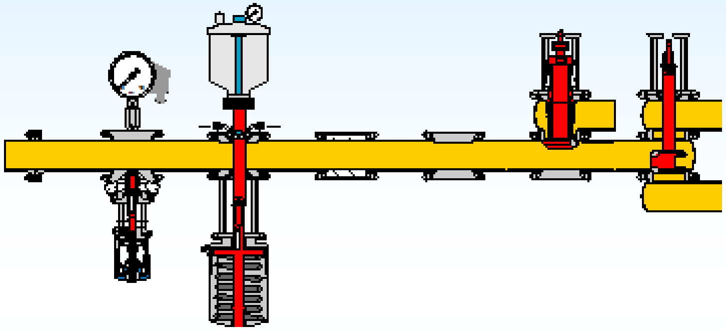
Partners in Hygienic Design

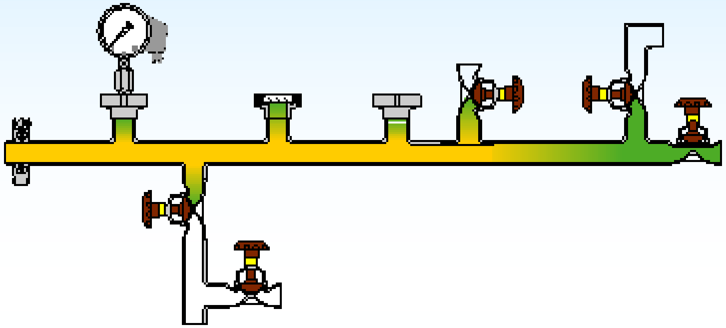
Potential savings in CIP of food production plants Through Hygienic Design

Abstract of thesis
Andreas Dorner, TUM

Analysis of potential savings for the food industry

by comparing the latest state of art of hygienic design versus legacy designs, that use hygienically risky components





STATE OF THE ART

THE COMMON WAY

To reduce the risk of undesired microbial growth, effective CIP is vital.
This can be achieved only by hygienically designed components.
Non-hygienic legacy designs are responsible for up to 20% of GMP claims.
The cleaning process is essential for the food safety and is often a CCP of the production process.
It can consume up to 70% of the total water consumption and water treatment.
This represents a massive opportunity for savings.

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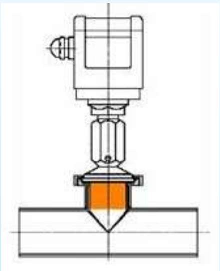
Possible Savings in operating Costs through Hygienic Design

- shorter cleaning time, increasing productive time.
- reduced chemicals and additives
- reduced power, steam and fuel consumption
- reduced water and water treatment costs

Correct hygienic design improves cleaning and sterilization via improvements in the mass-and heat- transfer from the CIP-liquids:
A temperature-sensor installed in a T-piece that was 2.6 diameters long and with a CIP-fluid temperature of 85°C,
reached only 65° C, even after a full 16 minutes.



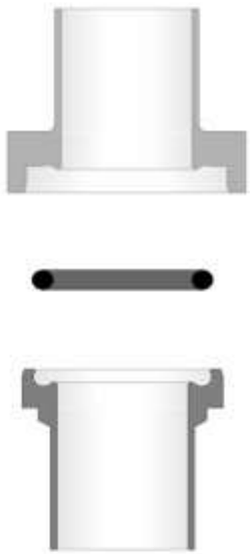
All pipe-connections compromise the inner surface of the pipe

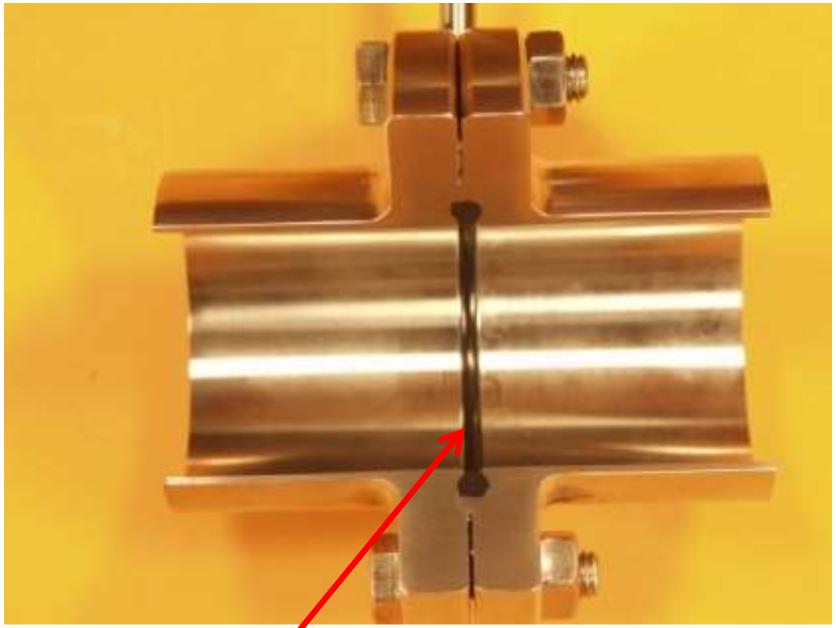
- more difficult to clean
- corrosion-resistance is degraded
- minimize use, preferably by using pipe-bending rather than pipe-bends

Design recommendations: Pipe-Couplings

- pipe-alignment, centering
- defined sealing-pressure via metal-to-metal contact
- room for thermal expansion of seals
- no crevice/gap, sealed by **elastic** material (not plastic)

Pipe-Couplings DIN 11864-2 Form A, DIN 11853-2
Design recommendations

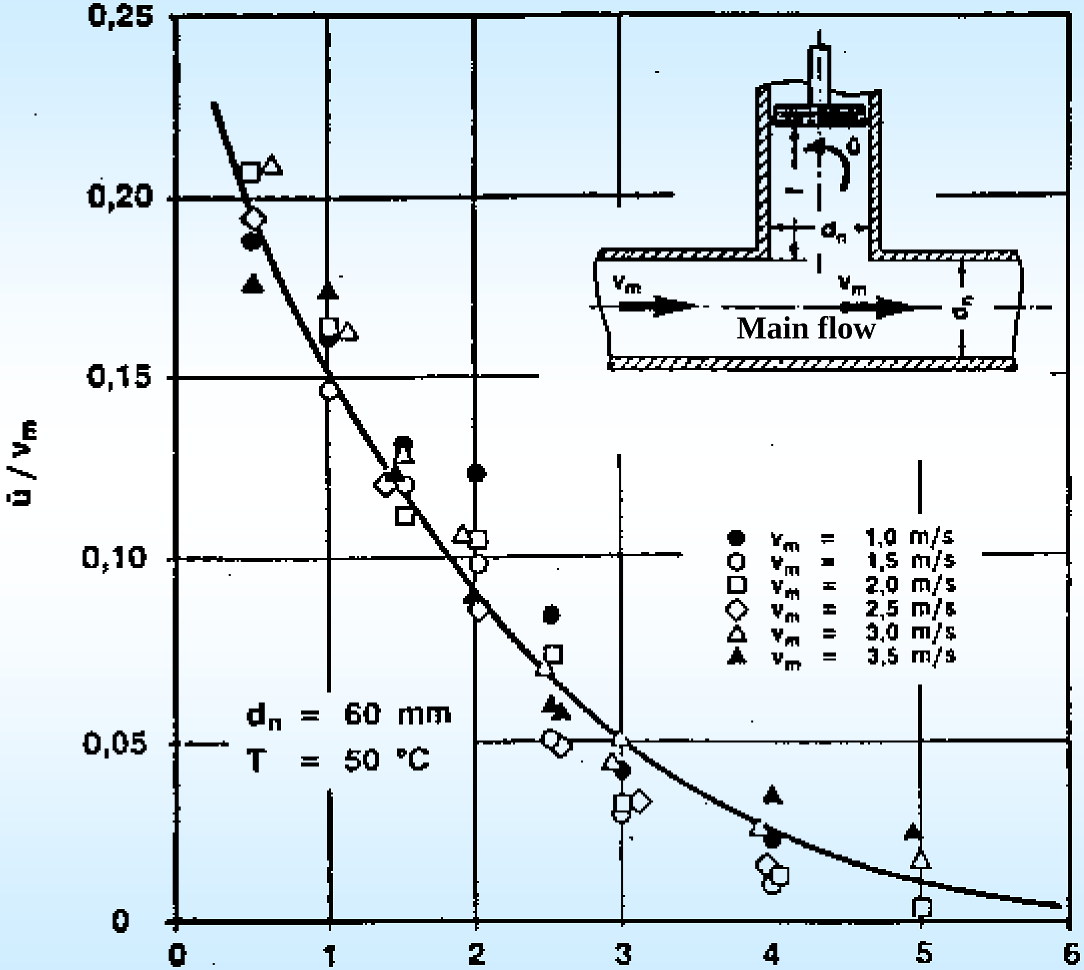




Centered sealing with defined compression

pipe-alignment, centering
defined sealing-pressure via metal-to-metal contact
room for thermal expansion of seals
no crevice/gap, sealed by elastic material

Fluid motion in a dead space



Comparison of flow between
Main flow and flow in dead space

Dead space depth

1d	13%
2d	8%
4d	2%

At flow velocity of 1m/s, exchange of detergent in a dead space depth of 8d takes 30 minutes.

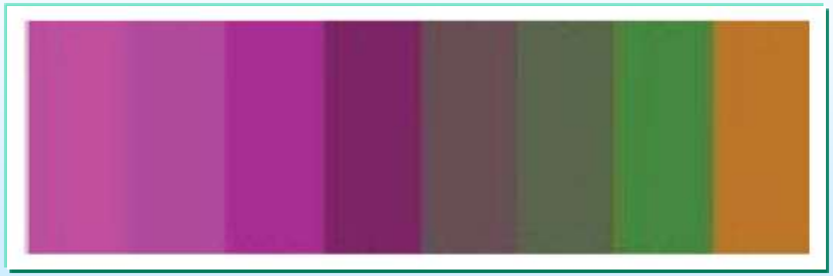
Different cleaning phases my not flush dead space because of less time.

Federal Institute of Milk Research, Kiel
Dr. Grasshoff

rel. dead space depth $\frac{L}{dn}$

For an optimal CIP process it is important that the installation is clean and in good hygienic condition, as quickly as possible.

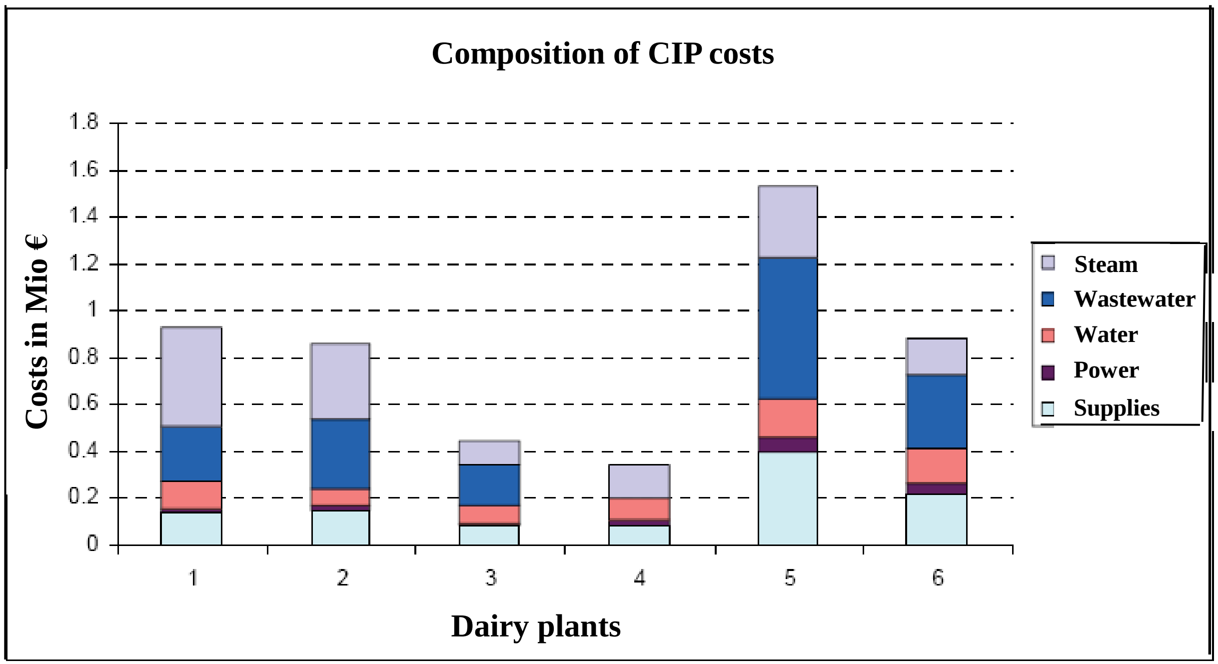
- To minimize CIP-time, it is vital to detect the instant when the installation is clean.
- a cleaning method is necessary to identify the real time of CIP success.
- for this study alkaline cleaning agent with a redox-indicator was used, which changes from violet through green to yellow, depending on the concentration of organic material remaining.
- This color-change was measured with an optical sensor.



Colour gradient from alkaline cleaning agent

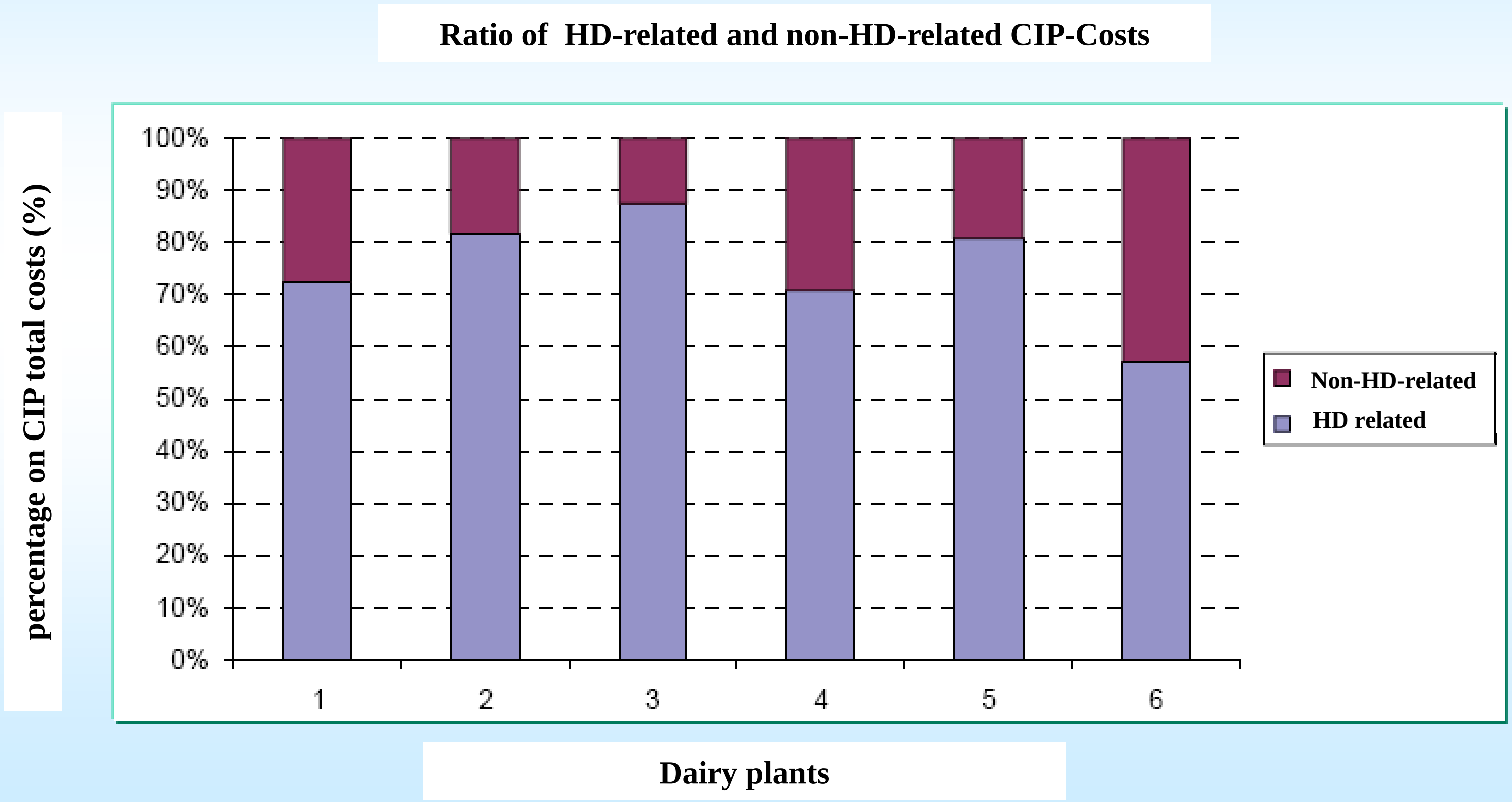
Analyses of 6 Dairies with an annual turnover of 140 Mio to 270 Mio €

Costs of CIP includes primary costs like cleaning materials, chemicals and secondary costs like power, water, waste water, steam.

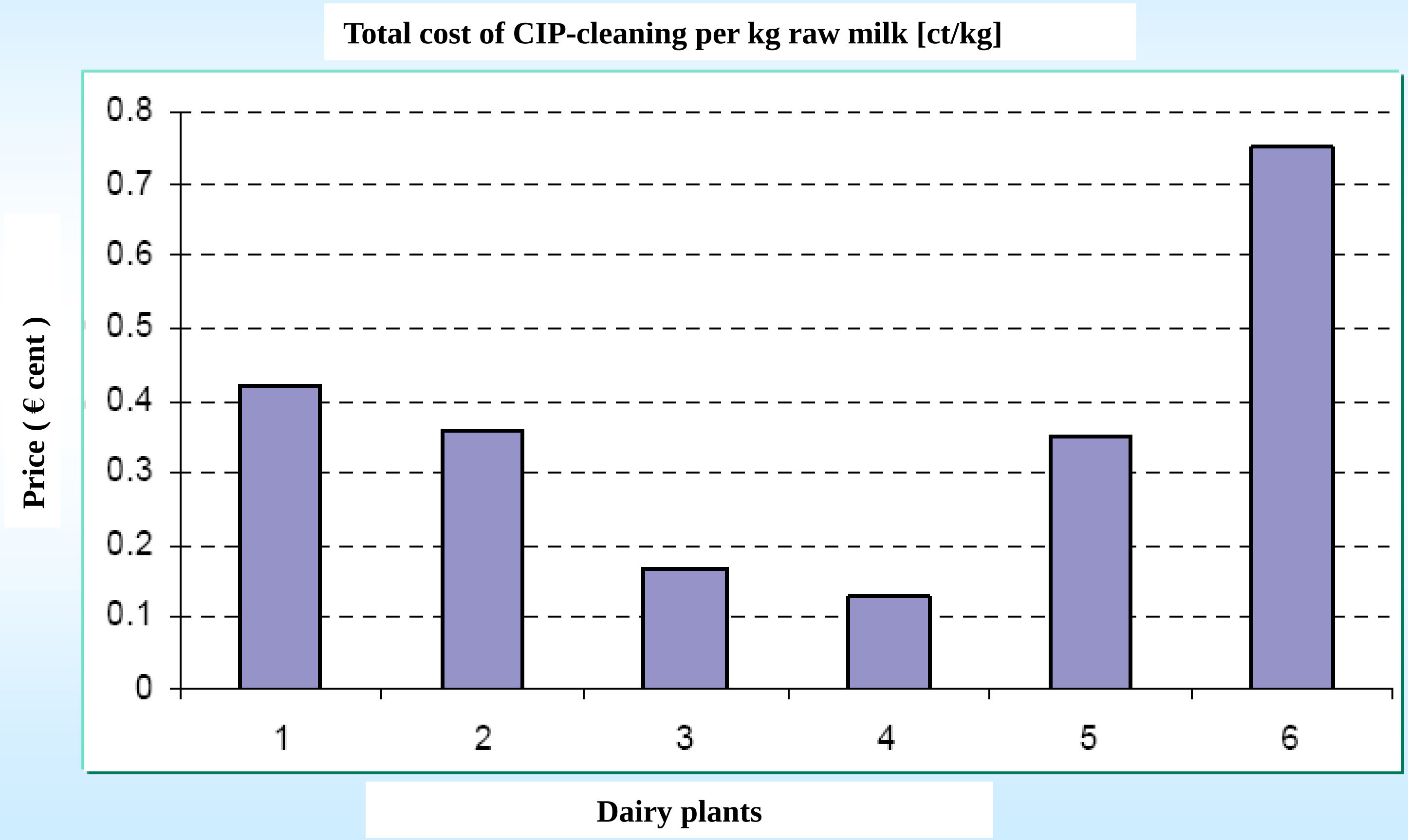


CIP Total Costs

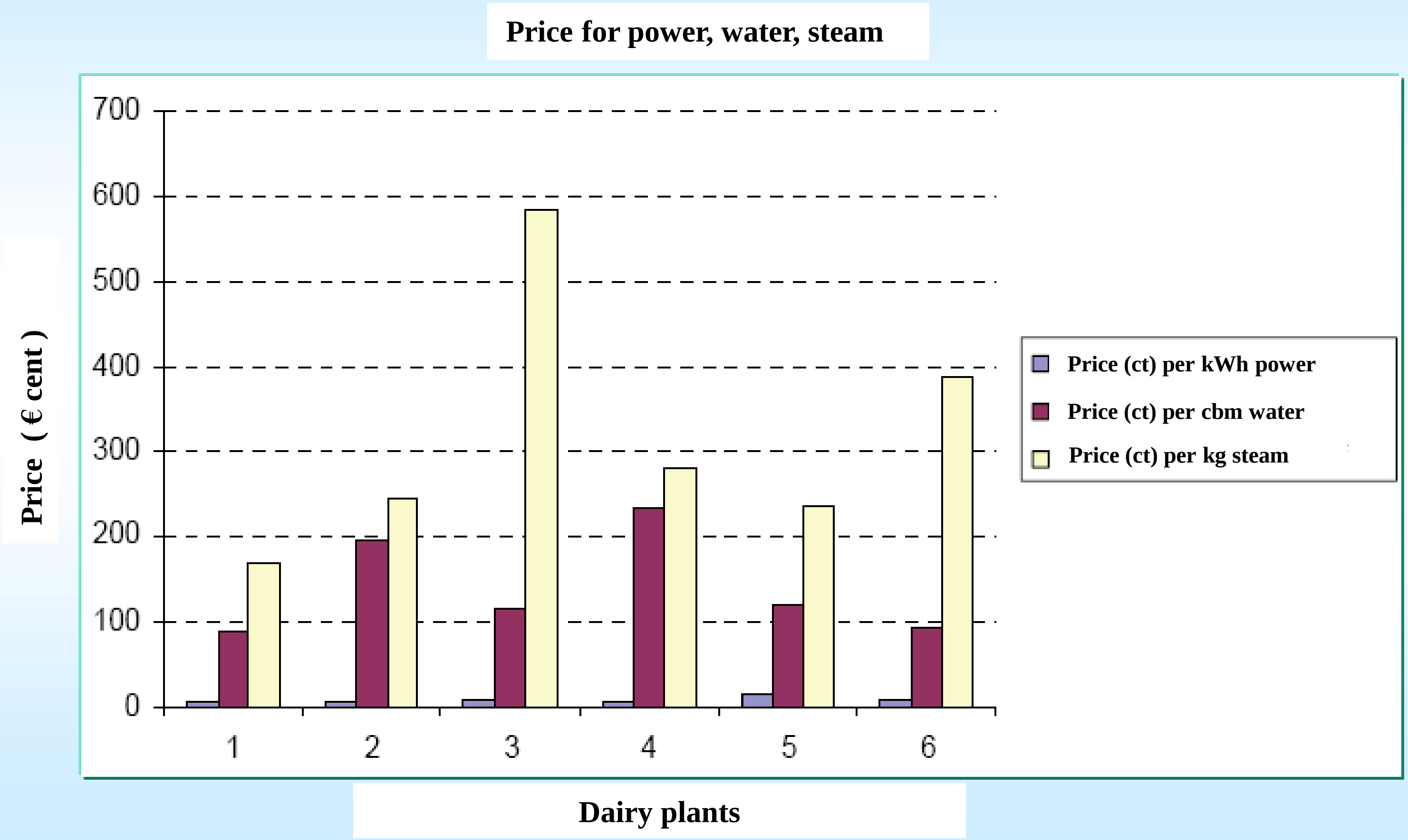
Costs for CIP by HD-related and non-HD-related



Costs


Total cost of CIP-cleaning per kg raw milk [ct/kg]
Price (€ cent)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
Dairy plants

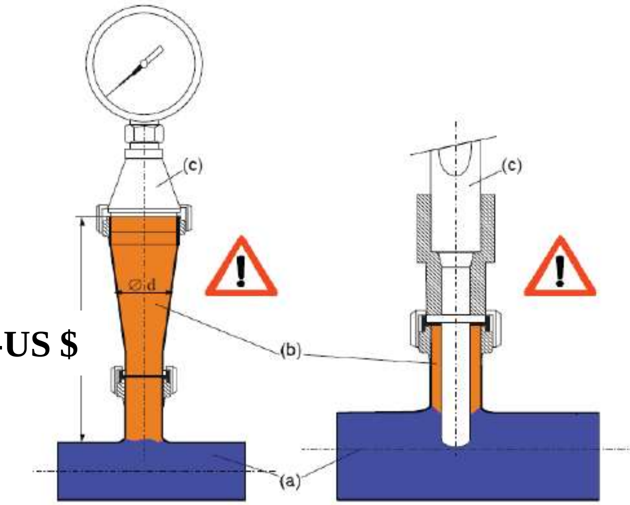
Costs

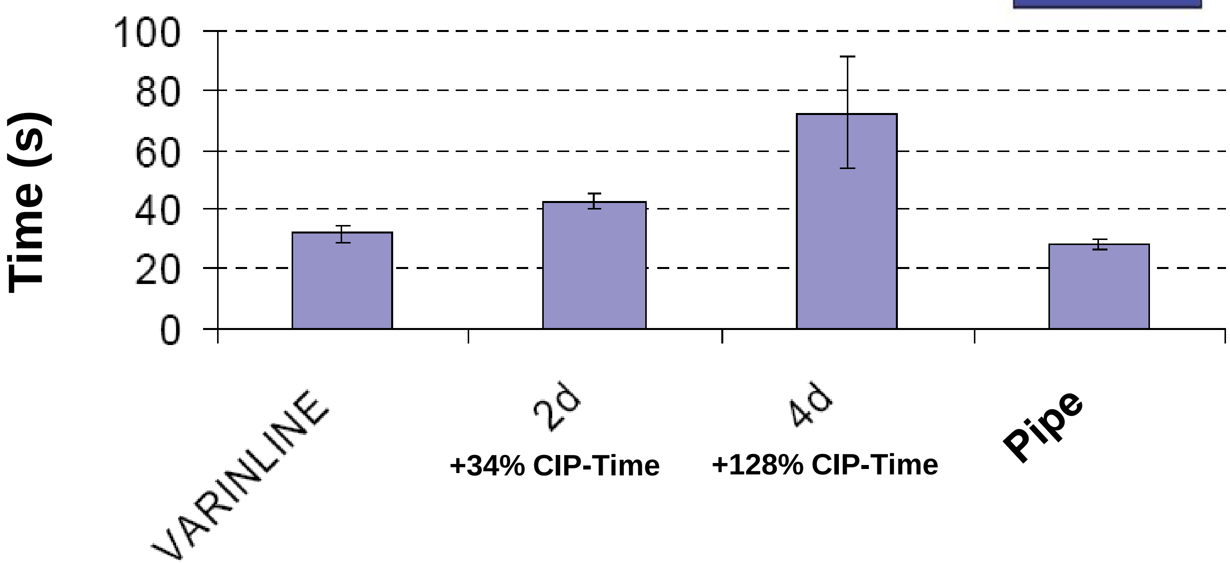

Price for power, water, steam
Price (€ cent)
700
600
500
400
300
200
100
0
1
2
3
4
5
6
Dairy plants
Price (ct) per kWh power
Price (ct) per cbm water
Price (ct) per kg steam

CIP Duration per Sensor-Connection

490,-US $

290,-US $



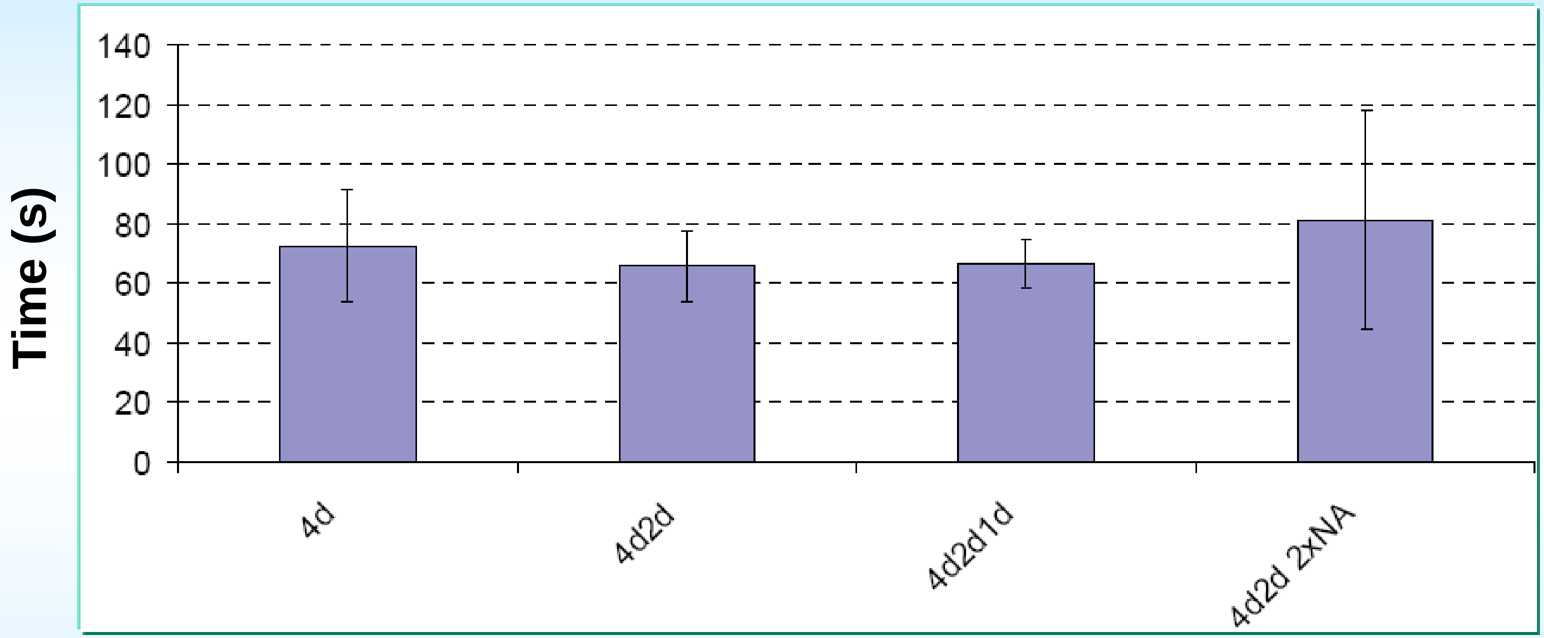


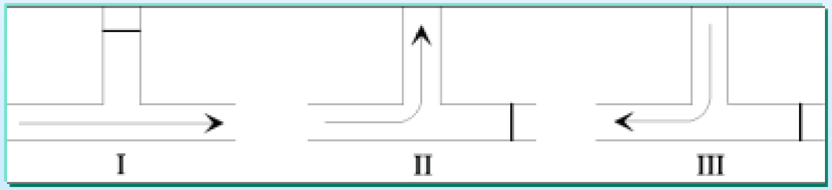
CIP total costs

Sensor with T-piece = 290,- US $

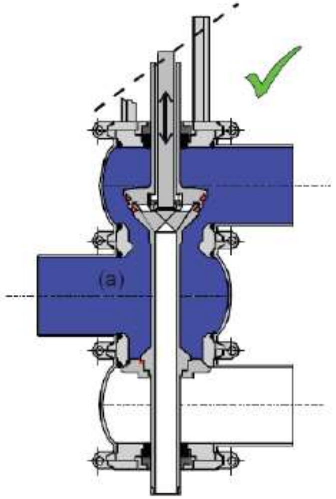
Sensor with Varinline = 200,- US $

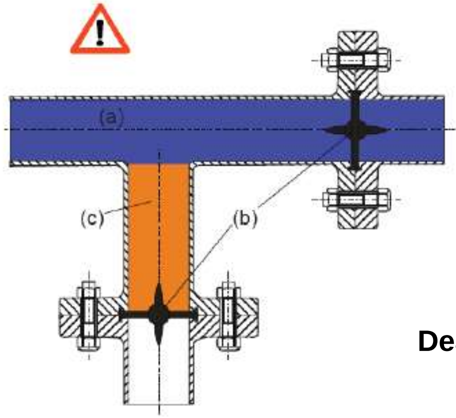
CIP Operating-Time for T-Piece Combinations



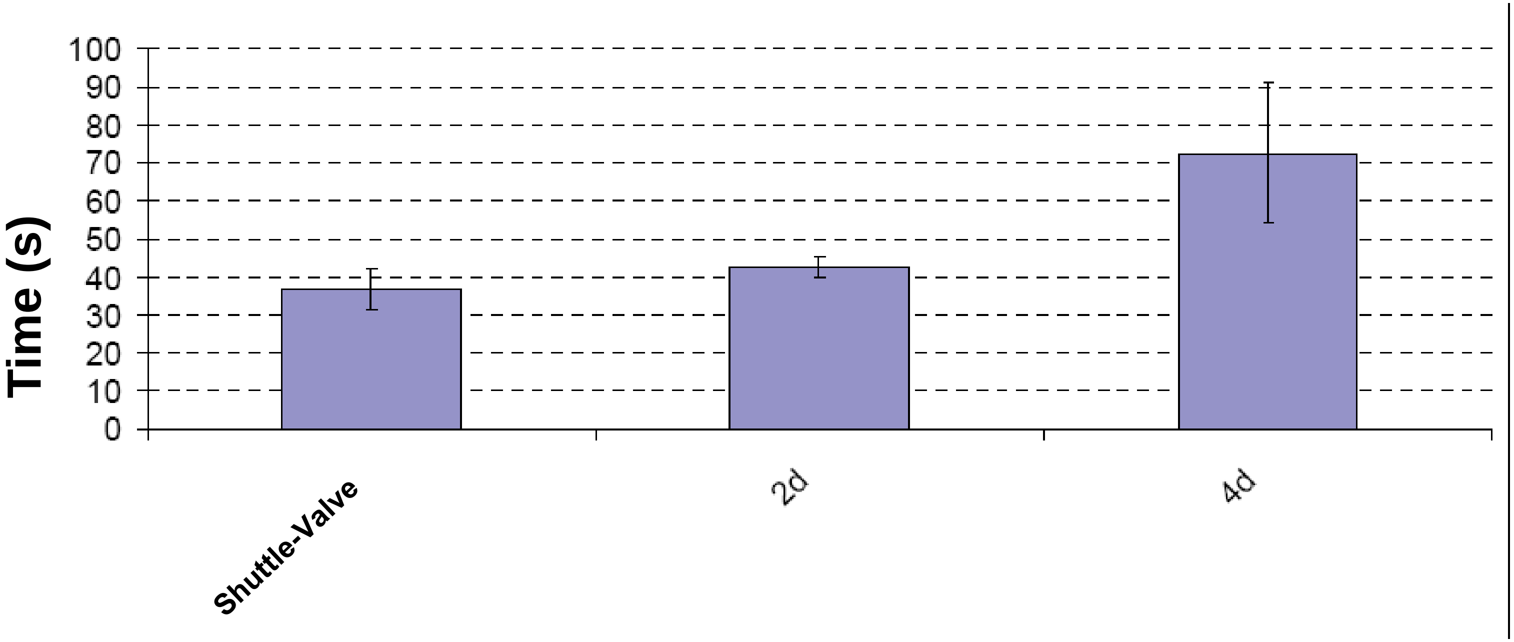


CIP Operating-Time for Valve-Sections





Dead End= 2,6d



CIP Operating-Time

Hygiene Installation **versus** **Legacy Design**
(State of the Art)

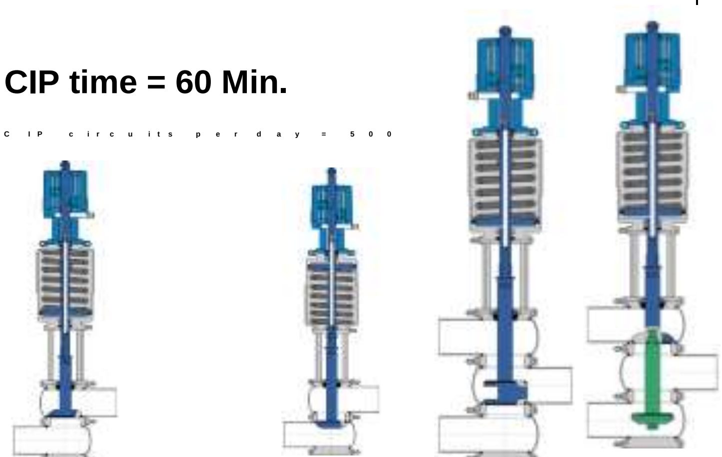
Example 1: Dairy Installation with 4.500 Tuchenhagen Valves and 5.000 m pipe line DN 80

CIP time per circuit (assumption)
5 Min. Pre rinse, 20 Min. caustic, 10 Min. Acid, 5 Min. Final rinse, 20 Min. Disinfection = 60 Min total CIP time

5.000 m = 60 Min. = 100 %

Total CIP time = 60 Min.

Total CIP circuits per day = 500



Example 2: Dairy Installation with 4.500 Γ- and T-shape Valves =

4.500 sockets = 360 m length of pipe

and 5.000 m pipe line = 5.360 m pipe line DN 80

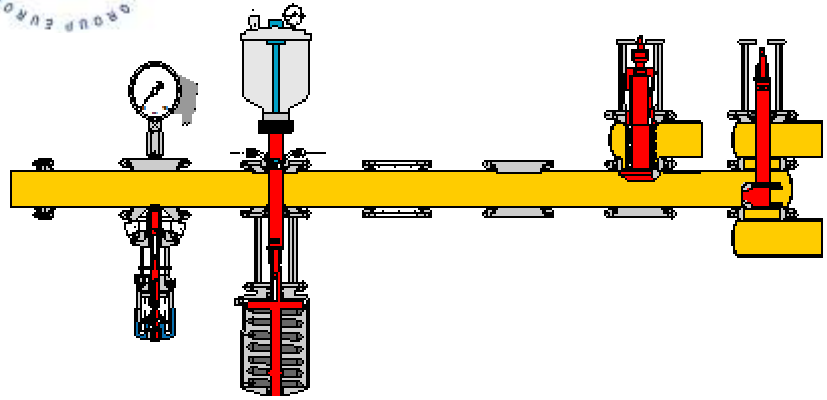
efficiency to clean Γ- and T-shape valves versus Tuchenhagen valves = 15 % (see graph Dr. Grasshoff)

5.360 m = 60 Min. = 100 % (5.000 m = 93 %, 360 m = 7 %)
5.000 m straight pipe will be cleaned in 55,8 Min.,
360 m Γ- and T-shape sockets will be cleaned in 28 Min.

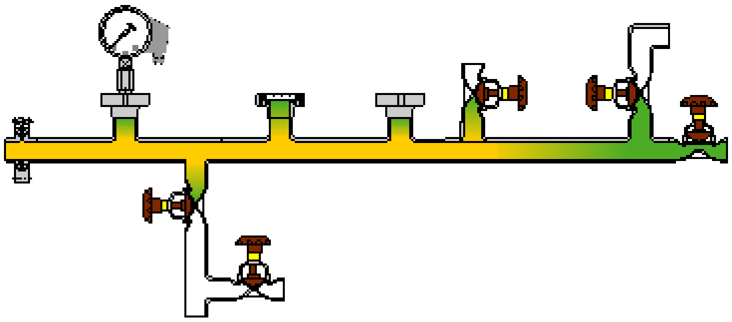
(60 Min. divided by 0,15 % = 400 Min. x 7 % = 28 Min.)

Total CIP time = 83,8 Min.

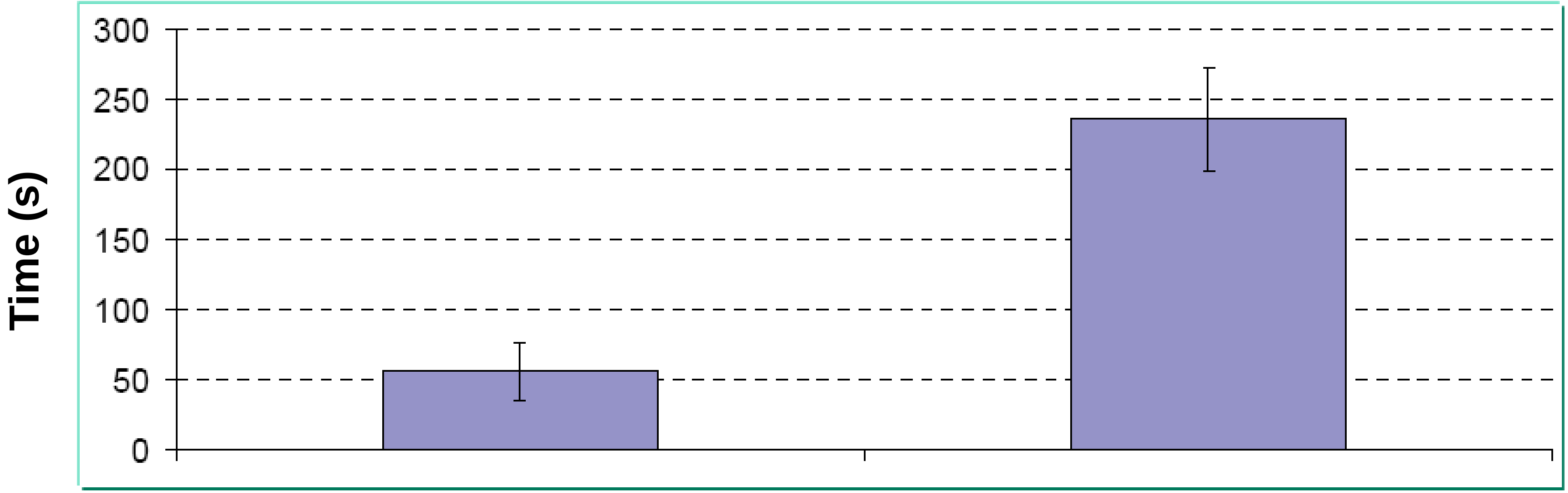
Because of the Γ- and T-shape valves, there is a surplus length of the pipe of 7 %, and a surplus cleaning time of 23,8 Min. which results to 40 % more CIP time and less production time.



STATE OF THE ART



LEGACY DESIGN



Hygienic Design module results in 76% less CIP time

Pay-off for one HD sensor (Varinline) compared with 4d-T-piece sensor per metric ton of raw milk and per dairy plant

Dairy plant						
1	**2**	**3**	**4**	**5**	**6**	
65.6	68.3	134.6	216.8	70.9	46.9	t raw milk

$$\frac{\textbf{Difference of investment costs}}{\textbf{HD relevant CIP portion of CIP total costs}} = \frac{\textbf{200€}}{\textbf{0.426kg /cent}} = \textbf{46.9 t}$$

A dairy with a raw milk intake of 380.000 l / day achieves it pay-off:

Dairy 4 in 0.6 days

Dairy 6 in 0.1 days

Pay-off for one HD Divert-Valve compared with block & bleed butterfly valve according to the raw milk [t] per dairy plant

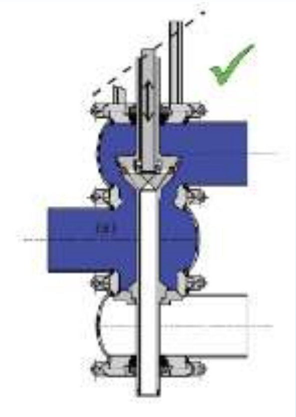
			Dairy plant			
1	**2**	**3**	**4**	**5**	**6**	
475.8	493.3	975.9	1571.8	513.7	339.6	t raw milk

$$\frac{\textbf{Difference of investment costs}}{\textbf{HD relevant CIP portion of CIP total costs}} = \frac{\textbf{1450 €}}{\textbf{0.427 kg /cent}} = \textbf{339.6 t}$$

A dairy with a raw milk intake of 380.000 l / day achieves it pay-off:

Dairy 4 in 4.1 days

Dairy 6 in 0.9 day



Pay-off for a HD module compared with the common way according to the raw milk [t] per dairy plant

Dairy plant

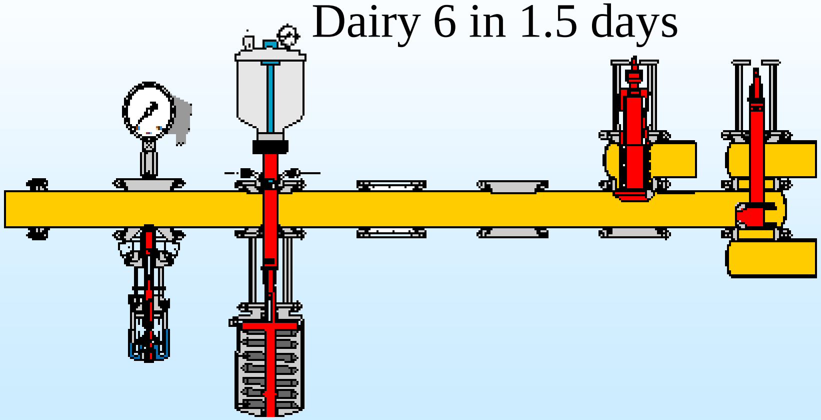
1	**2**	**3**	**4**	**5**	**6**	
800.7	830.1	1642.2	2644.9	864.4	571,4	t raw milk

$$\frac{\textbf{Difference of investment costs}}{\textbf{HD relevant CIP portion of CIP total costs}} = \frac{\textbf{2440 €}}{\textbf{0.427 kg /cent}} = \textbf{571.4 t}$$

A dairy with a raw milk intake of 380.000 l / day achieves it pay-off:

Dairy 4 in 6.9 days

Dairy 6 in 1.5 days



The figures from the previous tables show that the complete change of a production-plant to hygienic design needs high investments, which often deters budget-holders from opting for HD

Please note that the validation of the CIP program is essential

The work reported demonstrates that pay-back will be achieved in a vanishingly short time, with the added bonuses of faster processing, increased plant capacity and an extended plant lifetime.

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Thank you for your attention.