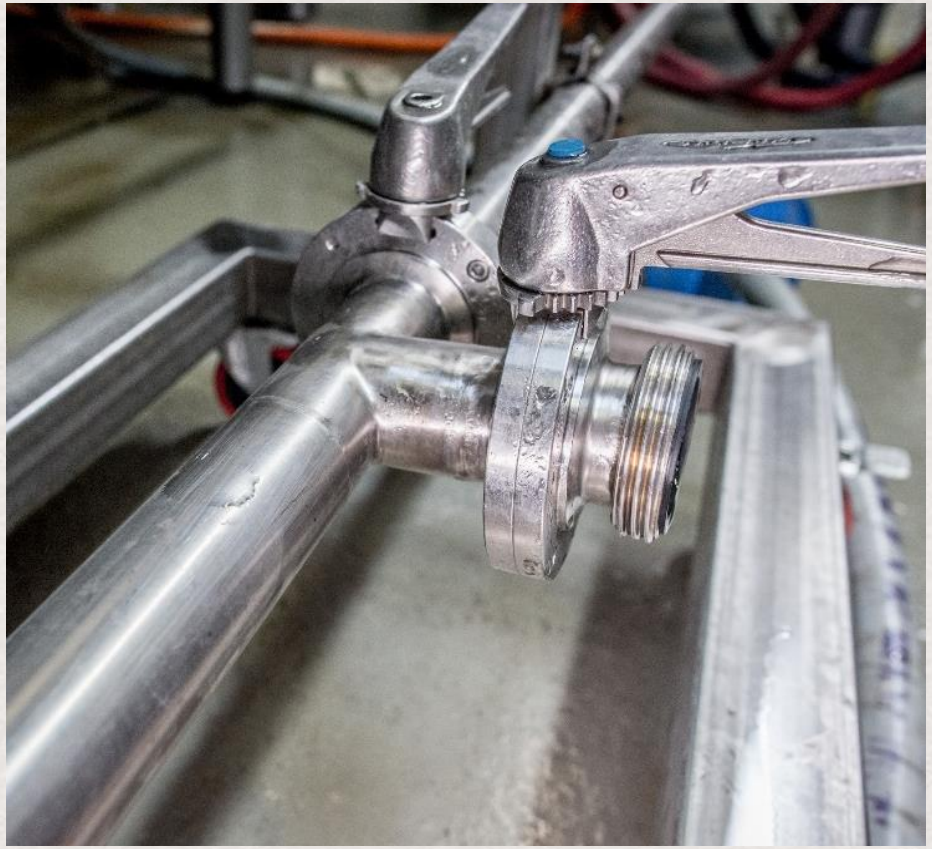
Sanitary welds

Proper weld seams

Best practices in design/layout

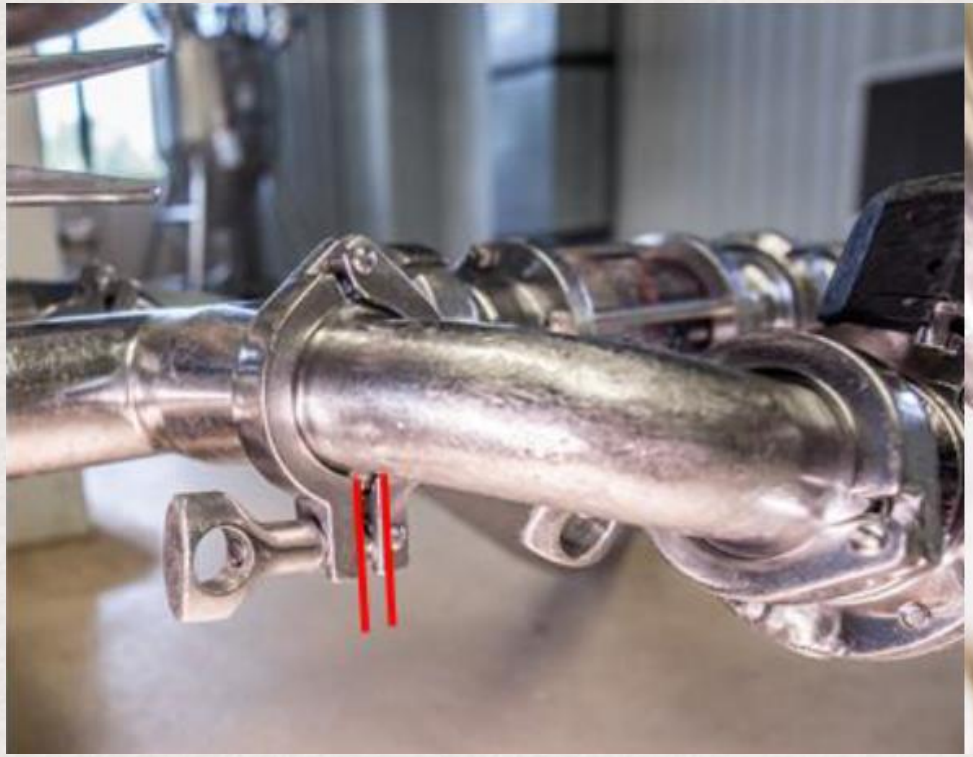
- Dead legs
  - No longer than 1.5x tube diameter
- T orientation
  - Horizontal or side orientation

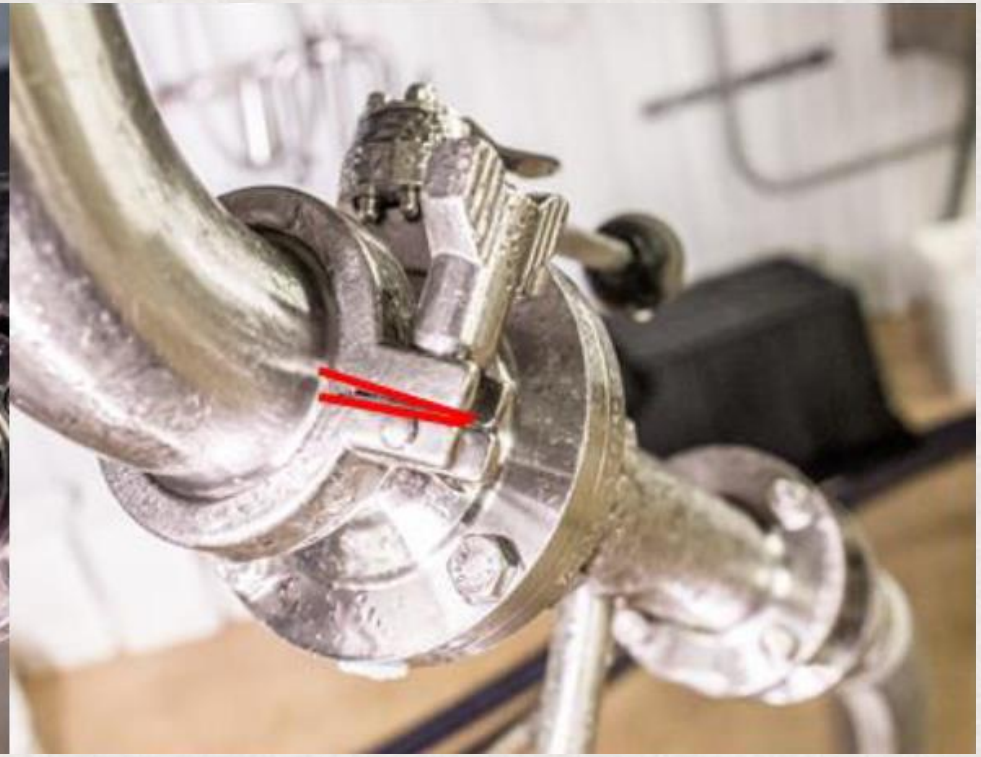




Best practices in design/layout

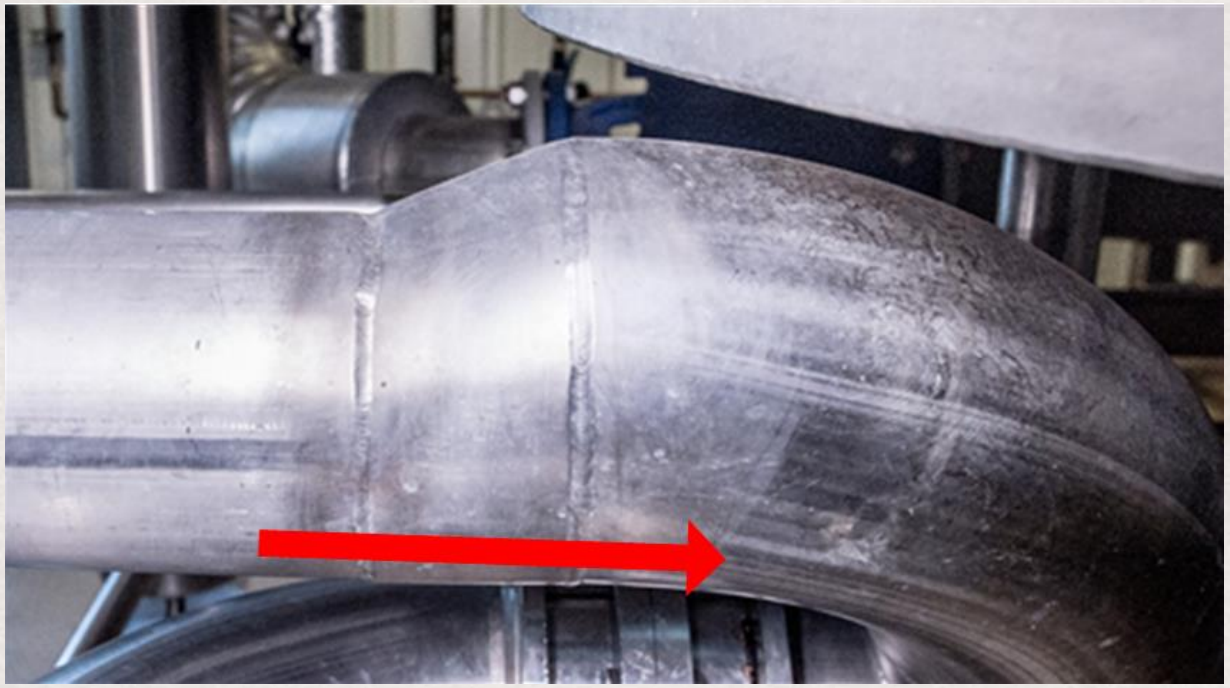
- Tri clamp orientation and tightness





Best practices in design/layout

- Concentric vs eccentric reducers



Eccentric Reducer

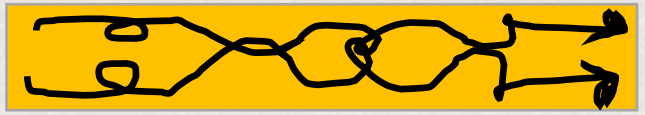
Concentric Reducer

Best practices in design/layout

- Slope
- No traps or sags in between hangers

CIP flow rates

- Turbulent vs laminar
- CIP rates should be 5 ft/second at a minimum



- $GPM = (Inner\ Diameter\ inches)^2 * \frac{5\frac{ft}{s}}{.4085}$

Sanitary Tube Size		Flow rate for 5 ft/s minimum
Outer Diameter (inches)	Inner Diameter (inches)	GPM
1.0	.87	9
1.5	1.37	23
2.0	1.87	43
2.5	2.37	69
3.0	2.87	101

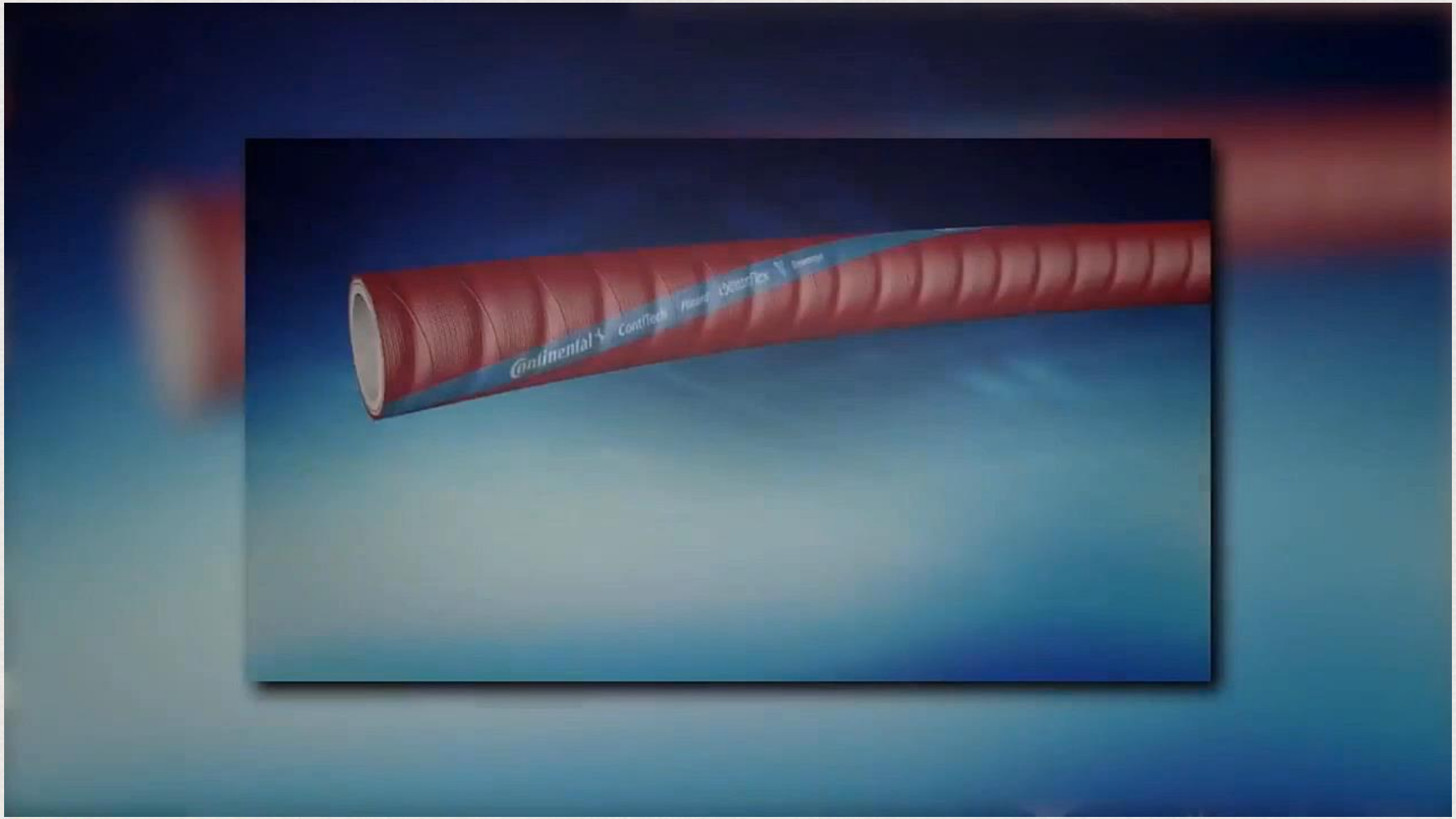
Sanitary Hoses and Fittings

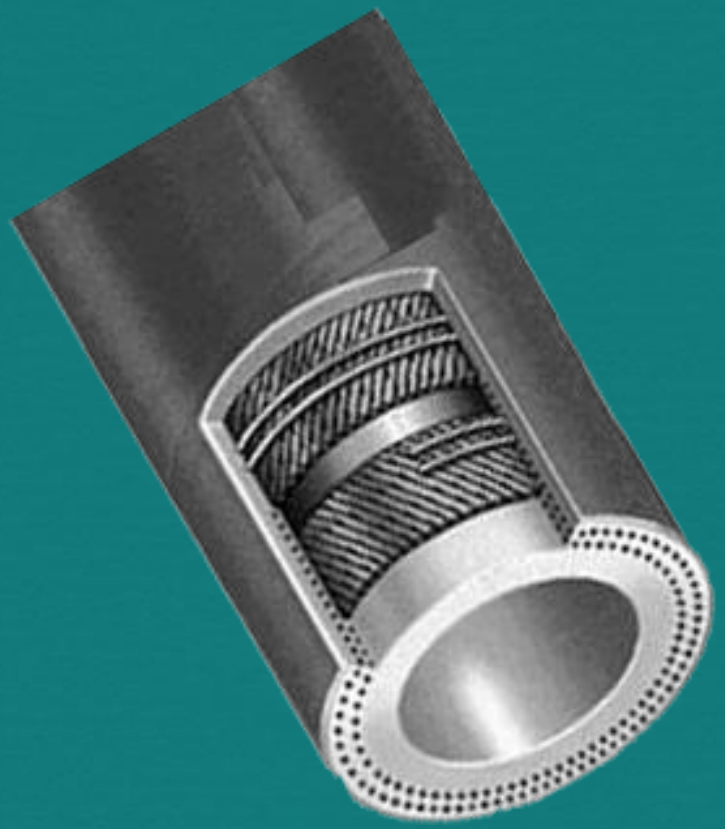
Kent Taylor – Blackstone Brewing Company

Don’t try this at home...

Anatomy of a Brewery Hose

Anatomy





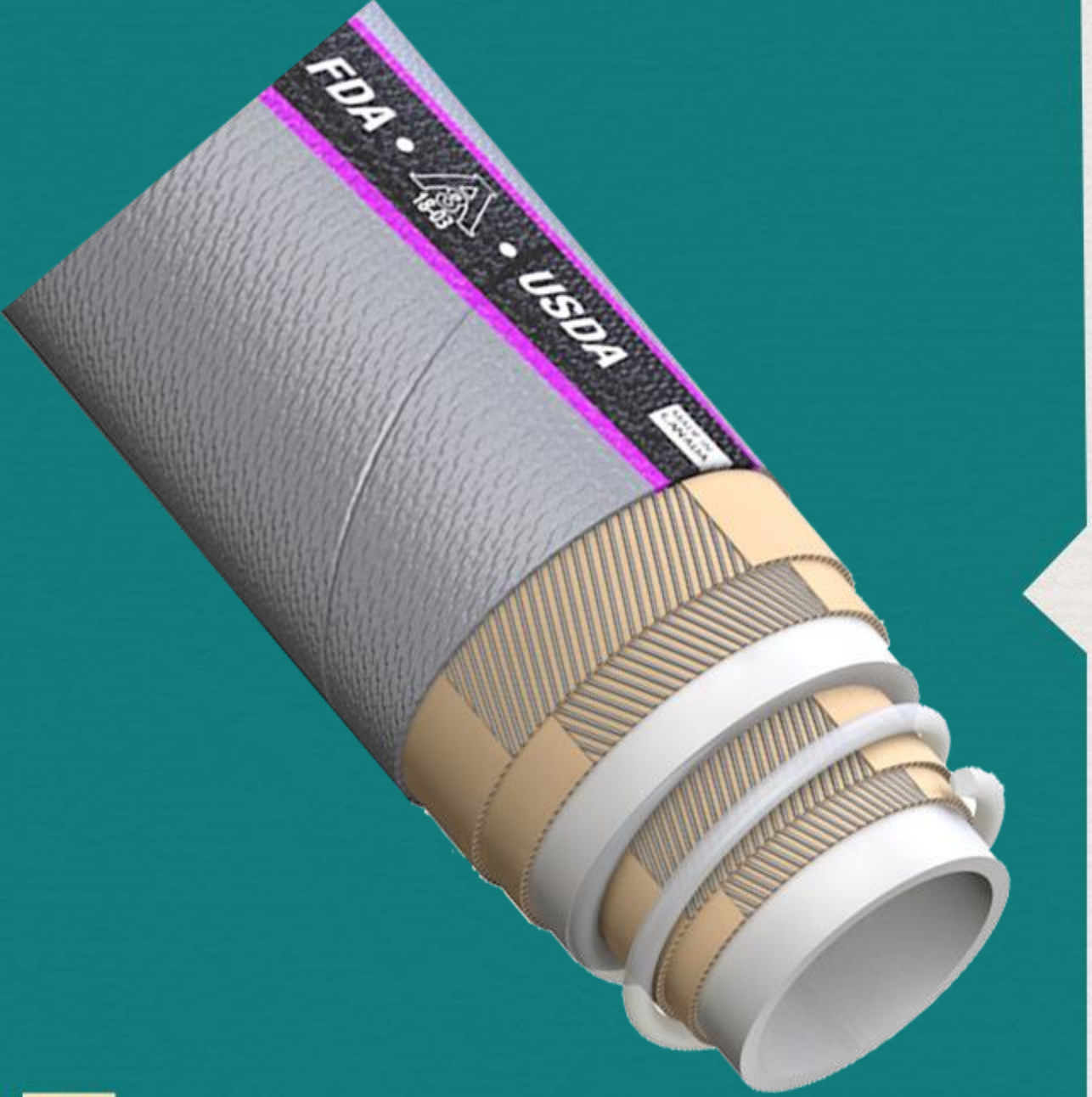
Food grade industrial hoses

Tube – the inner liner and can be made of white natural rubber or any of several varieties of white synthetic rubber.

Reinforcement layers - several layers of synthetic fabric with the number of layers dependent on the hose type and size.

Helix – many hoses have steel or plastic added in a helix to provide additional strength.

Cover – exterior is usually made from a synthetic rubber.



How Brewery Hoses Are Made

Mandrel – the outside diameter of the mandrel is the inside diameter of the hose. Sanitary hoses are measured inside. 1” hose is 1” inside diameter.

Handmade - each layer of the hose is placed on the mandrel one after the other.

Autoclave – the assembled hoses are placed in an autoclave and subjected to heat and pressure which vulcanizes the rubber and fuses the layers together.

Vulcanization – this process was discovered by Charles Goodyear in 1839.

How Brewery Hoses are made

What to look for in a brewery hose

- 3-A, FDA and USDA approvals
- Hoses listed as suitable for milk, wine, beer and other non-oily products are appropriate for breweries
- Be sure to check the temperature and pressure ratings
- Natural rubber can be used for brewery hose tubes but are generally not suitable for acid CIP (clean in place)
- Typically, tubes in brewery hoses are made from synthetic butyl rubber and are also suitable for acid CIP
- Cover should be non-marking, abrasion resistant and easy to clean

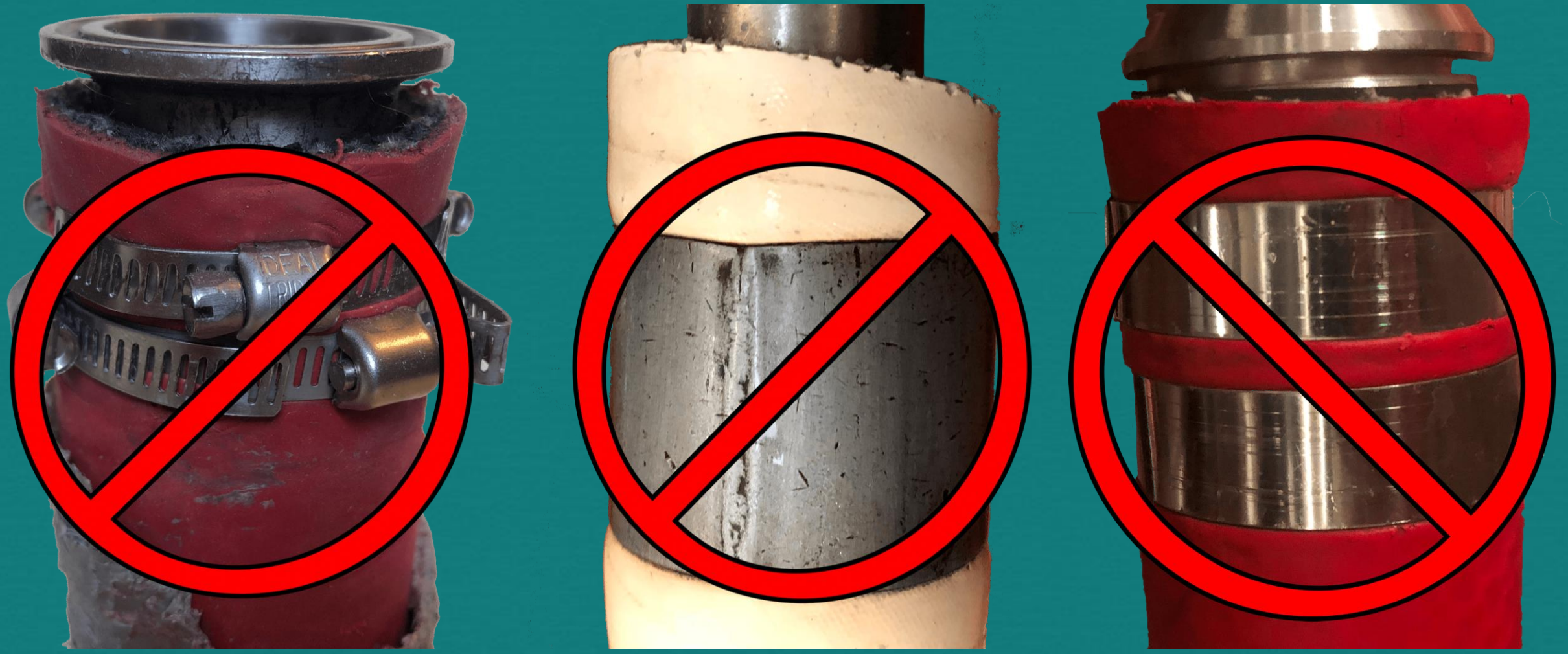
Hose End Fittings

Worm Clamps

Hydraulically Applied Band

Band Clamps

Not Sanitary



Not Suitable for Wort or Beer

3-A Sanitary Standards Inc.

The first standards for the hygienic design of equipment used in the dairy industry were introduced in the 1920s. These standards became known as '3-A standards' for the three interest groups that cooperated to improve equipment design and sanitation - regulatory sanitarians, equipment fabricators, and processors.

3-A Sanitary Standards, Inc. was incorporated as an independent not-for-profit corporation in 2002 dedicated to the mission of advancing food safety through hygienic equipment design. The membership consists of four associations: American Dairy Products Institute, International Dairy Foods Association, Food Processing Suppliers Association and the International Association for Food Protection.

Reprint from website - https://www.3-a.org/About/History

3-A Sanitary Fittings

3-A sanitary fittings are a hose end system comprised of a matched stem and ferrule which have achieved sanitary certification from the 3-A Sanitary Standards non-profit organization. These hose end systems are hydraulically installed.

Externally Crimped

Stem

Ferrule

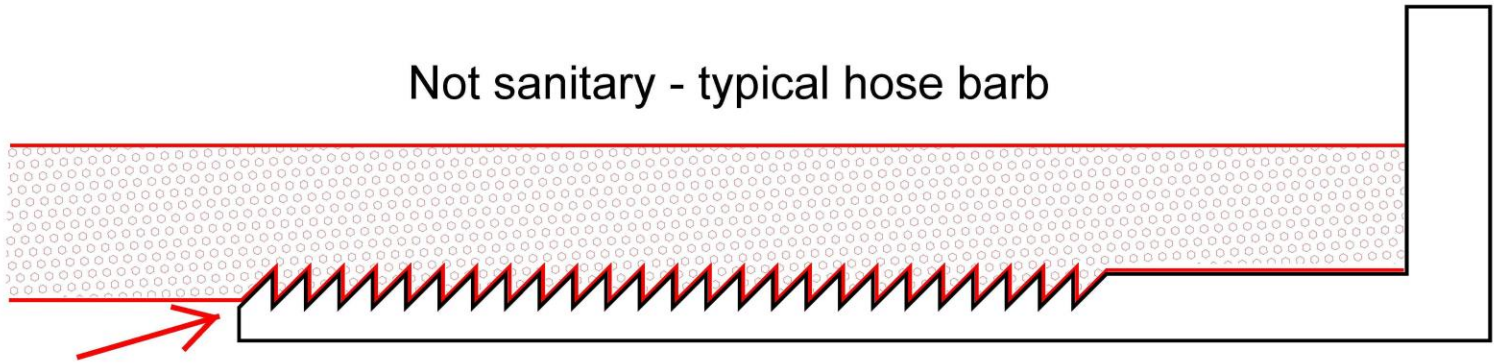
Internally Expanded

Stem

Ferrule

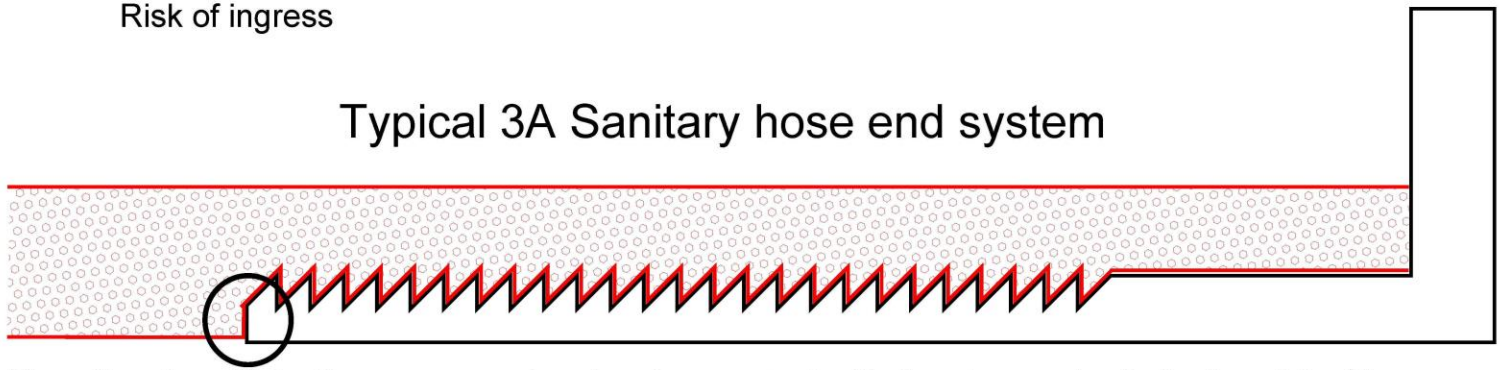
Cut sections of hose and TC hose end fitting

Not sanitary - typical hose barb



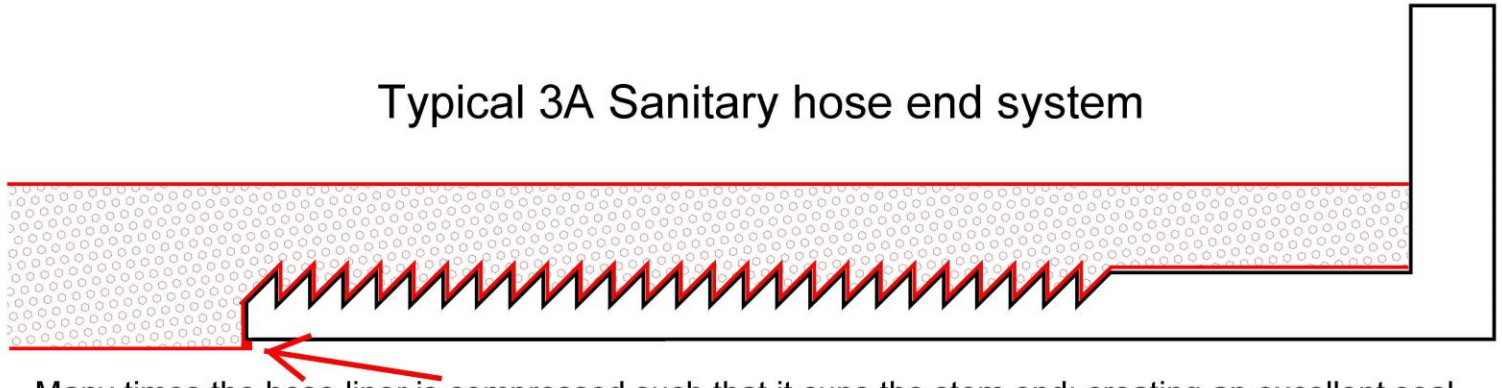
Risk of ingress

Typical 3A Sanitary hose end system



Hose liner is sufficiently compressed and makes contact with the stem end; eliminating risk of ingress

Typical 3A Sanitary hose end system



Many times the hose liner is compressed such that it cups the stem end; creating an excellent seal

Internally Expanded

- A tapered mandrel is hydraulically drawn through the stem, expanding it into the tube
- Also referred to as mandrel expanded fittings
- Mandrel is also sometimes referred to as a plug, bullet or plunger
- Witness marks are inside of the stem
- The inside of the stem should be smooth and free from scratches or gouges
- Cannot mix parts with crimp fittings

Externally Crimped

- Hose, stem and ferrule are assembled and placed into a specialized hydraulic press that uniformly squeezes (crimps) the ferrule.
- Cannot mix parts with internal expansion fittings
- Witness marks are on the outside of the ferrule

Which System Is Best?

- For years, only internal expansion was available
- External crimping has gained 3-A certification
- Internal expansion increases the internal diameter of the stem to equal the internal diameter of the tube
- External crimping decrease the diameter of the cover, reinforcement layers and tube to equal the internal diameter of the stem
- Both methods press the tube into and past the end point of the stem
- Do your research and choose wisely

Internal Hose Inspection

- Look for endoscope, borescope and/or inspection camera
- Ones without screens that use a phone or computer are less than $100 for 50’
- Focus on camera resolution
- Semi-rigid can inspect short hoses (+-15’; 1” diameter); larger diameters may require fish tape even for short hoses
- Longer hoses will require a fish tape or other method of pulling the camera (stainless steel or non-metal fish tape)
- Probably easier to insert camera to full length and perform inspection as camera is removed

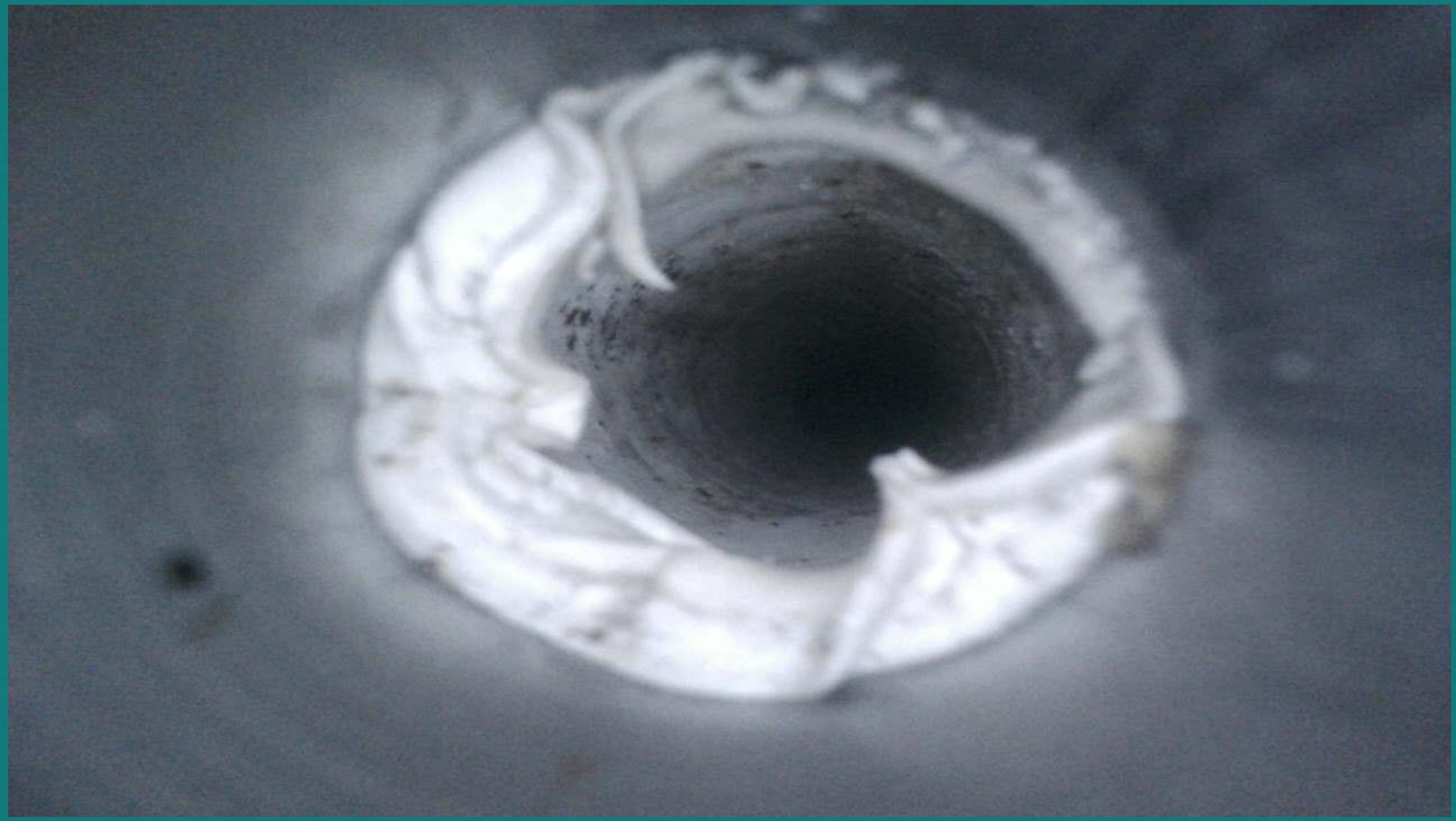
100’ hose - 50’ inspection camera; inserted at each end of hose; entire hose was inspected

Camera affixed to end of fish tape with electrical tape
5.0MP 1944P
6X Zoom

Stainless steel fish tape less than $100

Internal Hose Inspection

The Ugly



Caused by over crimping

Hose Storage

- Generally, dry is better
- Short-term storage packed in sanitizer
- Sanitizers will degrade after a few days/weeks depending on sanitizer

Want to Learn More?

Disclosure: Many of these videos are sales pitches so look past that and learn how brewery hoses are made and how fittings are installed.

Hose Construction:

https://www.youtube.com/watch?v=Bk1oU86UVMA

https://www.youtube.com/watch?v=QlaiPsMKKSE

https://www.youtube.com/watch?v=BJkOor_EOMs

Fitting Installation:

https://www.youtube.com/watch?v=YRBre_bTcbk

https://www.youtube.com/watch?v=qSJm9Z8cR2k&t=27s

https://www.youtube.com/watch?v=hly00FqGCJQ&t=163s

https://www.youtube.com/watch?v=e3T2uEf0Zko

https://www.youtube.com/watch?v=KQNZ2AtE6TE&t=299s (internal expansion starts at 8:30)

Wrap-up
Sanitary Hoses and Fittings

Special thanks for content and assistance

Eric Weiner - https://brewhose.com/

Randy Kish - https://www.continental-industry.com/

Matthew Bender - https://www.dixonvalve.com/

Other Sanitary Considerations

Chris McCombs - Coopersmith's Pub and Brewing

Hose Liquid Transfer Systems Pros and Cons

Pros –

- Quick and relatively inexpensive startup cost
- Flexibility
- Cleaning setup is straight-forward
- Easier to navigate, compared to multiple panels associated with stainless piping installations
- No added cost to expand tanks in the cellar

Cons –

- Hose material will degrade resulting in long-term recurring replacement cost
- Hose ends can come apart if not installed correctly, when under pressure, or as they age
- Ergonomic issues of hauling hoses
- Ends dropping can damage floor
- Safety concerns with tripping hazard
- Space needed for hanging hoses
- Fitting connections can become loose causing increased dissolved oxygen and potential microbiological issues

Hard-Piped Transfer Systems Pros and Cons

Pros –

- Superior durability
- Resistance to corrosion, ability to be CIP'd and steam-sterilized
- Space and time-saving
- Greatly reduces trip hazards
- Superior leak prevention
- Reduces dissolved oxygen pickup
- No ferrule seams to worry about

Cons –

- Higher initial cost to install
- Potential dead-legs where tees are installed
- Surface of piping gets really hot during CIP (clean in place) and SIP (sterilize in place)
- Less flexible for obvious reasons

Types of 3-A Process Connections

Tri-Clamp

- Very common in breweries
- Misaligned gasket and flange, which can cause unsanitary conditions.
- Misalignment can also cause an unsafe pressure failure of clamp.
- If used properly, they are a good option.
- Universal fittings; no male or female; no special tools required

Types of 3-A Process Connections

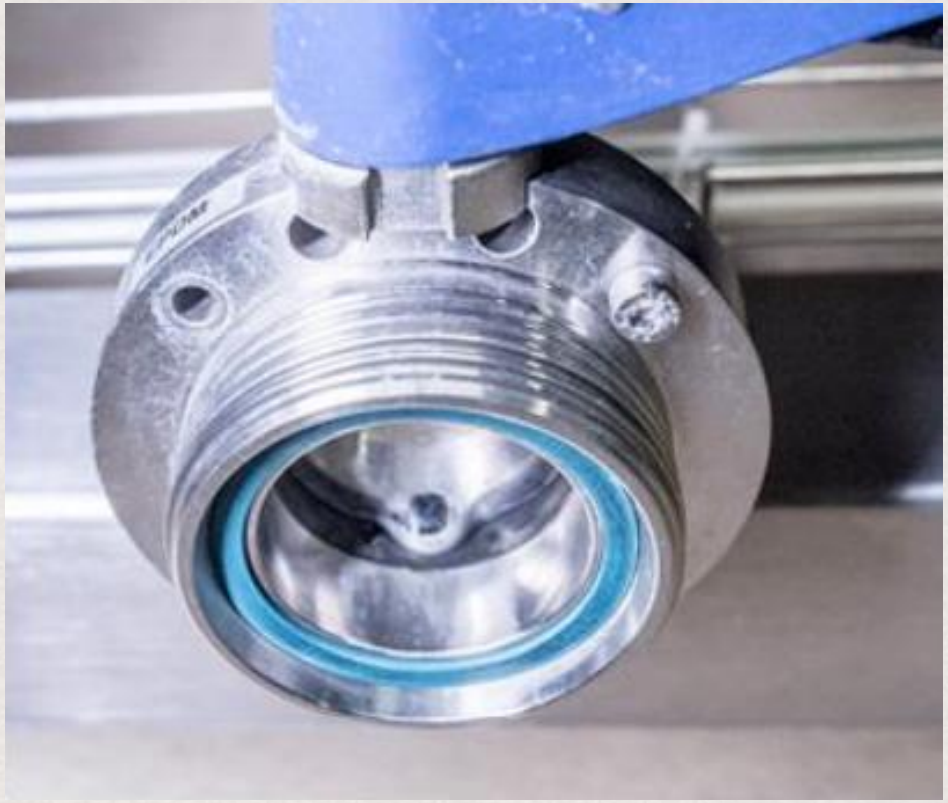
SMS

- Swedish standard piping union
- Seals against a flat surface with a flat seal
- Common in breweries where hoses are used.
- Good option for swing panels.
- Inspection and replacement of gaskets is important.
- Nuts require specialized spanner wrench (DIN & SMS use the same spanner)
- Male and female fittings

Types of 3-A Process Connections

DIN

- Translates to Deutsches Institut für Normung (German Institute for Standardization)
- Seals against a flat surface with a “D” profile recessed seal; beveled fitting assists with alignment
- Nuts require specialized spanner wrench (DIN & SMS use the same spanner)
- Male and female fittings



Types of 3-A Process Connections

Bevel Seat

- Seal is made secure with tension in angled seal and fitting.
- Common to see in smaller breweries where hoses are used.
- Important to change seals frequently.
- Can leak and pick up dissolved oxygen if not tightened properly
- Requires a wrench to loosen or tighten fitting
- Male and female fittings

Process Seal Materials

Buna-N (Nitrile Rubber) – Soft, flexible, good for processes that are taken apart on a regular basis; can fail sooner than other materials

EPDM (Ethylene Propylene Diene Monomer) – More durable overall and more chemical & heat -resistant than Buna; slightly higher cost per unit

FKM (Fluroelastomer) – Excellent heat and chemical-resistance; more durable and more expensive than other seal materials; great choice for hot-side or CIP skid applications

Silicone – Excellent heat-resistance; very flexible but easy to cut or shred; usually red, white or transparent in color; common in lab-scale equipment

PTFE (Teflon) – Excellent heat and chemical resistance; rigid; needs to be compressed tightly to form a seal; resilient

Other – There are a variety of other special purpose sealing materials

THANK YOU!

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