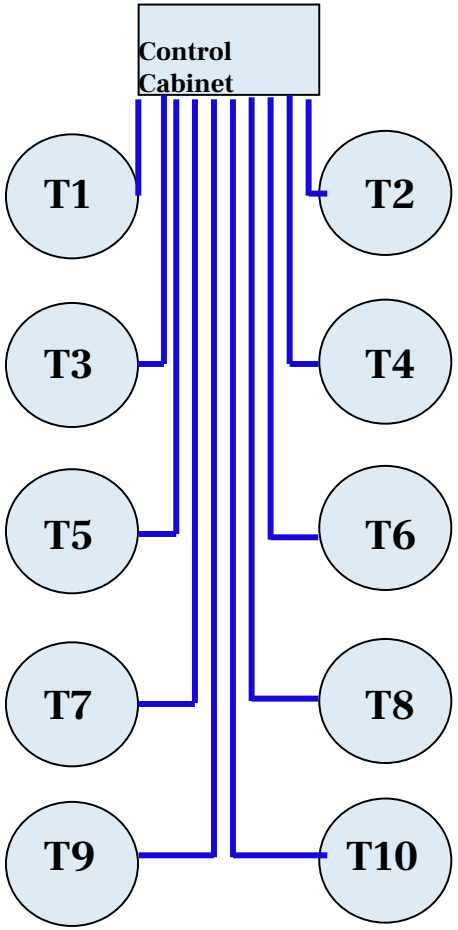
Winery Engineers Conference 2008
Decentralised Control concepts for Tank Farm

1. Centralised Control
2. Decentralised Control
3. Technology for decentralised control
4. Ethernet based fieldbuses
5. Webservers and email
6. Actuated valves
7. Tubing for decentralised installations

1. Centralised control Concepts

Installation Characteristics

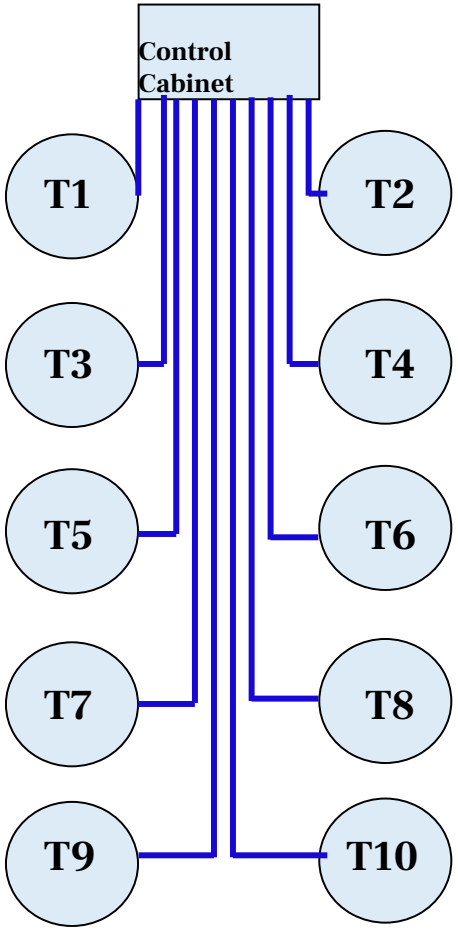
- Central control cabinet
- Long cable runs
- Intensive wiring terminals in cabinet
- Wiring cost often higher than the sensor or actuator.
- Only essential sensors installed because of high installation costs



1. Centralised control Concepts

Operational Characteristics

- Long cable runs – power loss, tedious to replace.
- Intensive wiring terminals in cabinet – Difficult to fault find.
- Only essential sensors installed – Limited Diagnostics, no redundancy.
- Long walks to manually switch valves and agitators.

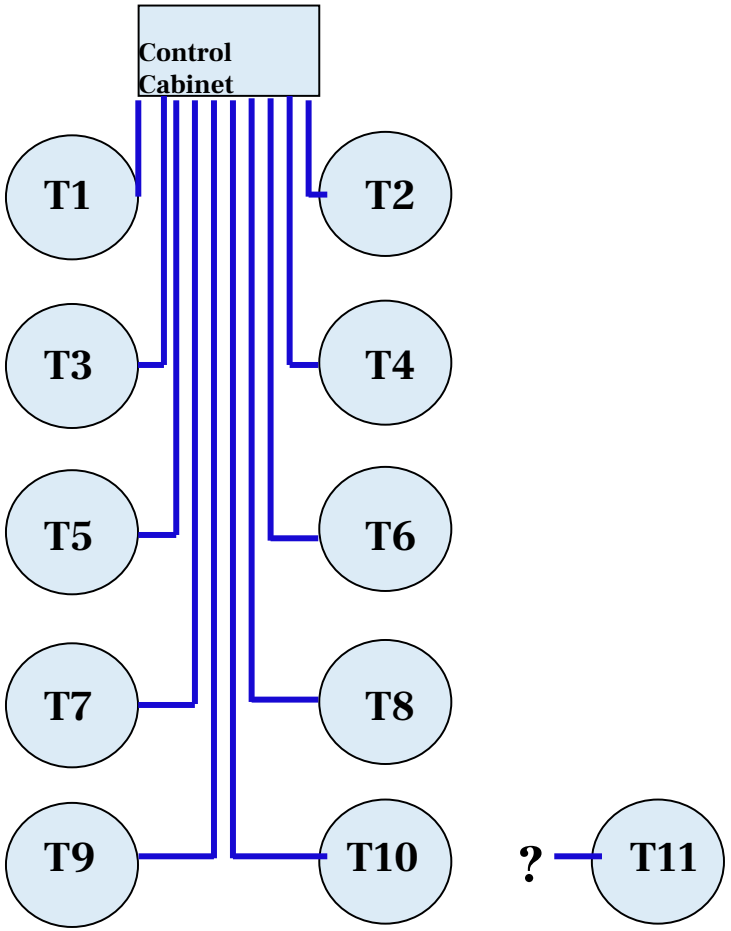


1. Centralised control Concepts

Expansion of tank farm difficult because:

- **Control cabinet is full.**
- **Cable ladders and conduit are full.**
- **Additional tanks furthest from control cabinet, hence long expensive cable runs.**

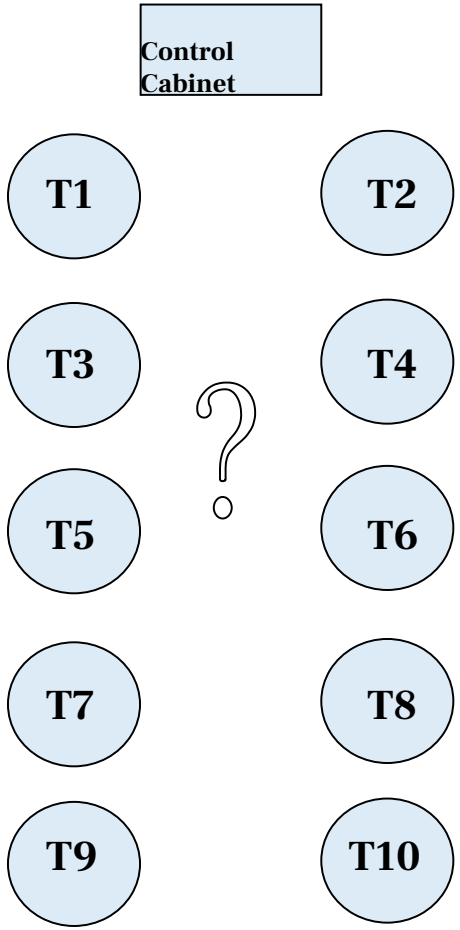
Centralised control is not scaleable.



1. Centralised control Concepts

How do we design the control system of a tank farm to be:

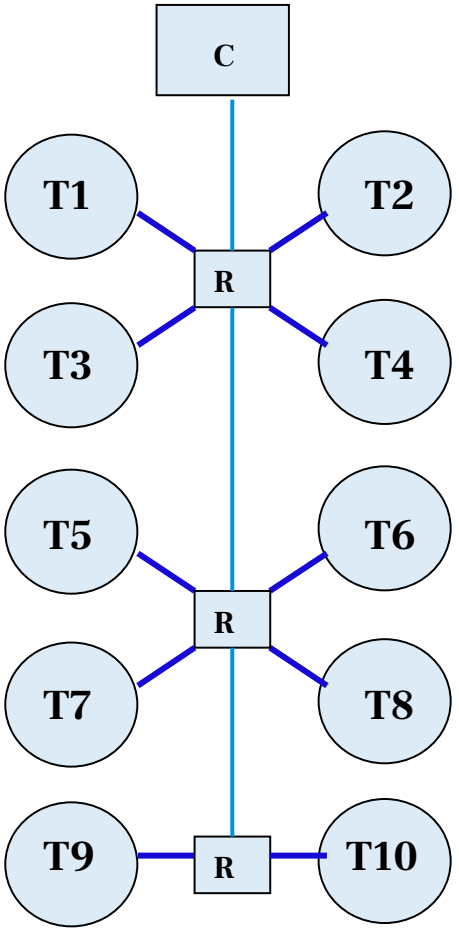
- **Simple**
- **Inexpensive**
- **Scaleable**
- **Autonomous**
- **Reliable?**



2. Decentralised control Concepts

Installation characteristics

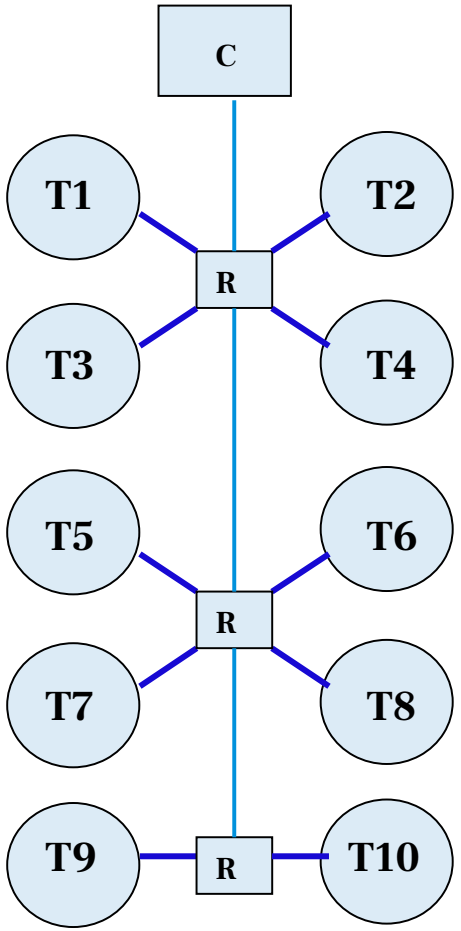
- Small central control cabinet
- Several small remote control cabinets servicing approx 4 tanks each.
- All wiring and plumbing of sensors and actuators over short distances to local control cabinets.
- Signals to and from main controller via a fieldbus.
- Single power cable distributing power to all control cabinets, signal switching occurs inside remote cabinets.



2. Decentralised control Concepts

New possibilities

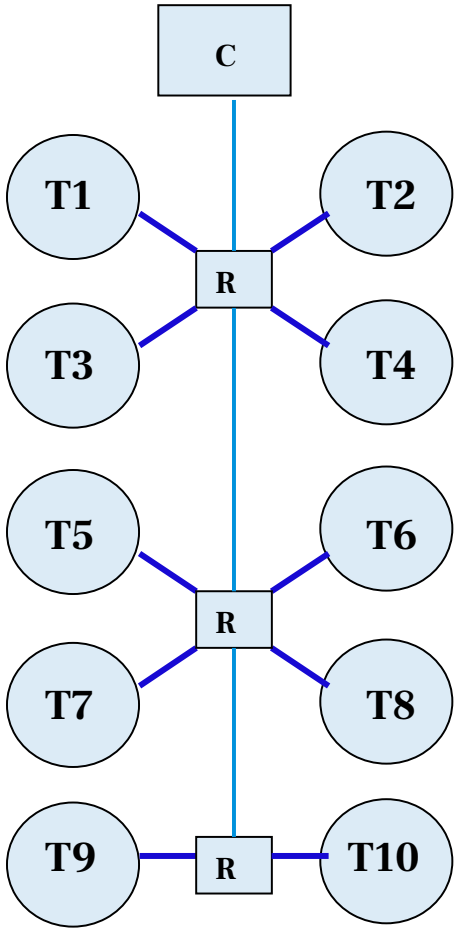
- Short cable runs means that it is easy to install additional sensors.
- Pneumatic actuators easier to install and use thanks to short tube lengths to local cabinet.
- Agitators wired to contactor in local cabinet and actuated from main controller.
- Single power cable distributing power to all control cabinets, signal switching occurs inside remote cabinets.



2. Decentralised control Concepts

Advantages

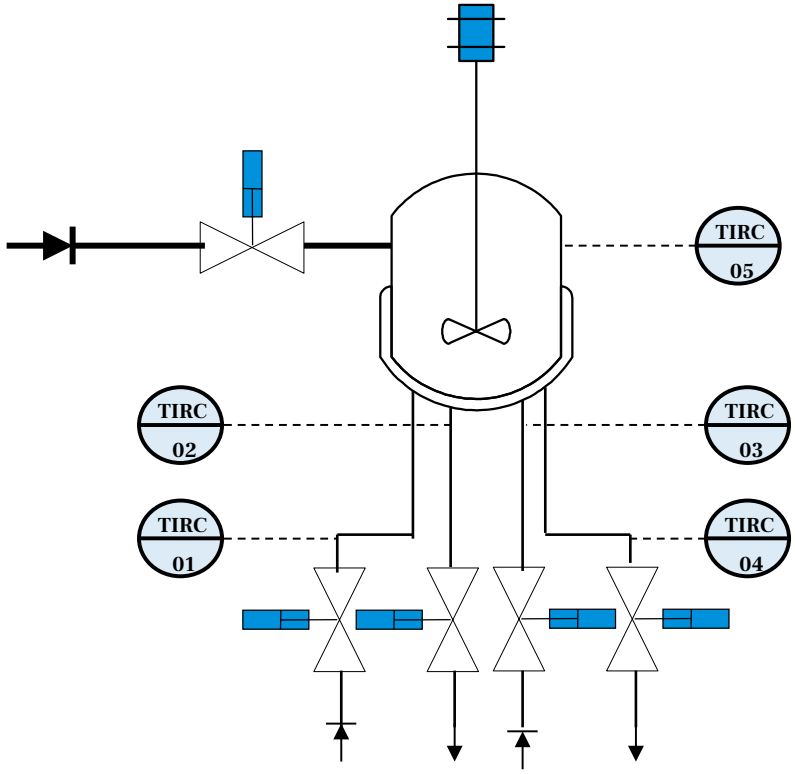
- High reliability thanks to extra sensors and reduced complexity.
- Lower installation costs thanks to reduced wiring and cable runs.
- Autonomous thanks to elimination of manual valves and remote switches.
- Scaleable – more tanks may be added to the existing control system, simply plug them in!



2. Decentralised control Concepts

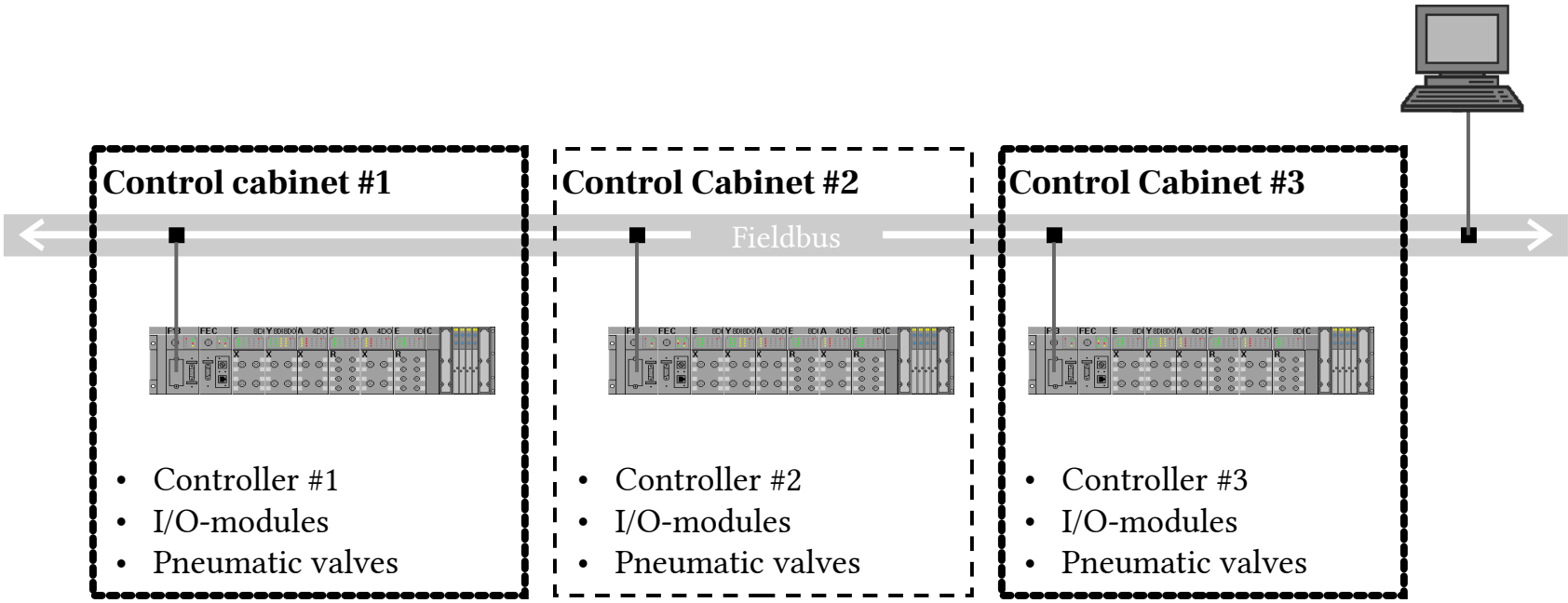
Detail – Control signals per tank.

Analogue Inputs (6)	
Cold Brine temperature in	Hot Brine Temperature in
Cold Brine temperature out	Hot Brine Temperature out
Wine temperature	Wine level
Digital Outputs (7)	Agitator On
Cold Brine in valve open	Hot Brine in valve open
Cold Brine out valve open	Hot Brine out valve open
Wine valve open	Agitator On
Digital Inputs (10)	
Cold Brine valve in open	Cold Brine valve in closed
Cold Brine valve out open	Cold Brine valve out closed
Hot Brine valve in open	Hot Brine valve in closed
Hot Brine valve out open	Hot Brine valve out closed
Local Pushbutton Agitator on	Local Pushbutton Agitator off



3. Technology for Decentralised Control

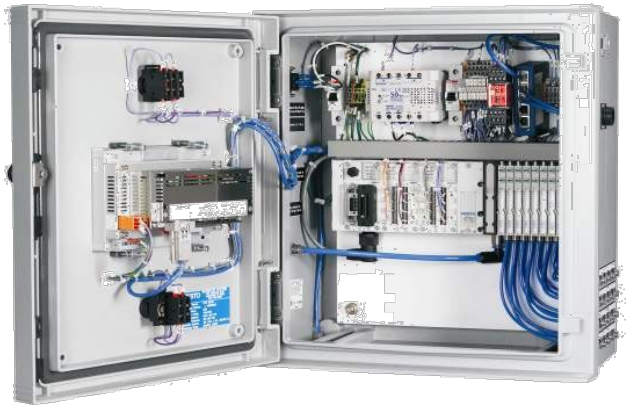
One Valve terminal central to each control cabinet.

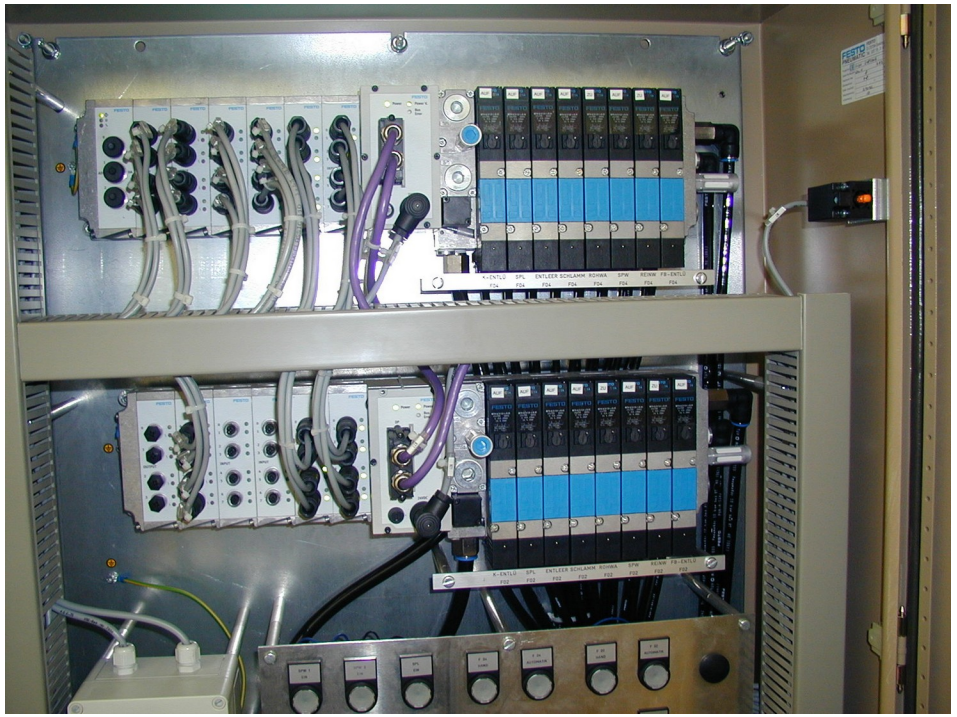


3. Technology for Decentralised Control

Valve terminals

- With digital inputs and outputs.
- With analogue inputs and outputs.
- With Pneumatic valves supplied from a common air supply.
- With a fieldbus interface to communicate to the main controller.





4. Ethernet Based Fieldbuses

Communication between master control system and remote cabinets is via an Industrial communications network, (FIELDBUS).

There are many Fielbuses on the market to choose from.

However the long distances encountered in tank farms favours Ethernet based Fieldbuses.

4. Ethernet Based Fieldbuses

Several available on the market, the main ones:

EtherCat

EtherNet/IP

Modbus over TCP/IP

ProfiNet

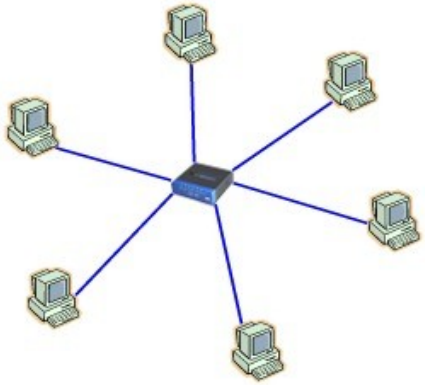
4. Ethernet Based Fieldbuses

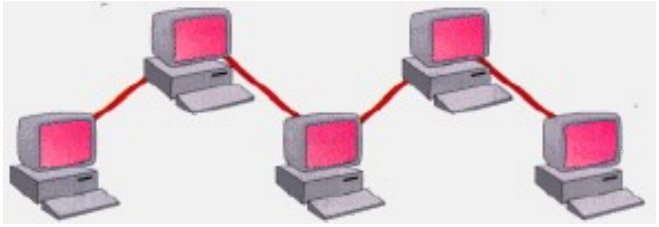
Through the use of ethernet switches several network topologies are possible:

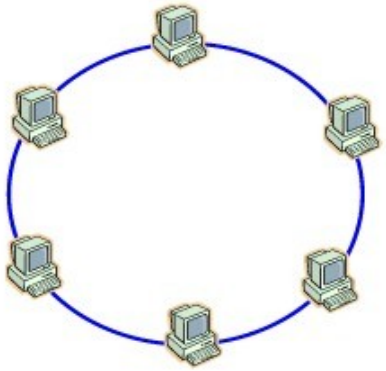
Star Topology

Line Topology

Ring Topology (Redundant)



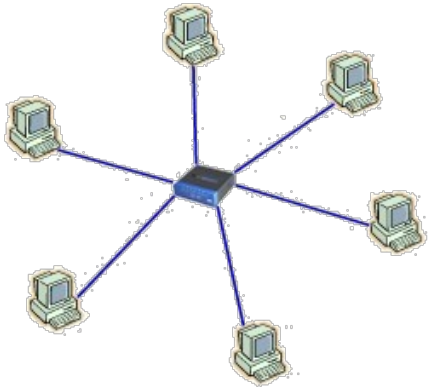


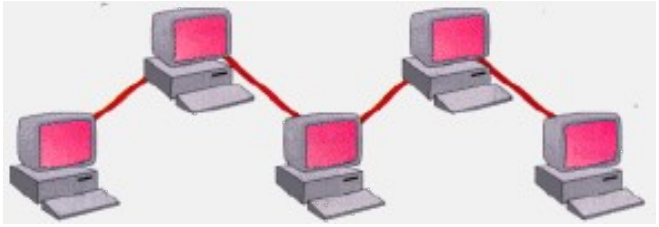


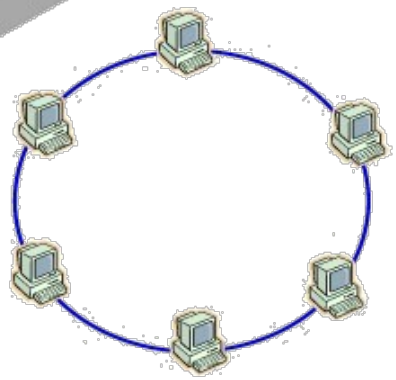
4. Ethernet Based Fieldbuses

Long distances are not a problem:

- **Max 100m per segment using twisted pairs (copper technology) 100Base-TX**
- **Max 412m per segment using fibre optics 100Base-FX**
- **Devices with integrated switch eliminates the need for an ethernet switch in each cabinet.**







5. Webservers and Email

Several Protocols may run over Ethernet at the same time.

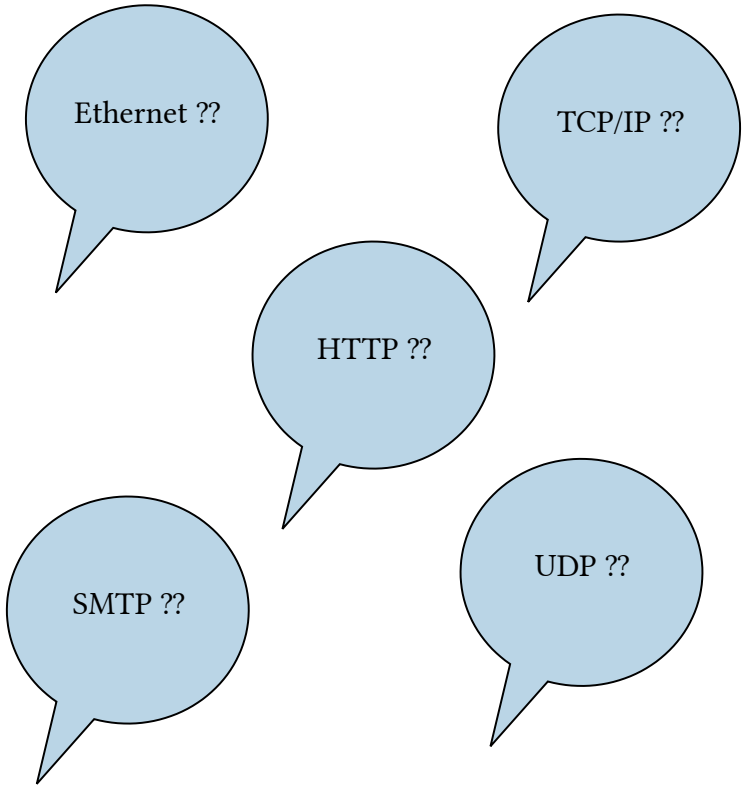
SMTP - Email

HTTP - Webpages

DHCP

Telnet

FTP



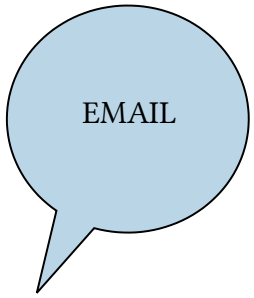
5. Webservers and Email

Email

TO: supervisor@winery.com

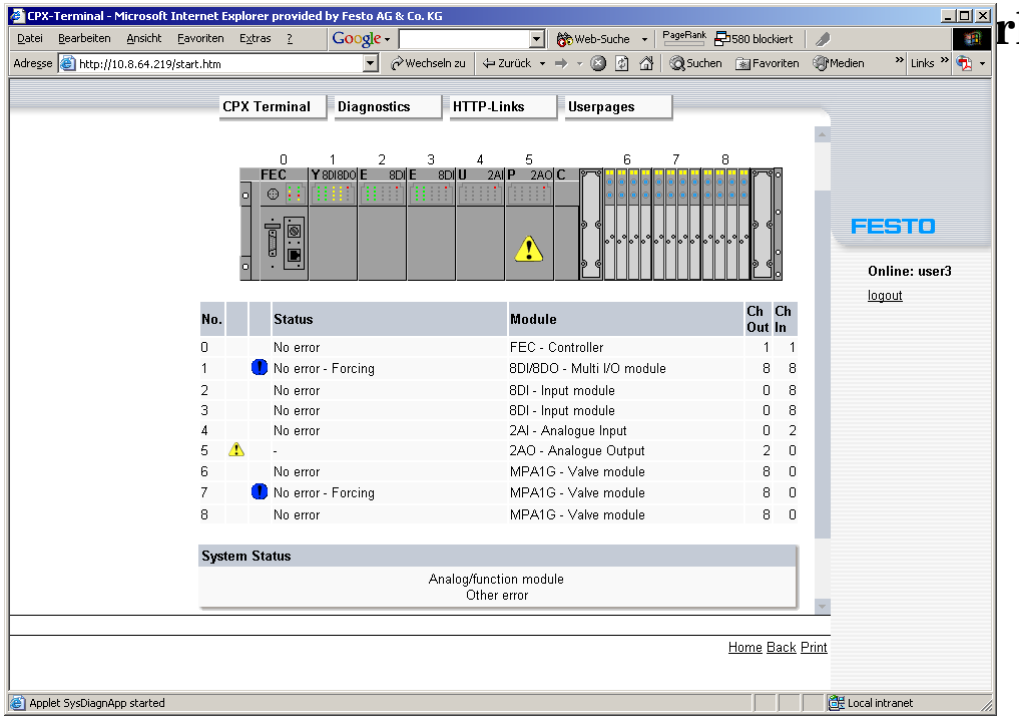
SUBJECT: Tank 12 High Temperature

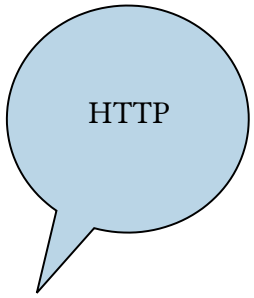
MESSSAGE: Warning wine temperature at 32 deg C!



5. Webservers and Email

Webserver integrated directly into remote devices.





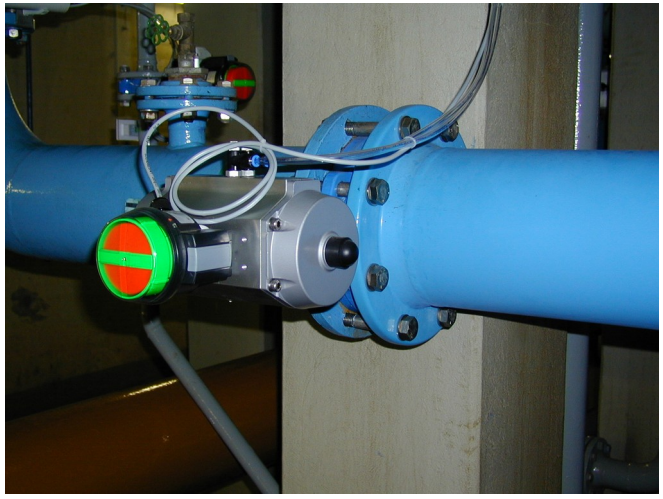
6. Actuated Valves

Pneumatically Actuated valves:

Ball Valves.

Butterfly valves.

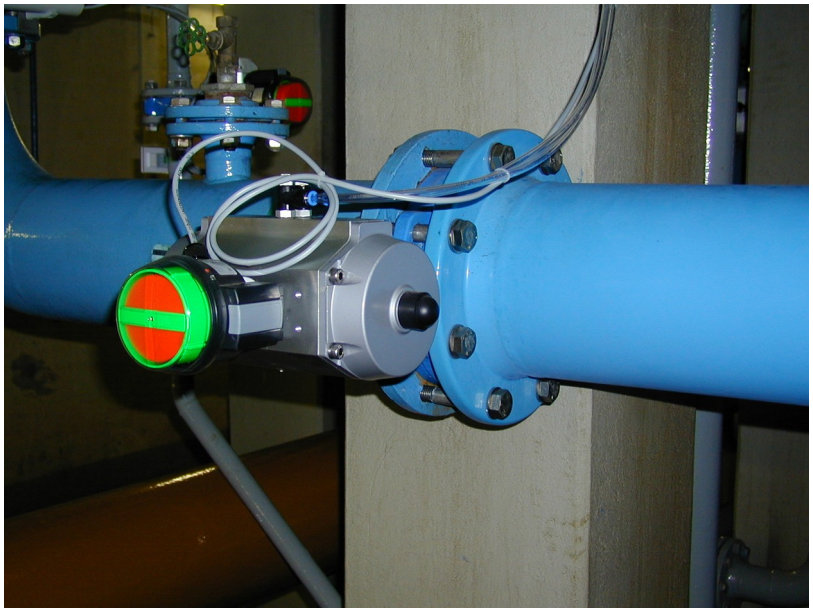
Knifegate valves.



6. Actuated Valves

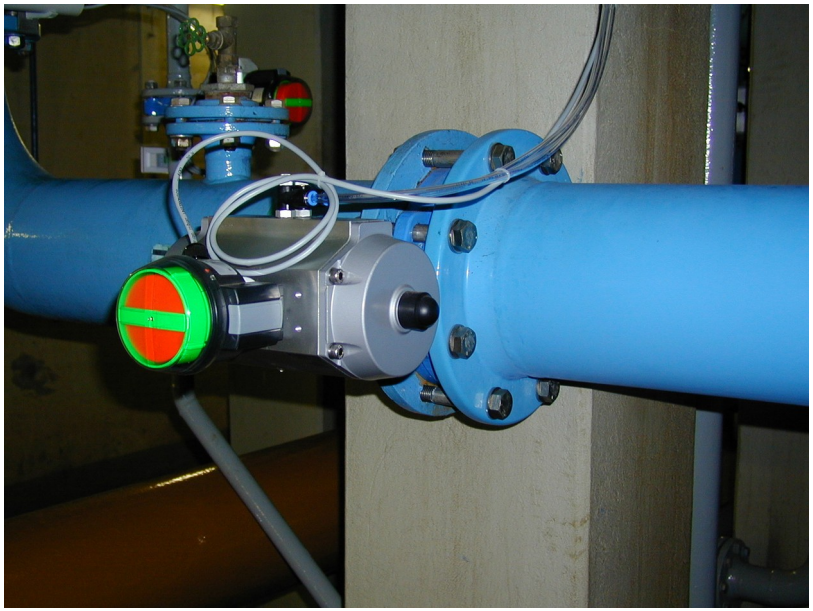
Positive feedback easy to integrate via 2 electrical limit switches.

Visual feedback via indicator on sensor box.



6. Actuated Valves

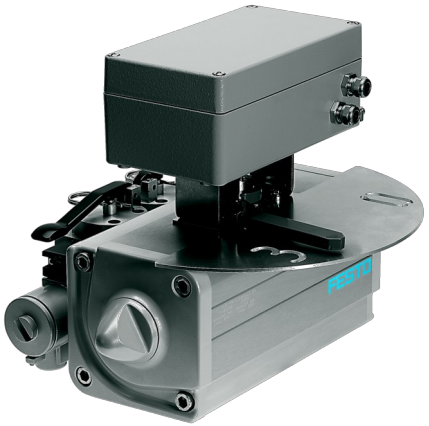
Opening and closing speed of valves may be adjusted via flow controls to prevent hammering.



6. Actuated Valves

Actuated valves may also be position via the use of a positioner to vary the flow rate of fluid.

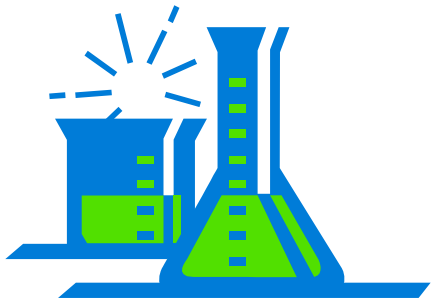
This allows for improvement in the regulation of temperature.



6. Tubing selection

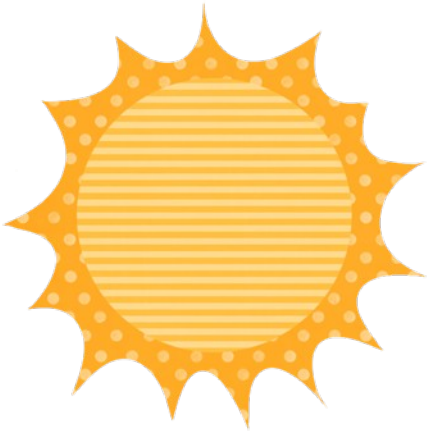
Pneumatic tubing installed in a tank farm is eposed to several elements.

- Sun -> UV rays
- Rain -> Hyrolisis
- High and low Temperatures
- Possible exposure to wine
- Caustic washdown



6. Tubing selection

UV Exposure



Polyethylene

Bild 10 PLN-8x1,25 natur

Polyethylene – Black Resistant

Bild 11 PLN-8x1,25 schwarz

Polyurethane

Bild 12 PUN-8x1,25 silber

Polyurethane

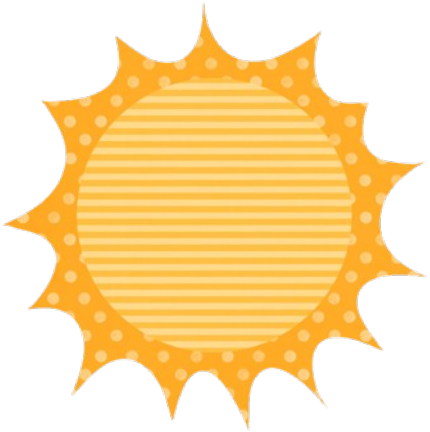
Bild 13 PUN-H-8x1,25 blau

Polyurethane Black - Resistant

Bild 15 PUN-H-8x1,25 schwarz

6. Tubing selection

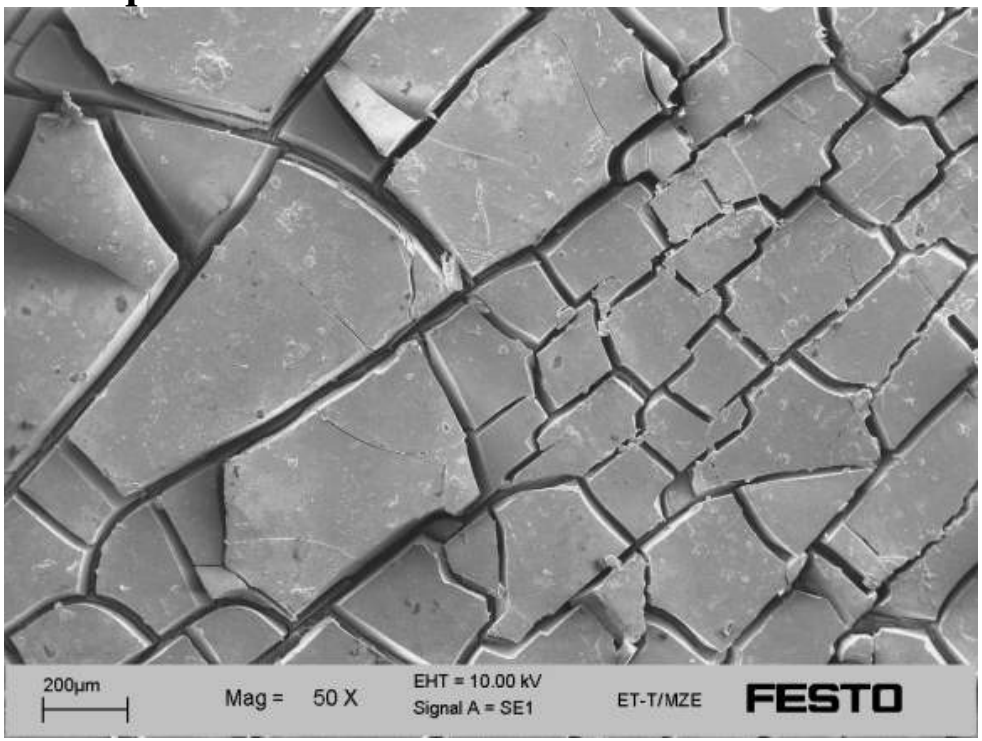
UV Exposure

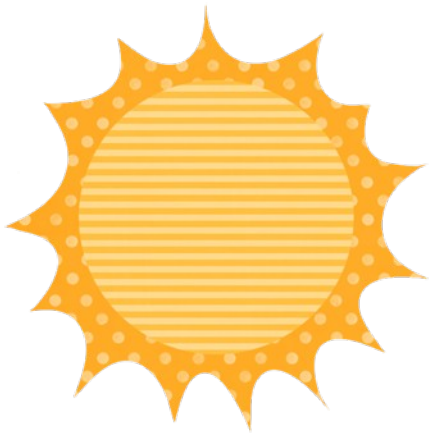


Changed colour and huge network of cracks due to UV radiation

6. Tubing selection

UV Exposure

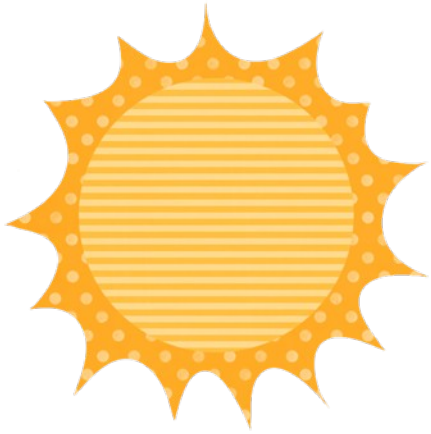




Huge network of individual cracks due to UV radiation

6. Tubing selection

UV Exposure



UV Resistant Tube:

Perfluor – alkoxyalkan also hydrolisis resistant

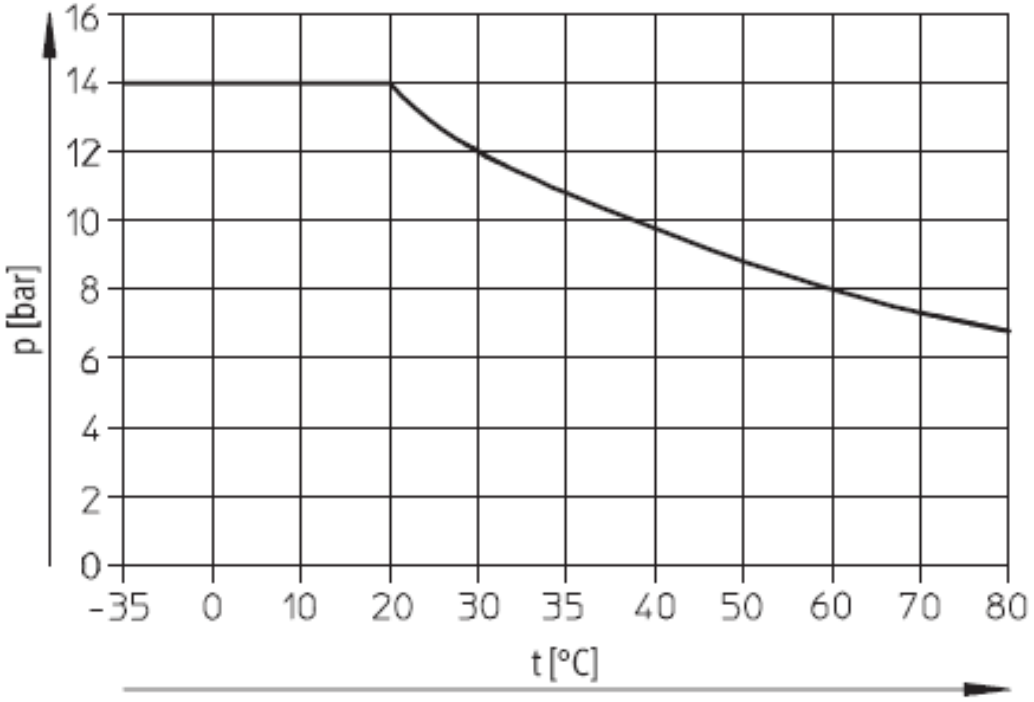
Polyethylene – Black only also hydrolisis resistant

Polyurethane –Black only

6. Tubing selection

High temperatures

Operating pressure p as a function of temperature t

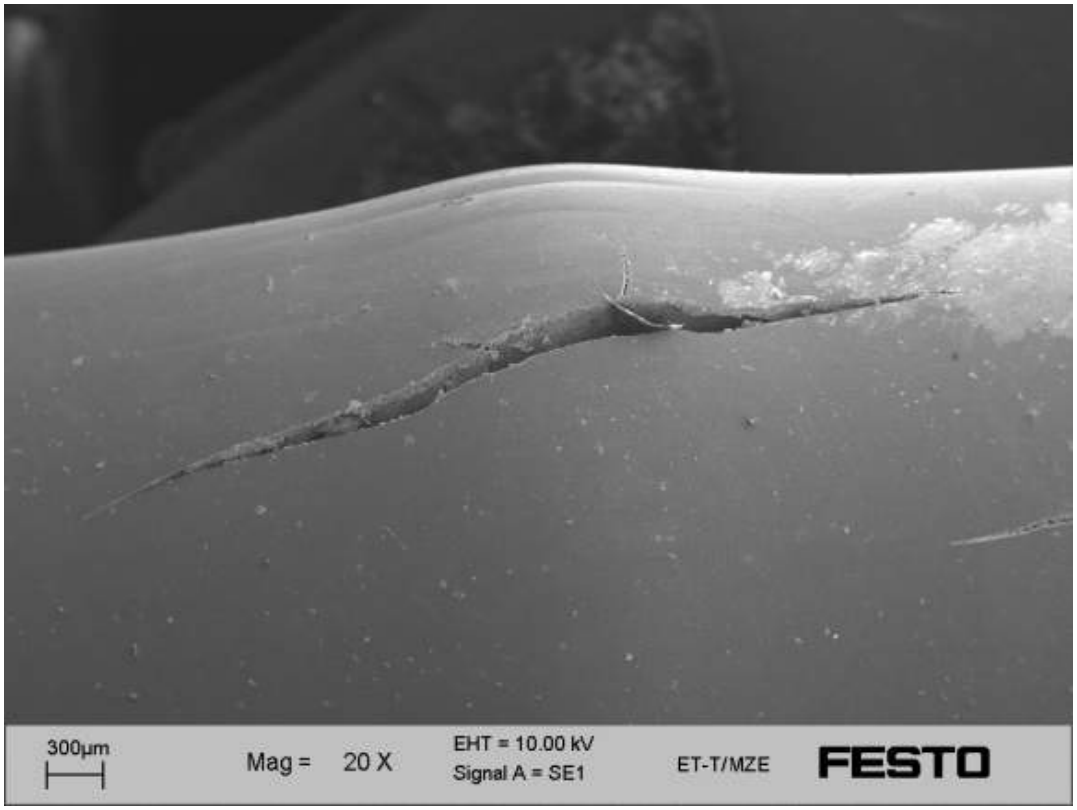


6. Tubing selection

Ballooning due to operation outside the pressure – temperatre curve

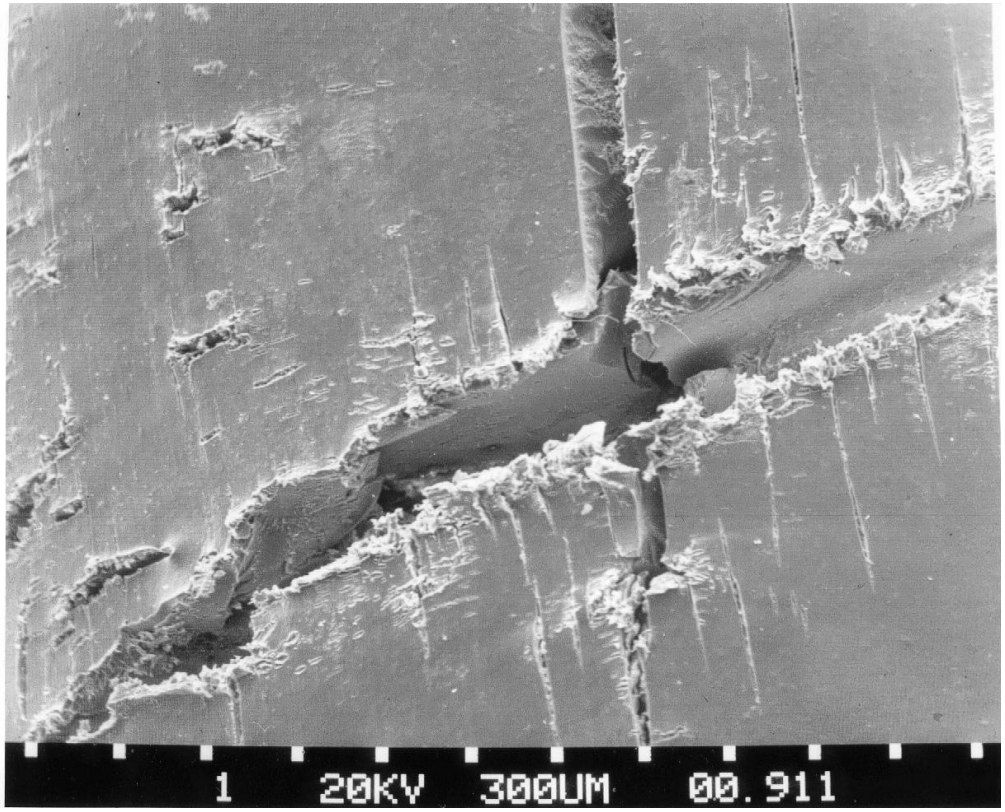
6. Tubing selection

Stress crack with little or no branching after ballooning.



6. Tubing selection

Exposure to water can lead to Hydrolosys of plastic tubing.

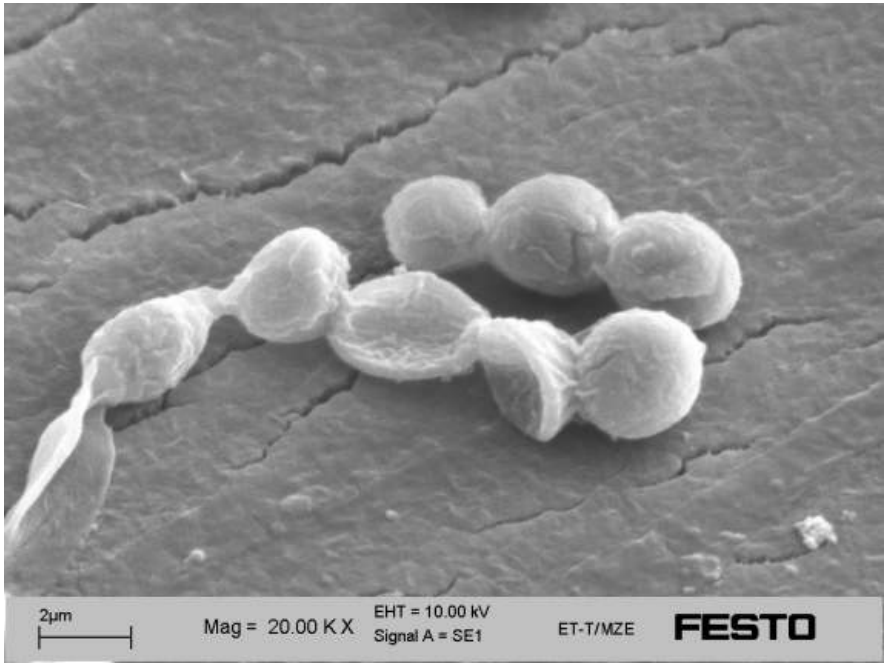


6. Tubing selection

Microbial Damage – Bacteria Structures on the tube.

6. Tubing selection

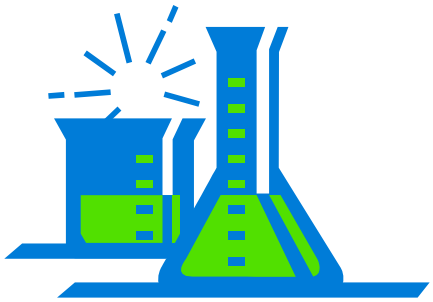
Microbial Damage – Bacteria Structures on the tube.



Direct microbial degradation, whereby constituents of the polymer are used as a source of carbon or nitrogen for the metabolic process.

6. Tubing selection

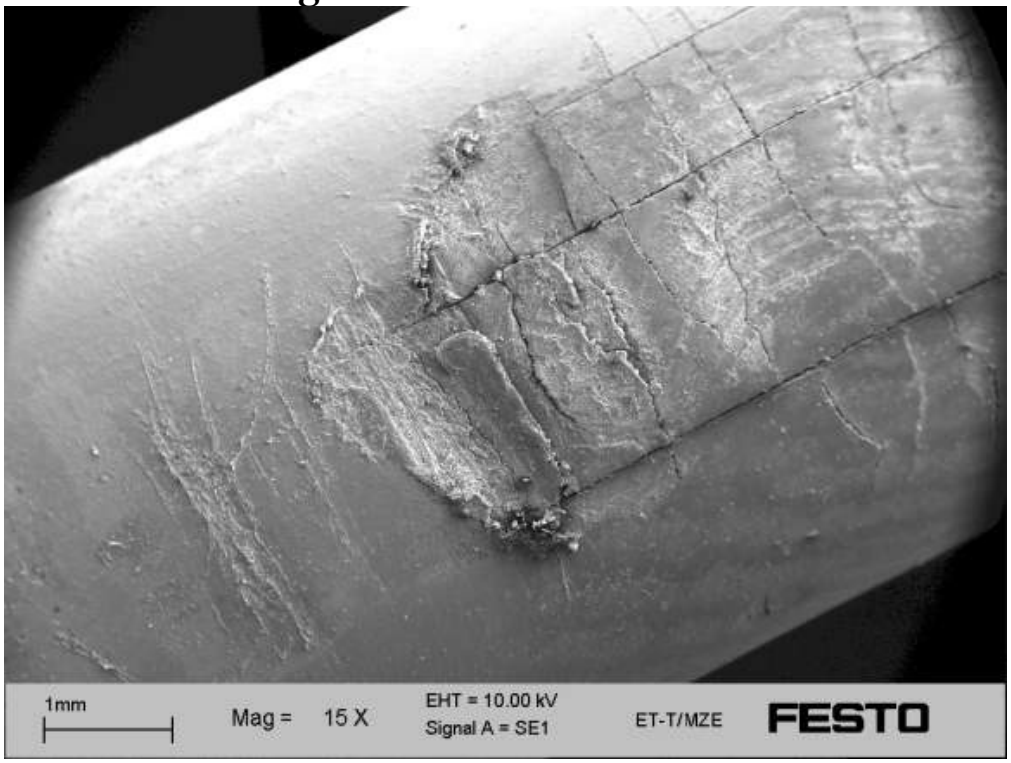
Chemical damage.

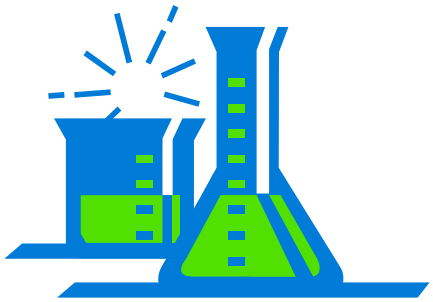


Network of individual cracks.

6. Tubing selection

Chemical damage.

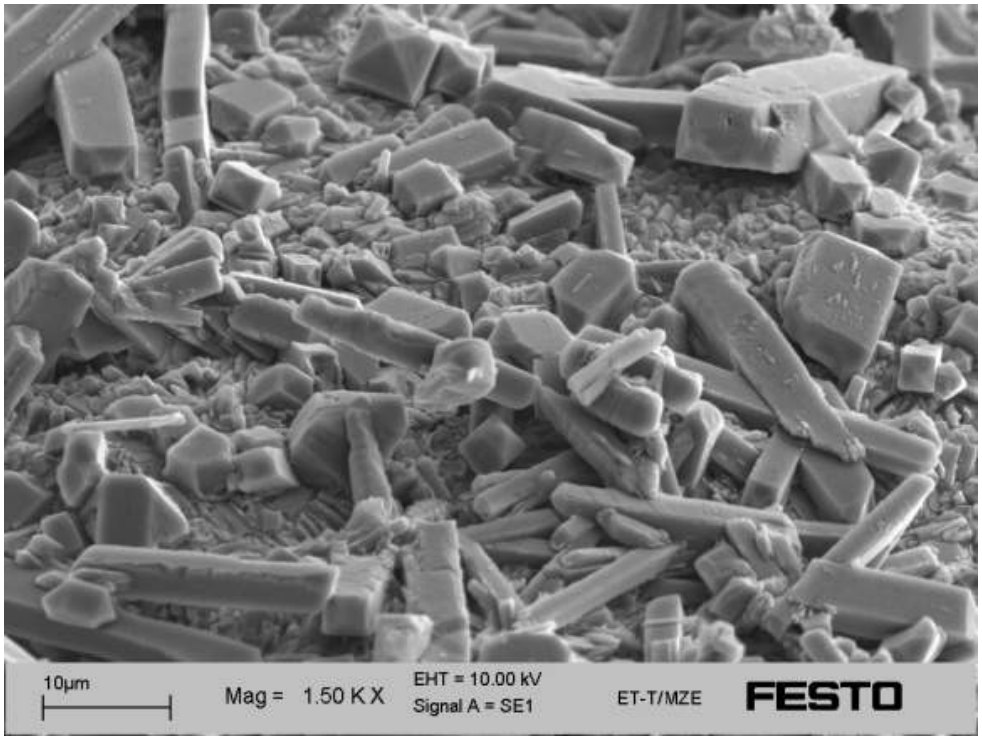


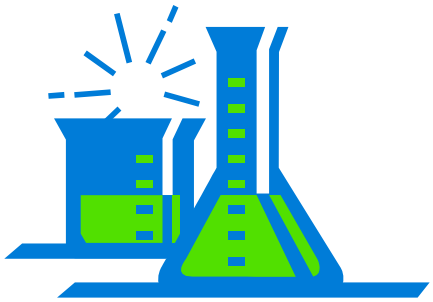


Network of individual cracks.

6. Tubing selection

Chemical damage.





Residue of the medium causing the damage is also frequently found in the form of salts

6. Tubing selection

Tubing	Chemical damage	Stress cracks	Microbial damage	Physical damage
Polyesterurethan	-	0	-	0
Polyetherurethan	+	0	++	+
Polyamid	0	0	0	0
Polyethylen	+	+	++	+
Perfluoralkoxypolymer	++	++	++	++

++	Damage impossible
+	Damage seldom
0	Damage occasional
-	Damage frequent

Thank You For Your Attention!