

Technical, environmental and health aspects of
hot tap water

by

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Technical, environmental and health aspects of hot tap water

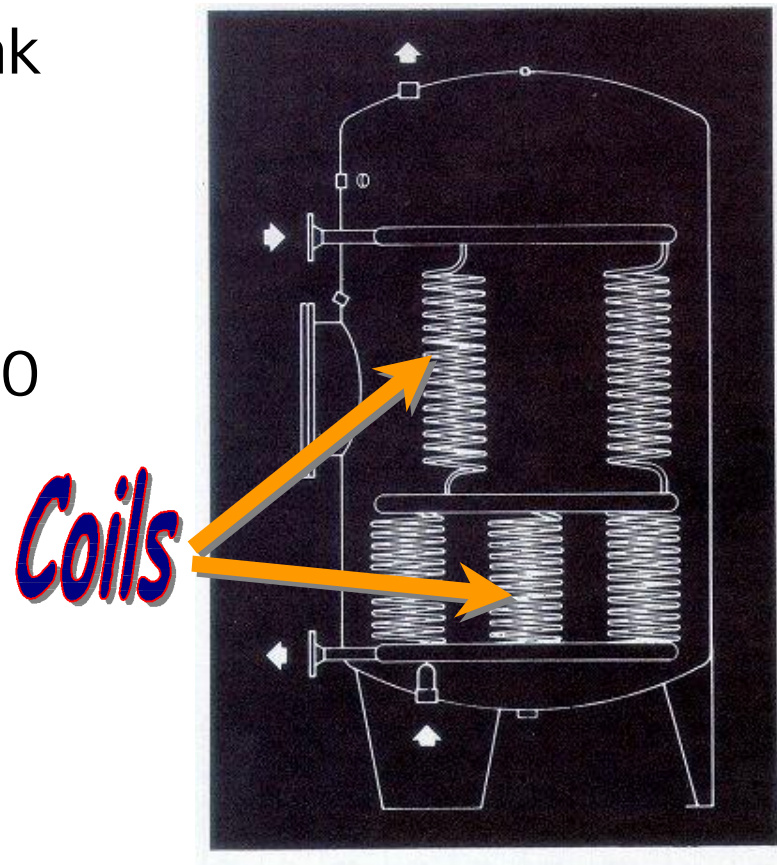
- Hot Water tanks
- Hot Water temperature
- Pipe installation and materials

Technical, environmental and health aspects of hot tap water

- Hot Water systems
 - Tanks with inner coils
 - Tanks with outside heat exchanger
 - Heat exchangers

Hot water Tanks and systems

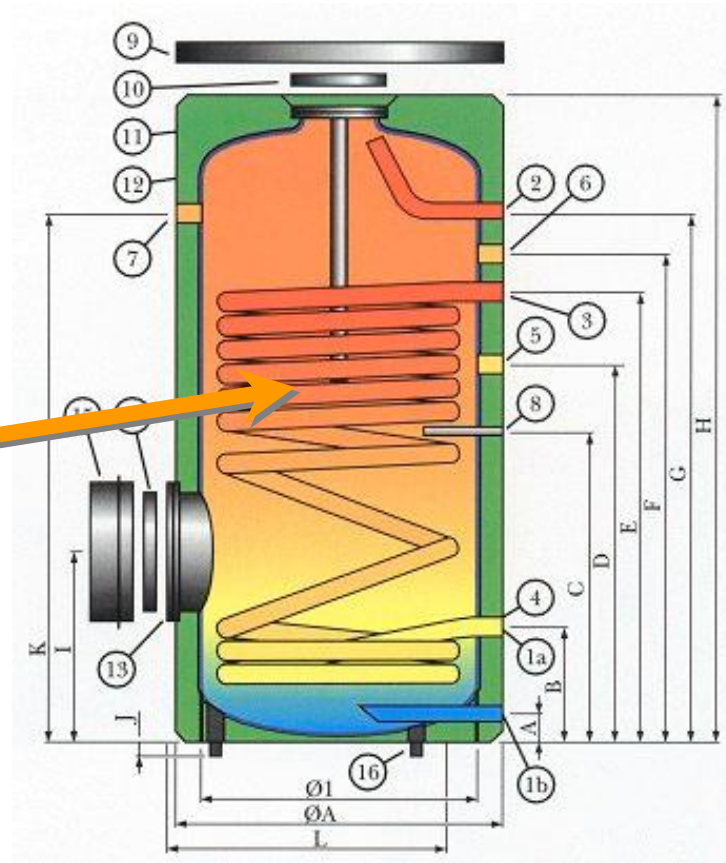
- Hot water iron Tank with more inner coils.
- Tank size is normally about 1000 litre up to 4000 litre.
- The coils can be made of steel or stainless steel.



Hot Water Tanks and systems

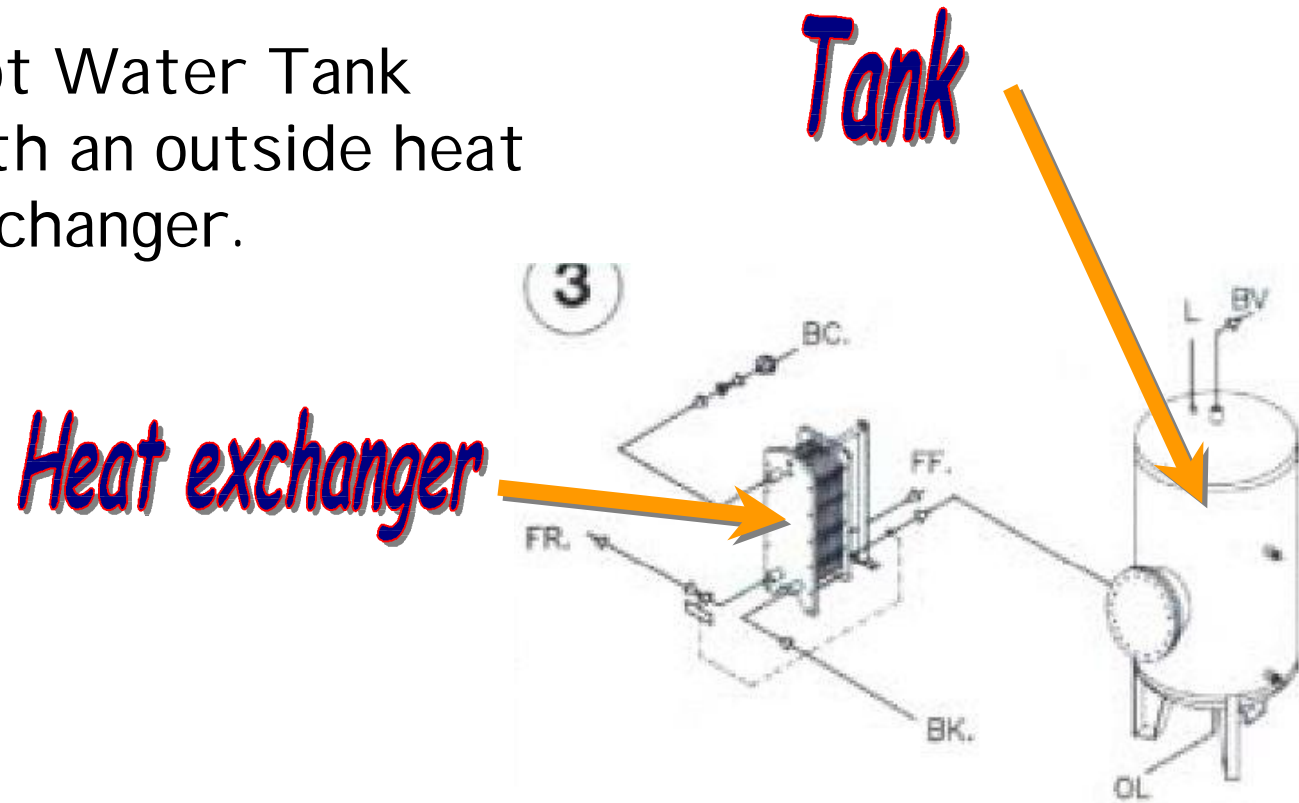
- Hot Water stainless steel Tank with one big inner coil.

Coil



Hot Water Tanks and systems

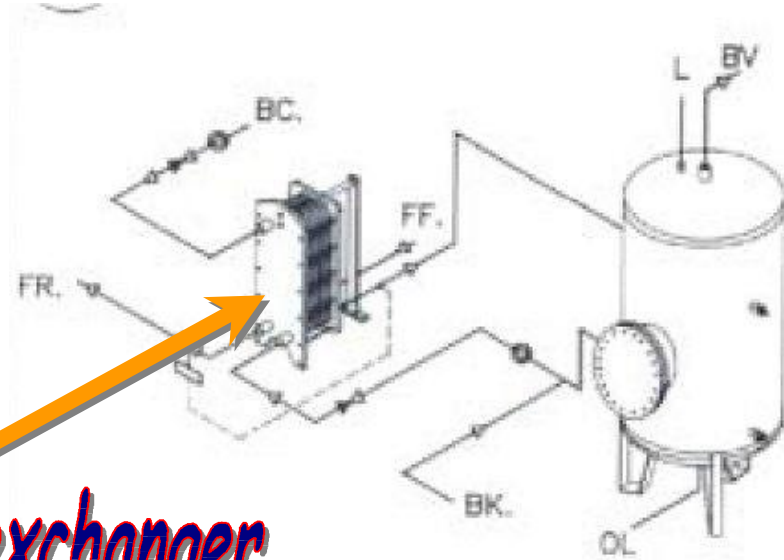
- Hot Water Tank with an outside heat exchanger.



Hot Water Tanks and systems

- Hot Water Tank with an outside heat exchanger.
- The hot Water is heated up in the heat exchanger and circulated to the storage tank

Heat exchanger



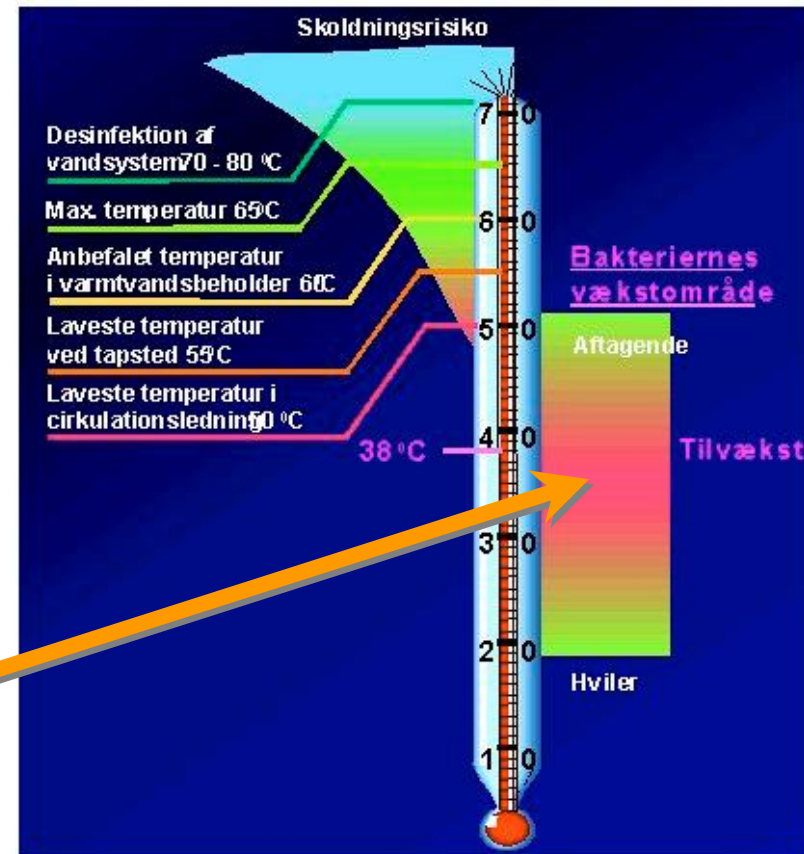
Hot Water and heat exchangers

- Plate heat exchanger
- Without tank



Hot Water temperature

- Profile for the critical temperatures in hot Water systems.
- From 20 - 50 °C there is a great risk for legionella, and the worst temperature is about 38 °C

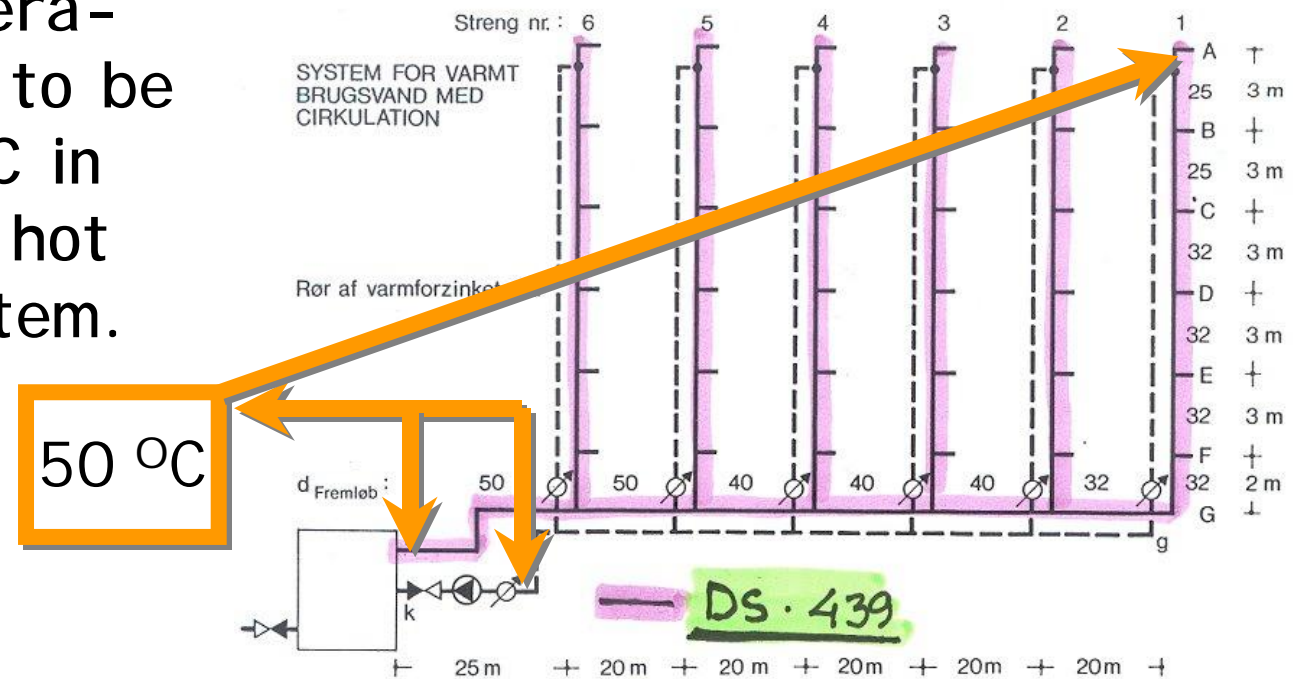


Hot Water Tanks temperature

- The hot water temperature must be over 50 °C in the whole system. That means from the outlet of the tank to the return to the tank.
- The temperature must could be raised to over 60 °C in case of legionella in the system.
- According to DS 439-2000

Hot Water temperature

- The temperature have to be over 50 °C in the whole hot water system.



Water quality and materials

- Types of pipes for use in waterinstallations:
 - Galvanised steel pipes
 - Copper pipes
 - Stainless steel pipes
 - Polymer pipes
 - PEX-pipes
 - ALU-PEX-pipes
 - PP-pipes

Water quality and materials

Type of water ¹⁾	Limitations for the use
pH < 7, alkalinity (HCO ₃ ⁻) < 1 mmol/l Ca ⁺⁺ < 0,5 mmol/l ²⁾ (20 mg/l)	Galvanised steel is not to be used
Agressive carbon dioxide > 2	Galvanised pipe is not to be used
Cl ⁻ + 2SO ₄ ⁼⁼ /HCO ₃ ⁻ > 1 measured in mmol/l	Galvanised pipe is not to be used
PH < 7 and with hydrogen carbonate content less than the sulphate content measured in mg/l (HCO ₃ ⁻ /2SO ₄ ⁼⁼ <1)	Pitting in copper pipe may occur
High content of chloride in relation to the temporary hardness	Brass may de-zinc. Dezincing resistant alloys may be used
Cl ⁻ > 150 mg/l	Increased risk of corrosion in stainless steel pipe
High conductivity (> 100 mS/m)	Magnesium anodes corrode quickly. Risk of unpleasant odour and generation of hydrogen
Low conductivity (> 30 mS/m)	Magnesium anodes in uncoated steel tanks can only be used in particularly suitable structures or through mounting of additional anodes
Very low conductivity (< approximately 10 mS/m)	Electrolysis and enamelled tanks with anodes cannot be used

1) Information about the type of water can be obtained from the water supply company

2) Equal to temporary hardness originating from calcium being more than 0,5 mmol/l (2,8 °d German degrees of hardness)

Water quality and materials

- The characteristics of galvanised pipes are:
 - Traditionally used as predominant pipe material for larger installations (both in Eastern and Western European countries)
 - Galvanised steel pipes should only be selected in cases, where there is positive experience with their application for the respective water quality.
 - According to the Danish norm DS 439 (2001)
 - Larger installations should be corrosion protected by **electrolysis system**, unless experience shows that it is not necessary.
 - Re-circulation shall provide minimum flow velocity of 0.05 - 0.1 m/s in corrosion protected systems.
 - Copper pipes may only be connected to the galvanised pipes down-stream and the pipes should be separated from each other by a loop-section of a PEX-pipe.

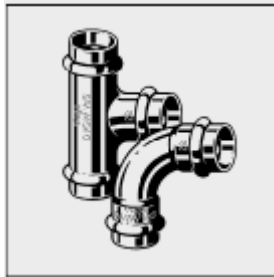
Water quality and materials

The characteristics of copper pipes are:

- Predominant pipe material for small-scale installations (family houses etc.)
- max. \varnothing 50 mm (commonly $\leq \varnothing$ 28 mm)
- pipe connection by soldering (easier than threading or welding!), welding (**large diameters, $d \geq 35$ mm**) and more recently compression fittings
- Higher corrosion resistance than steel pipes
- water quality precondition acc. to DS 439: $7.5 < \text{pH} < 9$ (except of inter-nally tin-plated copper pipe: no restrictions)
- must not be installed upstream of galvanised steel pipes
- **Depending on the water quality, the concentration of copper in the tap water can reach and even exceed permissible values (*copper migretion*). Counter-measure: apply internally tin-plated copper pipe.**
- observe maximum flow velocity to avoid turbulence corrosion
- allow free expansion of pipes; otherwise risk of fatigue

Water quality and materials

- Copperpipes with an inner tin (sn) surface.
- Only tinplated pressfittings can be used for this pipes
- No copper migration.



Water quality and materials

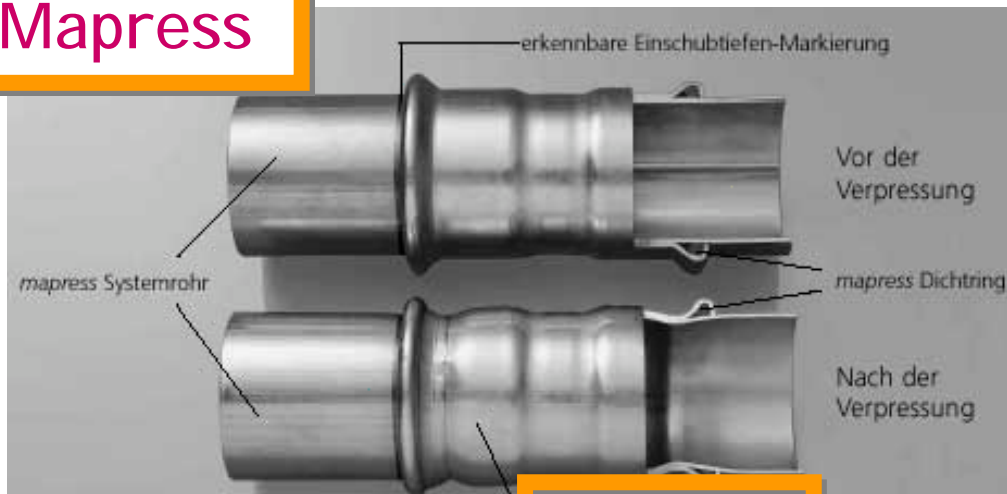
Stainless steel

- The characteristics of these pipes are:
 - Water quality precondition acc. to DS 439: $\text{Cl}^- < 150 \text{ mg/ltr}$ (as the *one and only* limitation!)
 - For handling, assembly etc. of stainless pipes and fittings, a certain set of rules has to be strictly observed: *No* contact whatsoever with ordinary steel; tools (saws, tongs etc.) which have been used for ordinary steel must *not* be used for stainless steel.
 - Pipe connections with press fittings => very fast assembly without fire risk

Water quality and materials

Stainless steel

Mapress



Viega



Pressing Tools



The fitter needs a special tool to press the mapress pressfittings with mapress or copper pipes. This tool consists of a pressing (actuator) unit, and jaws or collar. Different units, jaws and collars are used, depending on the sizes of the pipes and pressfittings being used. We offer our customers a wide range of manageable pressing tools. These include models that automate and electronically monitor the pressing operation.

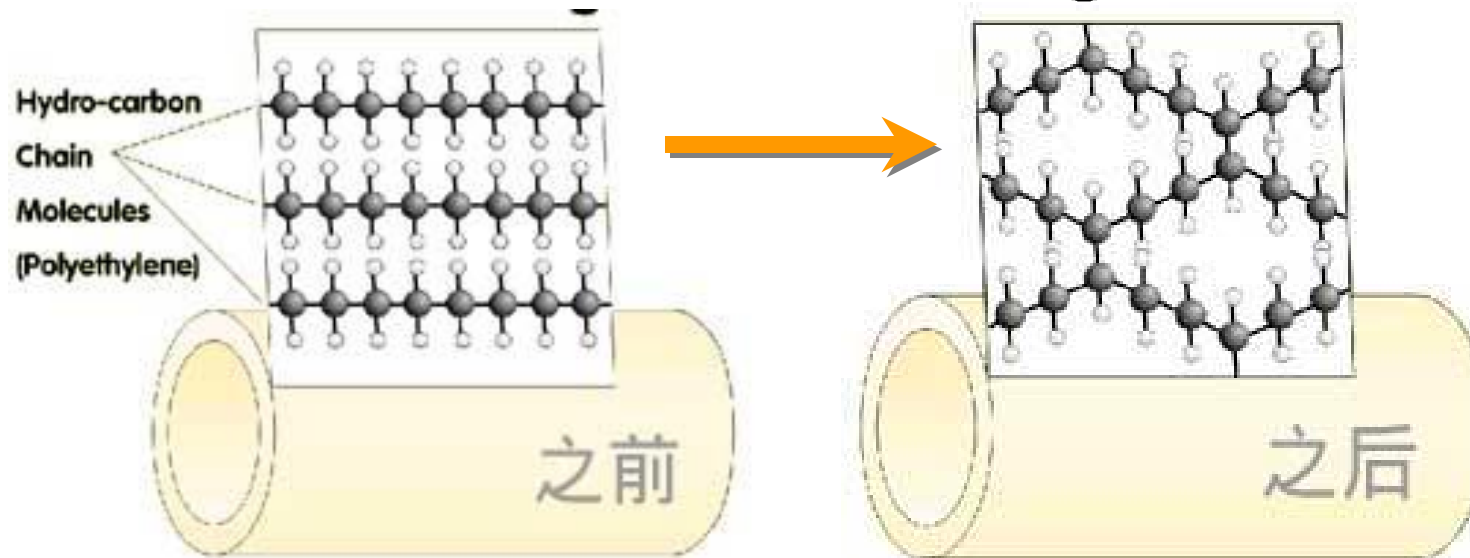
You can rely on the expertise of our partner [Novopress GmbH](#), the supplier of this professional pipe connection equipment.

Water quality and materials

- The characteristics of PEX- pipes are:
 - chemical resistance to all types of water
 - very smooth internal pipe walls
 - pipes do not burst when water freezes.
 - PEX pipe is delivered on coils. It has permanently the tendency to coil and is therefore mainly used for laying in concealed casing pipes.
 - In case of visible installations: very short distance between pipe bearings necessary; alternatively lay pipes on cable channels
 - High expansion coefficient
 - Pipe connections with compression fittings or press fittings => very fast assembly without fire risk

Water quality and materials

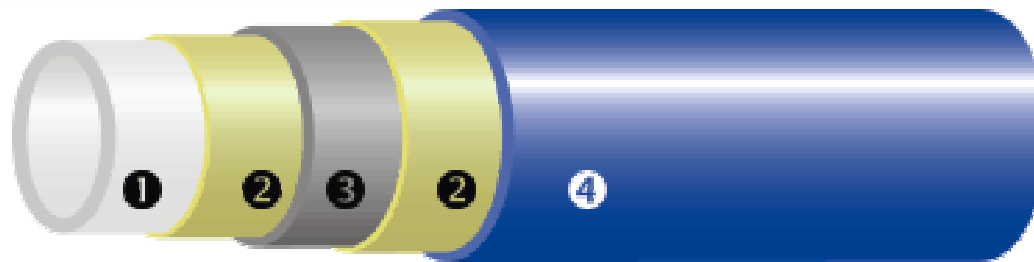
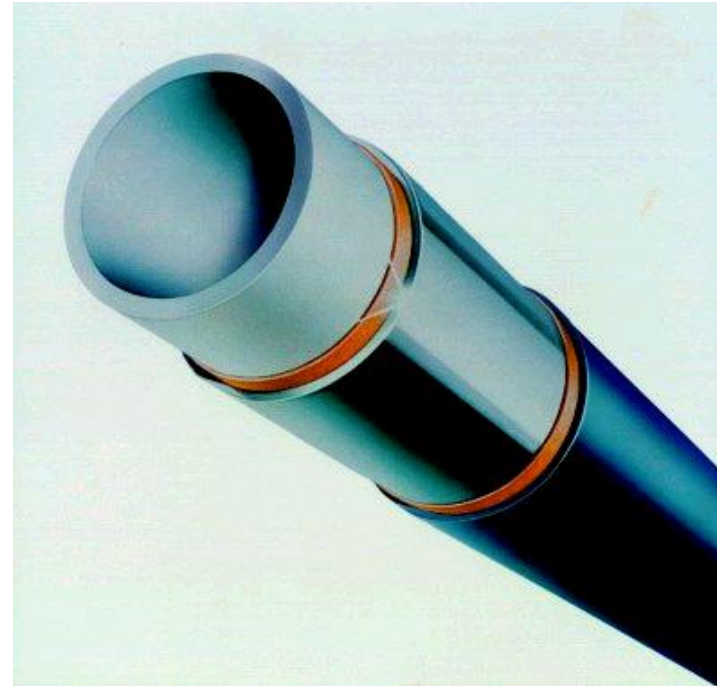
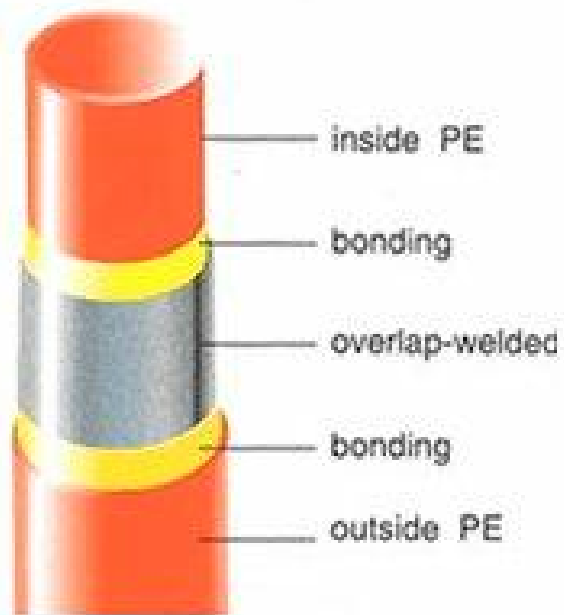
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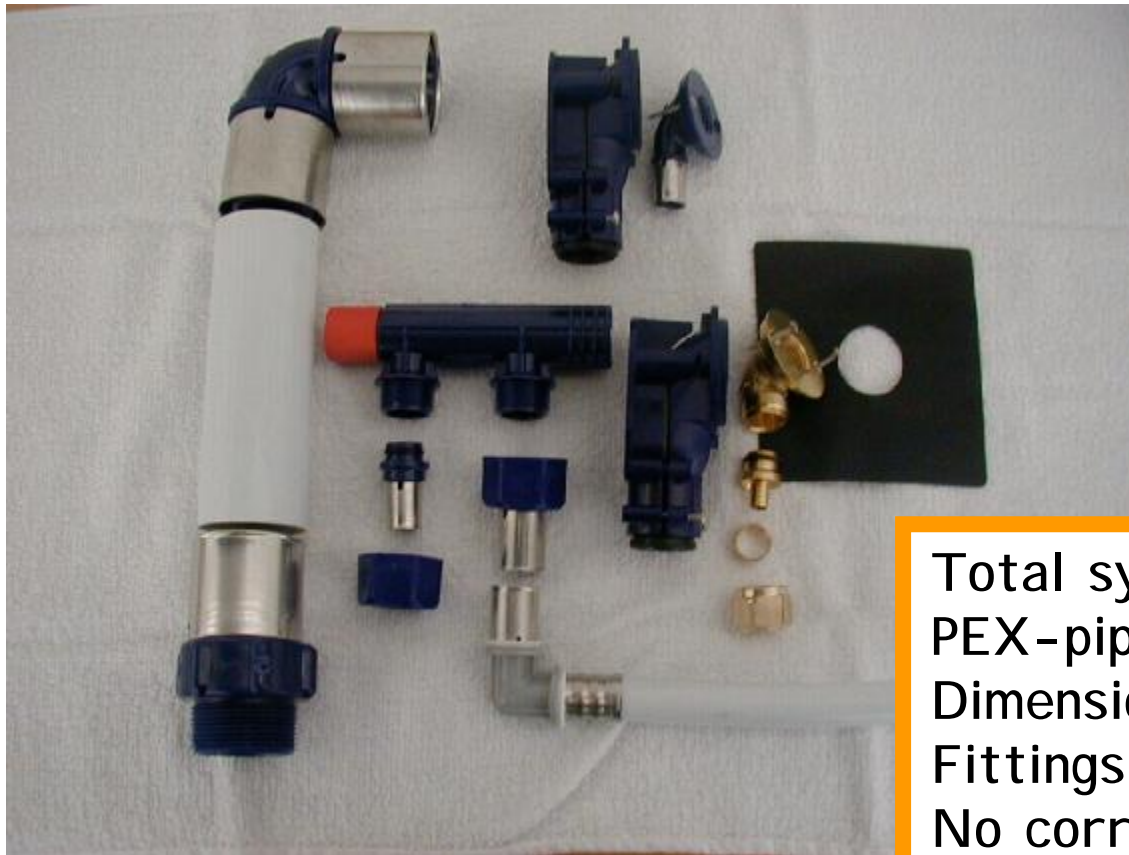
Water quality and materials

- Multilayer-pipes (“alu-PEX-pipes”)
 - This (relatively new) type of pipe consists generally of various layers of aluminium and polymer. The internal layer, which is in contact with the medium, is of cross-linked polyethylene (PEX)..
 - These pipes feature the main advantage of pure PEX pipes (100% chemical resistance against any type of water) without featuring some of the disadvantages such as low form stability, high expansion coefficient etc. Therefore, pure PEX pipes are mainly used in the special case of pipe-in-pipe systems (casing pipe + medium pipe) for under-floor distribution pipes, while for visible pipes, aluPEX is generally the preferable solution.
 - For aluPEX pipe connections, the following methods are used:
 - compression fittings (for small dimensions) and
 - press fittings (for all dimensions)

Water quality and materials



Water quality and materials

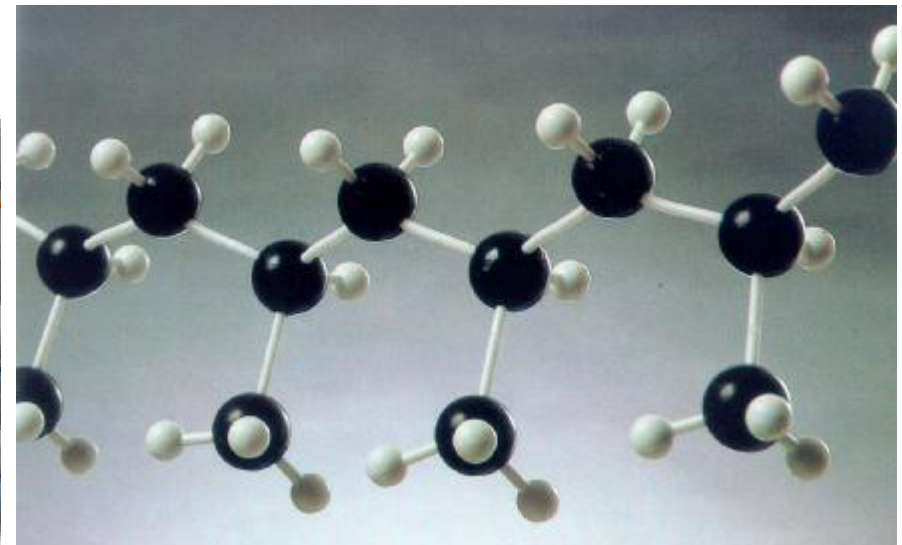
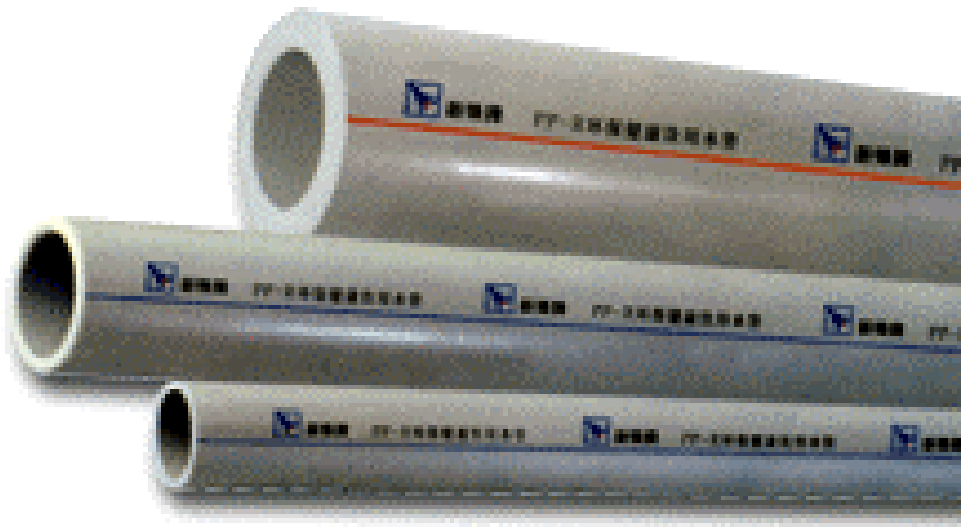


Total system of multilayer PEX-pipes.
Dimensions up to 100 mm.
Fittings in all dimensions.
No corrosion risk.

Water quality and materials

- Polypropylene (PP) pipes
- Can be used in plumbing applications for hot and cold water supply. With its many advantages over the old / traditional metal pipes
- Maximum hot water temperature in Germany 70 °C. Is not approved in Denmark for hot water.

Water quality and materials



Corrosion and corrosion protection

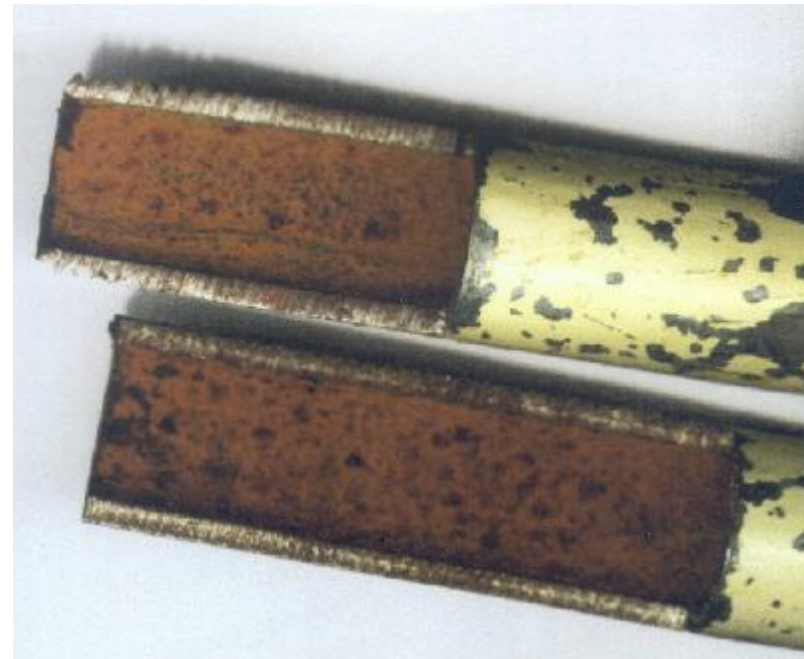
- Corrosion kan **only** take place under the following cirkunstanses:
- There have to be:
 - Metal
 - Water
 - Oxygen
- That means:
 - metal + water + oxygen => corrosion
 - $2\text{Fe} + 2\text{H}_2\text{O} + \text{O}_2 \Rightarrow 2\text{Fe}(\text{OH})_2$
- All parts have to be represented in the equation

Corrosion and corrosion protection

- Galvanised steel pipes
- The use of galvanised steel pipe is always connected with a pronounced risk of corrosion. It is advised to use galvanised steel pipe only, if one has reliable and safe experiences from the water supply area in question.

Corrosion and corrosion protection

- Corrosion on galvanised steelpipes in water containing either a lot of calcium (hard water) or very little of calcium (soft water).
- Both kind of water will give trouble with corrosion.
 - High conductivity
 - Low conductivity and CO_2



Corrosion and corrosion protection

- Pit corrosion in a hotwaterinstallation on a galvanised steelpipe



Corrosion and corrosion protection

- Pit corrosion on a galvanised steel pipe from a hotwaterinstallation..



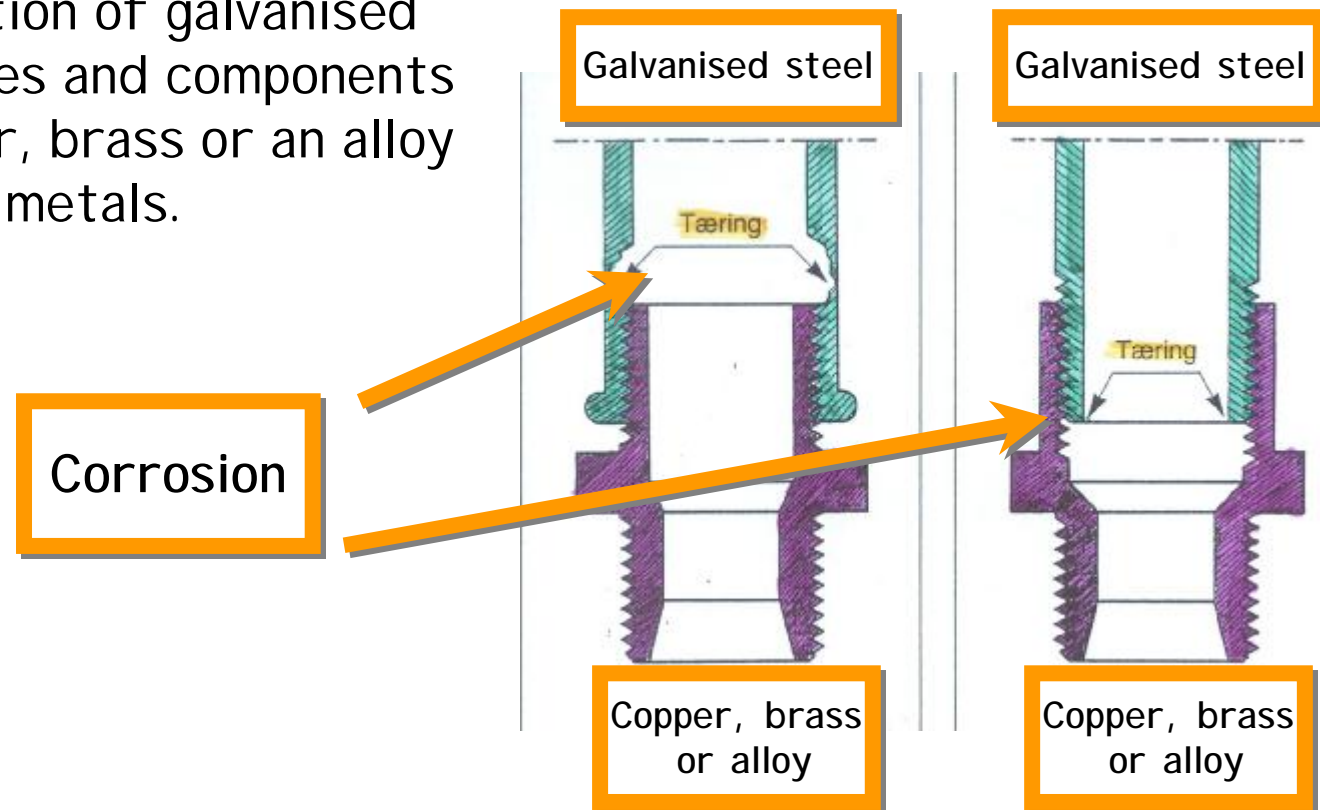
Corrosion and corrosion protection

- Pit corrosion in a galvanised steel pipe from a hotwaterinstallation.



Corrosion and corrosion protection

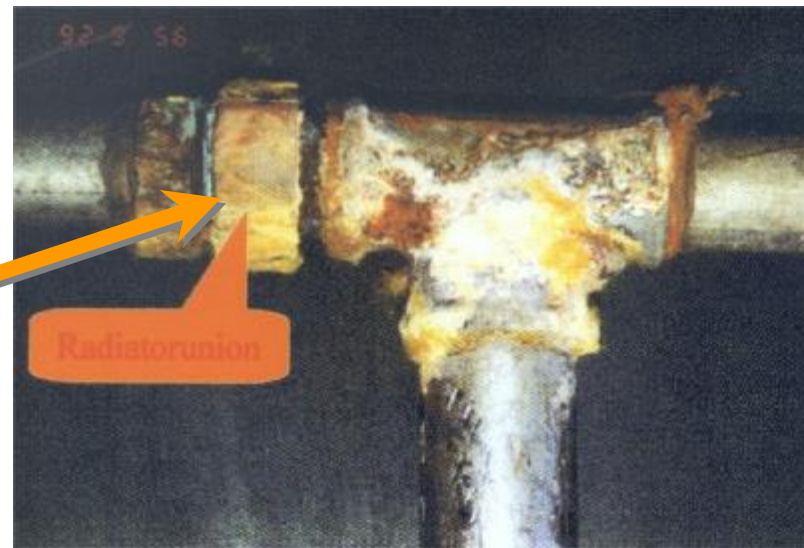
- Combination of galvanised steel pipes and components of copper, brass or an alloy of other metals.



Corrosion and corrosion protection

- Corrosion in a galvanised steel pipe connected to a brass fitting

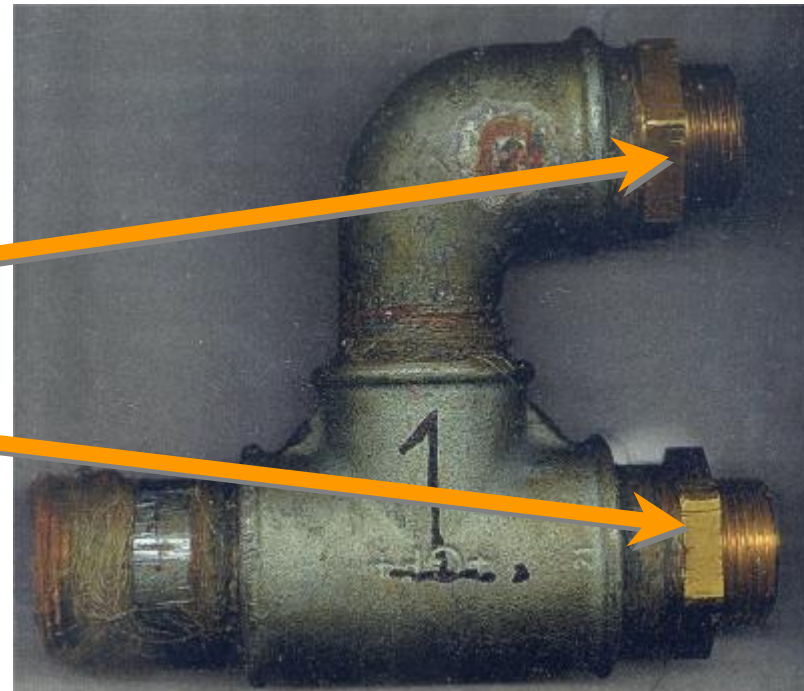
Brassfitting



Corrosion and corrosion protection

- Corrosion in a galvanised pipefitting connected to brass fittings for PEX-pipes.

Brass fittings for
PEX-pipes



Corrosion and corrosion protection

- Corrosion in a galvanised pipefitting in connection with a nickel plated valve.

Nickel plated valve



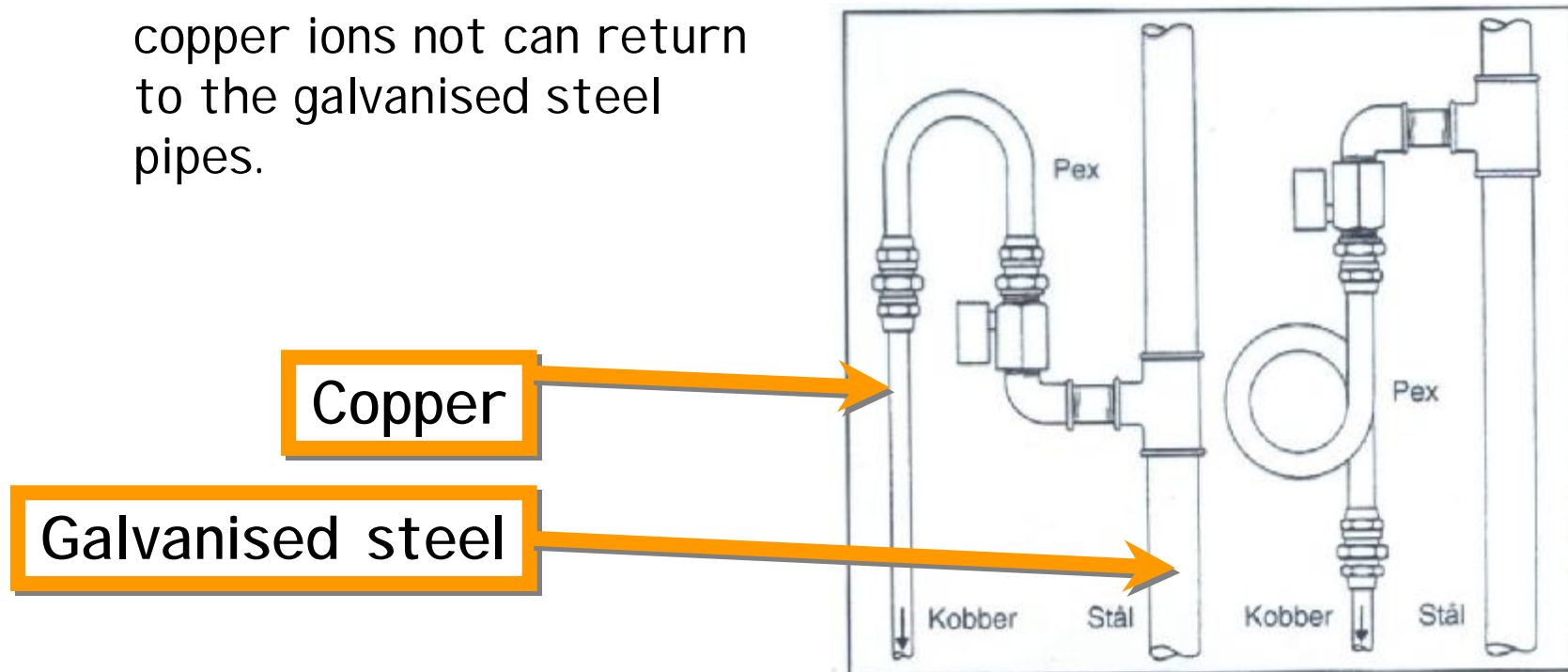
Corrosion and corrosion protection

- Combination between galvanised steel and copper must be made so copper ions not can return to the galvanised steel pipes.



Corrosion and corrosion protection

- Protection with PEX so copper ions not can return to the galvanised steel pipes.

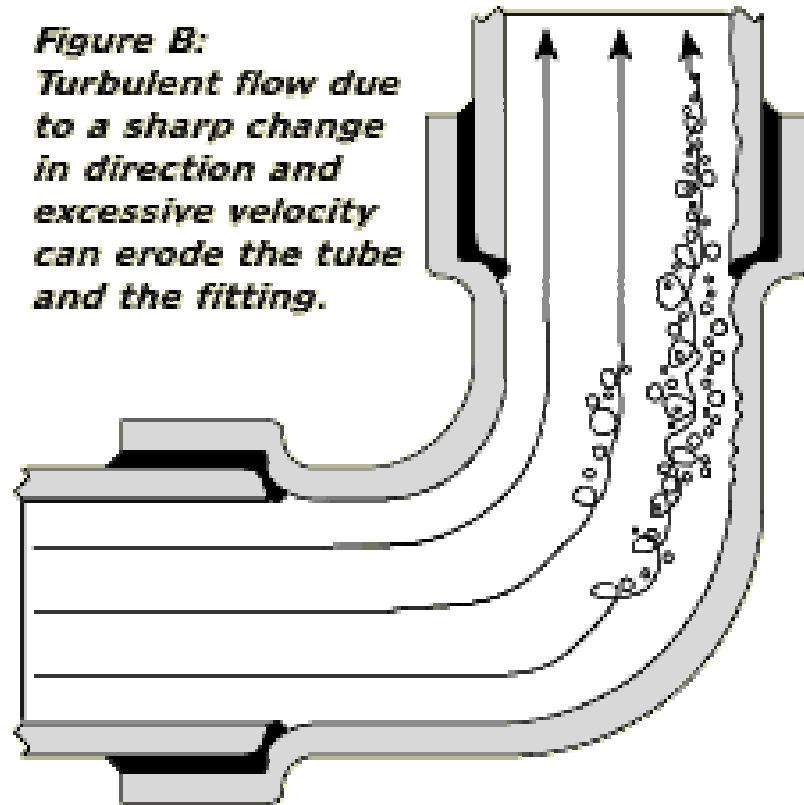


Corrosion and corrosion protection

Turbulence corrosion in copperpipes

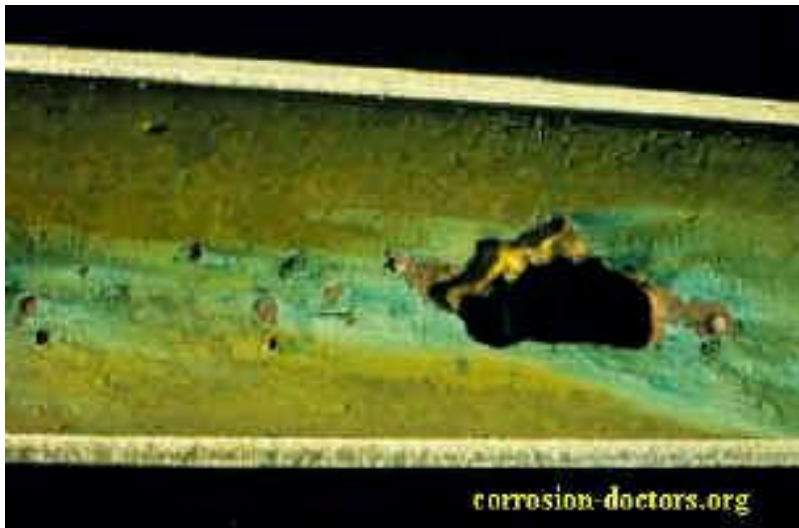
Type of pipeline	Installation method	Max. allowable velocity in m/s at temperature °C <25°C <70°C	Notes
Dis tribution line	Changeable	No limit	
	Not changeable	2,0 1,3	
Connection pipe	Changeable	No limit	
	Not changeable	4,0 4,0	
Line with continuous flow such as circulation lines		2,0 0,5	

Figure B:
Turbulent flow due to a sharp change in direction and excessive velocity can erode the tube and the fitting.



Corrosion and corrosion protection

Turbulence corrosion in copperpipes



Corrosion and corrosion protection

- Copper pipe expands considerably when heated. The expansion, for example, by heating up by 60 °C is 1 mm/m pipe. The pipes must be allowed to expansion freely, otherwise breakage from fatigue will occur.



Corrosion and corrosion protection

- These pipes are not allowed to expansion freely, therefor a breakage from fatigue will occur.



Corrosion and corrosion protection

- Stainless steel pipes which is not connected correctly before pressing.
- If the chloride contents is $> 150 \text{ mg/l}$, corrosion can take place between the fitting and the pipe.



Corrosion and corrosion protection

Electrolysis and catholysis

- The primary function of **electrolysis** and **catholysis** is to protect the pipe installation against corrosion.
- The **electrolysis** and **catholysis** ensure that there will be no oxygen on the surface of the pipe.

Unprotected

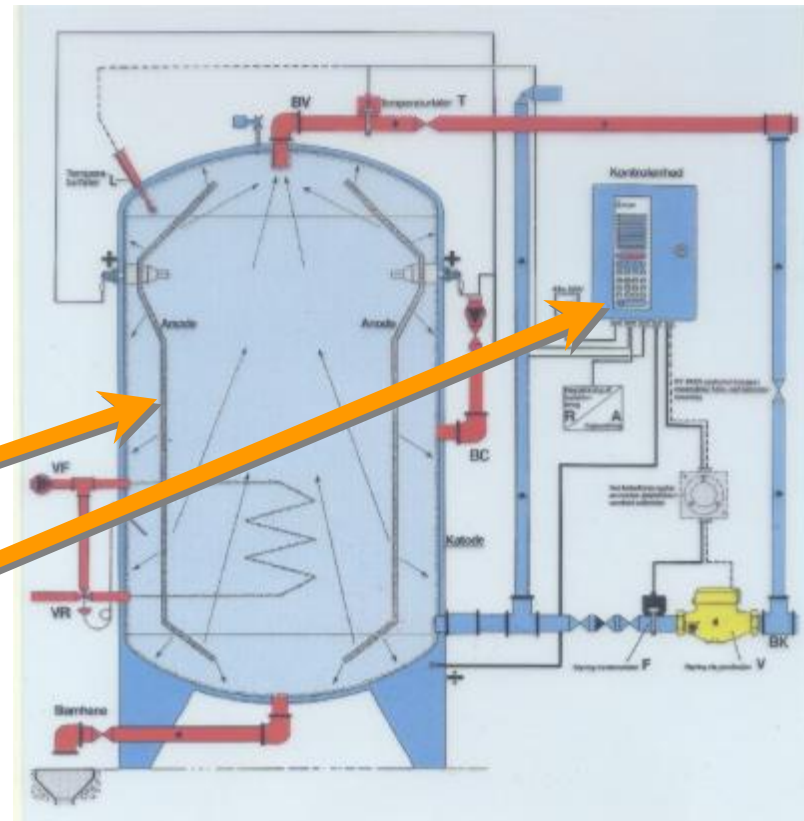


Protected



Electrolysis and catholysis

- Normal Electrolysis with aluminium anodes in the tank and controlled by a control box in the room.
 - Anodes
 - Control box



Electrolysis and catholysis

- Normal Electrolysis with aluminium anodes in the tank and controlled by a control box in the room.
 - Anodes
 - Control box



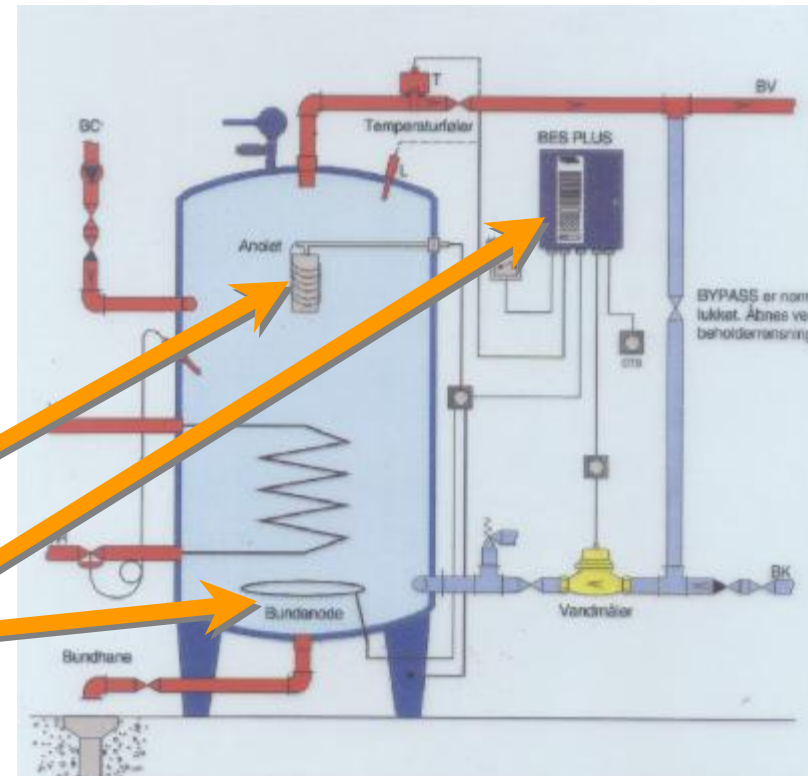
Electrolysis and catholysis

- Normal Electrolysis with aluminium anodes in the tank and controlled by a control box in the room.
 - Anodes
 - Electrical comections



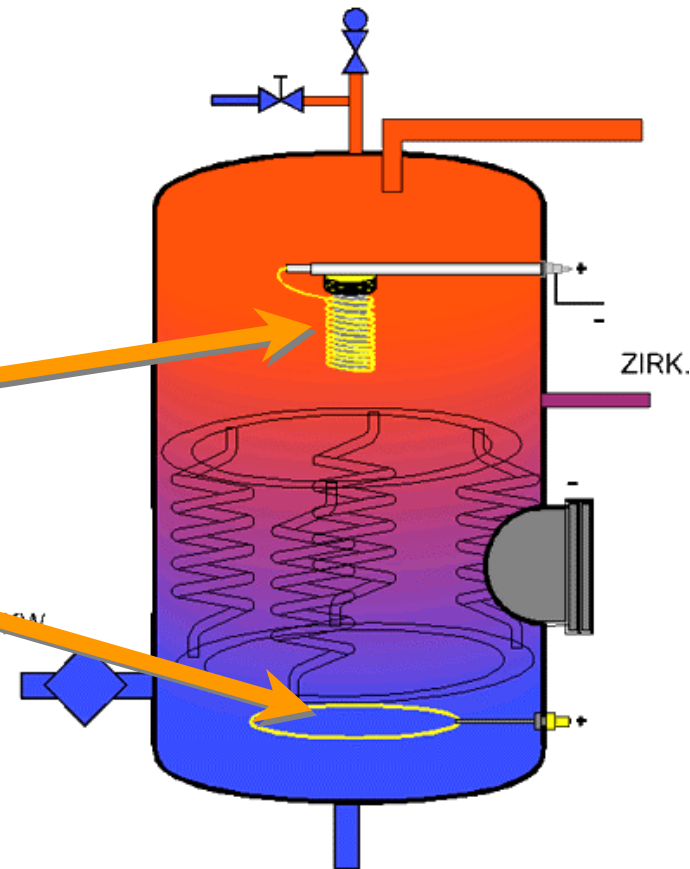
Electrolysis and catholysis

- Katorack (catholysis) with special anodes in the tank and controlled by a control box in the room.
 - Anodes
 - Control box



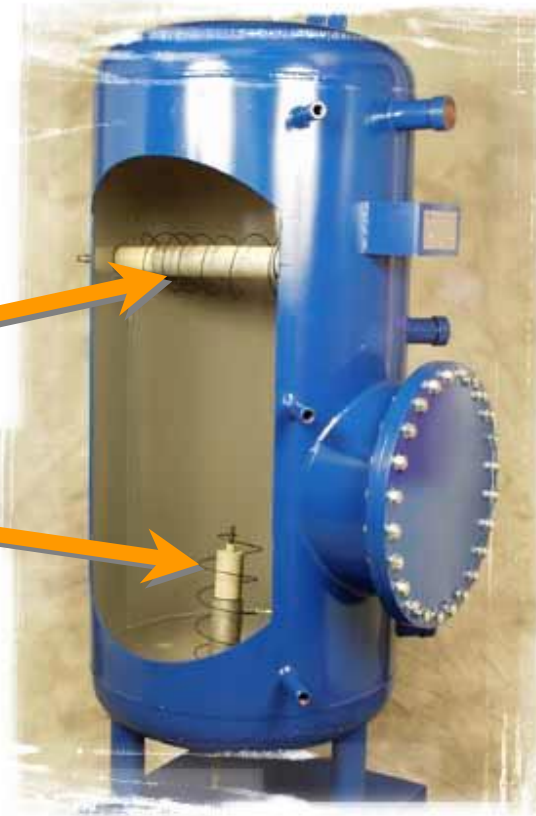
Electrolysis and catholysis

- Catholysis with special anodes in the tank.
- Anodes



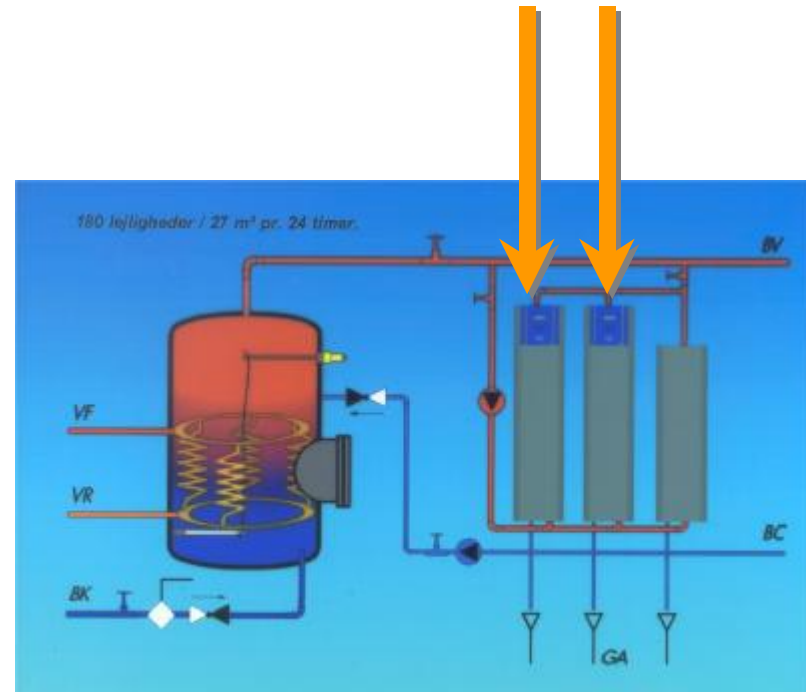
Electrolysis and catholysis

- Catholysis with special anodes in the tank.
- Anodes



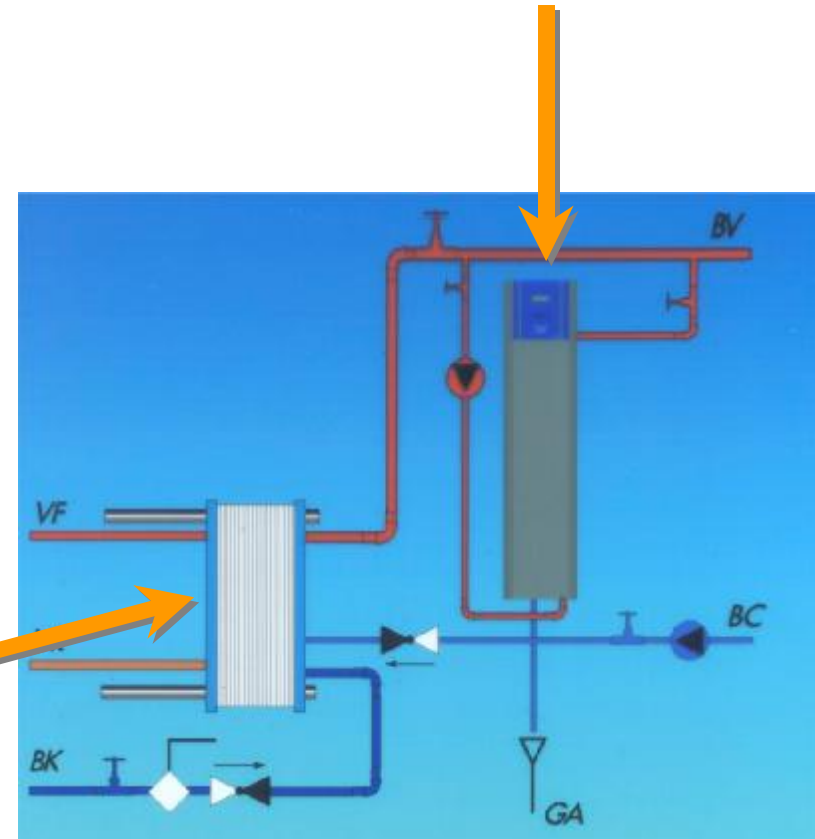
Electrolysis and catholysis

- Catholysis units for a tank where the system is placed outside the tank. Normally used in connection with tanks of stainless steel.



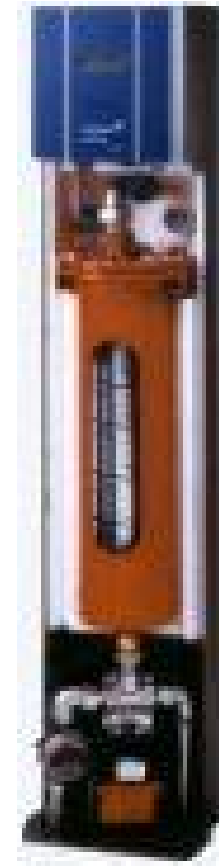
Electrolysis and catholysis

- Catholysis units for a system with a heat exchanger where the system is placed in connection to the heat exchanger.



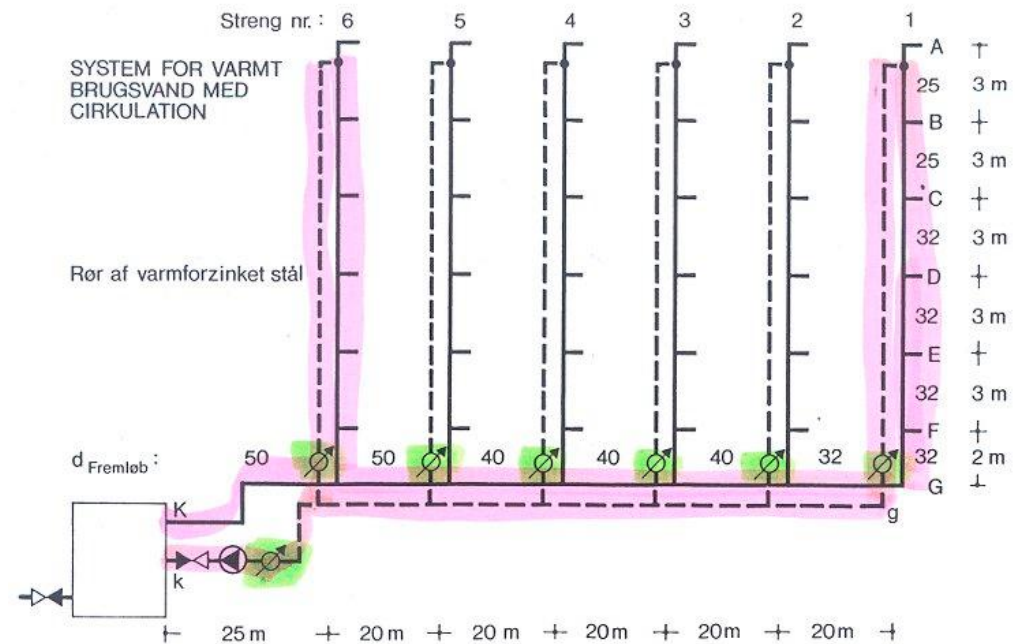
Electrolysis and catholysis

- Catholysis unit



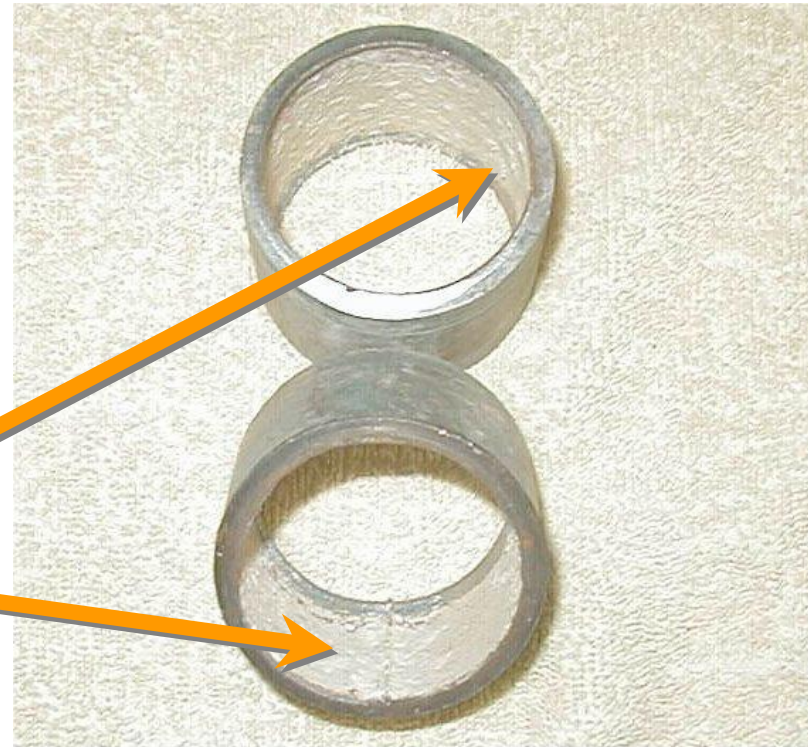
Electrolysis and catholysis

- Re-circulation shall provide minimum flow velocity of 0.05 - 0.1 m/s in corrosion protected systems



Electrolysis and catholysis

- Pipeinstallation protected by electrolysis. The inner of the pipe has got a protecting surface by aluminium.



Electrolysis and catholysis

- Pipeinstallation protected by catholysis. There has been corrosion in the pipe but is stopped by the catholysis wich remove the oxygen from the surface

Black.
Meens no oxygen

