SUNCOMBE
CIP & PROCESS ENGINEERS

Design for CIP

I MECH E

By

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Suncombe Ltd

Topics to be Covered

1. What is CIP?
2. Why CIP?
3. Advantages of CIP
4. Cleaning in Place Detail
5. Types of CIP Systems
6. Sterilisation in Place
7. Monitoring
8. Design Consideration
9. Summary

What is CIP (Clean in Place)?

CIP - Clean in Place

Equipment and techniques to allow cleaning of process equipment without dismantling or manual cleaning

SIP - Sterilisation in Place

Heat or Chemical Sterilisation of Process Equipment

COP - Clean Out of Place

Move Parts and Equipment to a COP system for cleaning

Cleaning of Surfaces & Walls

Why CIP?

- Reproducible, Repeatable and Controllable Results
- Reduction of Cleaning Time
- Automatic cycles ensure every item is cleaned every time
- Increased productivity through reduction of down time
- Chemical Handling Reduction
- Simple Operation

Advantages of CIP

- Cost and Utility Savings including chemicals, water and effluent, labour time etc.
- Health and Safety
- Batch Traceability and Records
- Stronger Chemicals and higher temperatures can be used
- More complex processing systems can be used
- Environmental Issues and Legislation

Why Use CIP

1) CIP is superior to any cleaning method

- Automated, with parameter monitoring & control
- Repeatability → reliability
- Human errors eliminated
- Eliminate contaminated products

2) Lower operating costs

- Reduced labour costs
- Cleaning turnaround time reduced
- Water / solvents / detergents usage significantly reduced

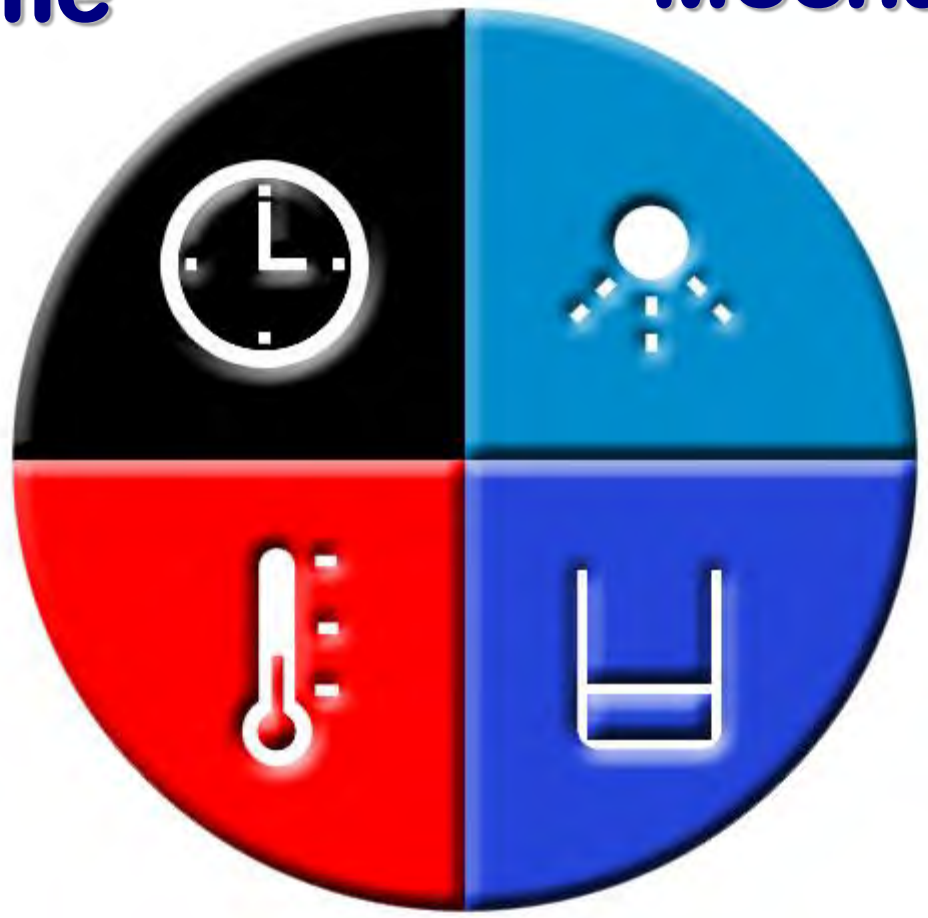
3) Safety Improvement

- Reduced exposure of product to personnel
- No equipment dismantling / vessel entry
- Eliminates hazardous activities, eg HP water blasting

CIP Variables

Time

Mechanical



Chemical

Temperature

Temperature

Effect on cleaning operation:

Soil	Effect
Proteins	medium
Fats	good
Sugars	good
Salts	good

Note : *Generally a 10°C temperature increase will improve cleaning efficiency by 50% (above 30°C)*

Mechanical

Effect on cleaning operation:

1) Turbulence in Piping

Laminar flow	*Re < 2,300*
Transition flow	*2,300 < Re < 3,000*
Turbulent flow	***Re > 3,000***

LAMINAR FLOW

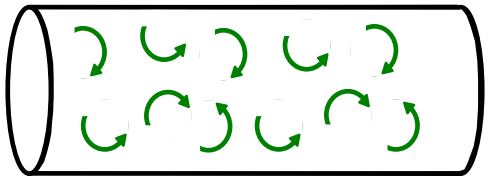
Reynolds number, $Re = \frac{D\,v\,\rho}{\mu}$

D is pipe internal diameter

v is fluid velocity

ρ is fluid density

μ is fluid viscosity



TURBULENT FLOW

Note : ***Normally take velocity to be >2 m/s***
→ 1½" tube at 2 m/s → Re = 78,000

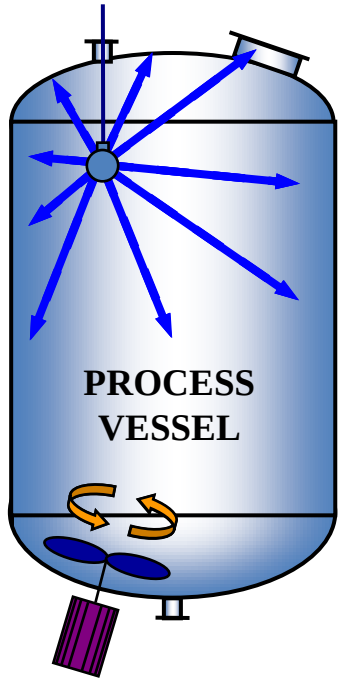
Mechanical (continued…)

Effect on cleaning operation :

2) Action in Equipment

a) Automatic Tank Wash devices

- Fixed Spray Devices
- Self-powered Rotating
- Self-powered Turbine



Chemical (Detergent)

Effect on cleaning operation:

Soil	Water	Alkali	Acid
Proteins	poor	good	medium
Fats	poor	good	medium
Sugars	good	--	--
Salts	medium	medium	good

Note : *required concentrations depend on soil level, processes used, working time, temperture, ….*

Water Used for Cleaning Process

Quality of Water used for aqueous cleaning is critical for performance:

- Chemical properties (pH, hardness, etc.)
- Biological properties (bioburden, endotoxins)

- Pre-Rinsing. Solely for flushing out of residue prior to washing step. Usually based on practicality of what water is available.
- Washing. Most critical is water hardness – effects efficiency of cleaning of aqueous surfactant solutions.
- Rinsing. In general, the final rinse used for equipment should use the same quality water as used in the final stage of manufacture.

Time (Duration)

The duration of each CIP cycle step is to be optimised according to the main following parameters :

- Type of Process Equipment
- Type of Process Carried Out
- Duration of Process Run
- Cleaning solution temperature
- Chemical concentration

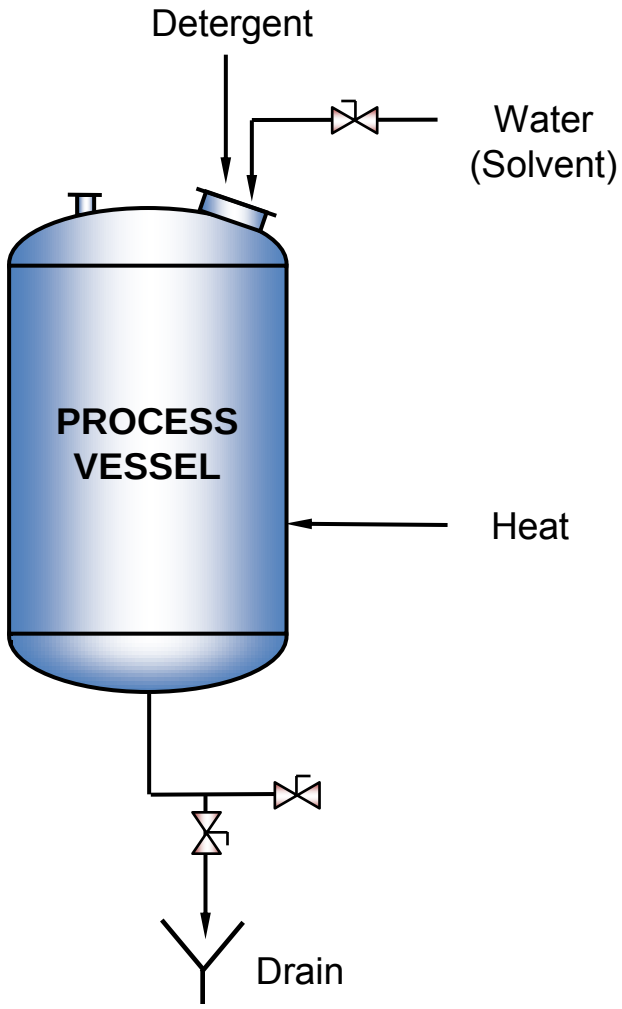
Typical CIP Programme

Step	Operation	Cleaning Agent	Temp. (ºC)	Time (Min.)	Usage
1	Pre-Rinse	Water	20 – 30	2 – 5	To drain
2	Alkali Clean	2% Caustic	70 – 90	5 – 30	Re-circulated
3	Inter-rinse	Water	20 – 30	1 – 5	To drain
4	Acid clean	1% Phosphoric	50 – 70	3 – 15	Re-circulated
5	Inter-rinse	Water	20 – 30	4 – 10	To drain
6	Sterilant	Peracetic Acid	20 – 30	3 – 15	Re-circulated
7	Final Rinse	Water	20 – 30	4 – 10	To drain

Types of CIP Systems

- Boil Out (Fill / Flood) System
- Total Loss
- Single Use Recirculation
- Re - Use (Recovery)
- Multi Channel
- Fixed & Mobile Systems
- WIP and COP

Boil Out System (Fill/Flood)



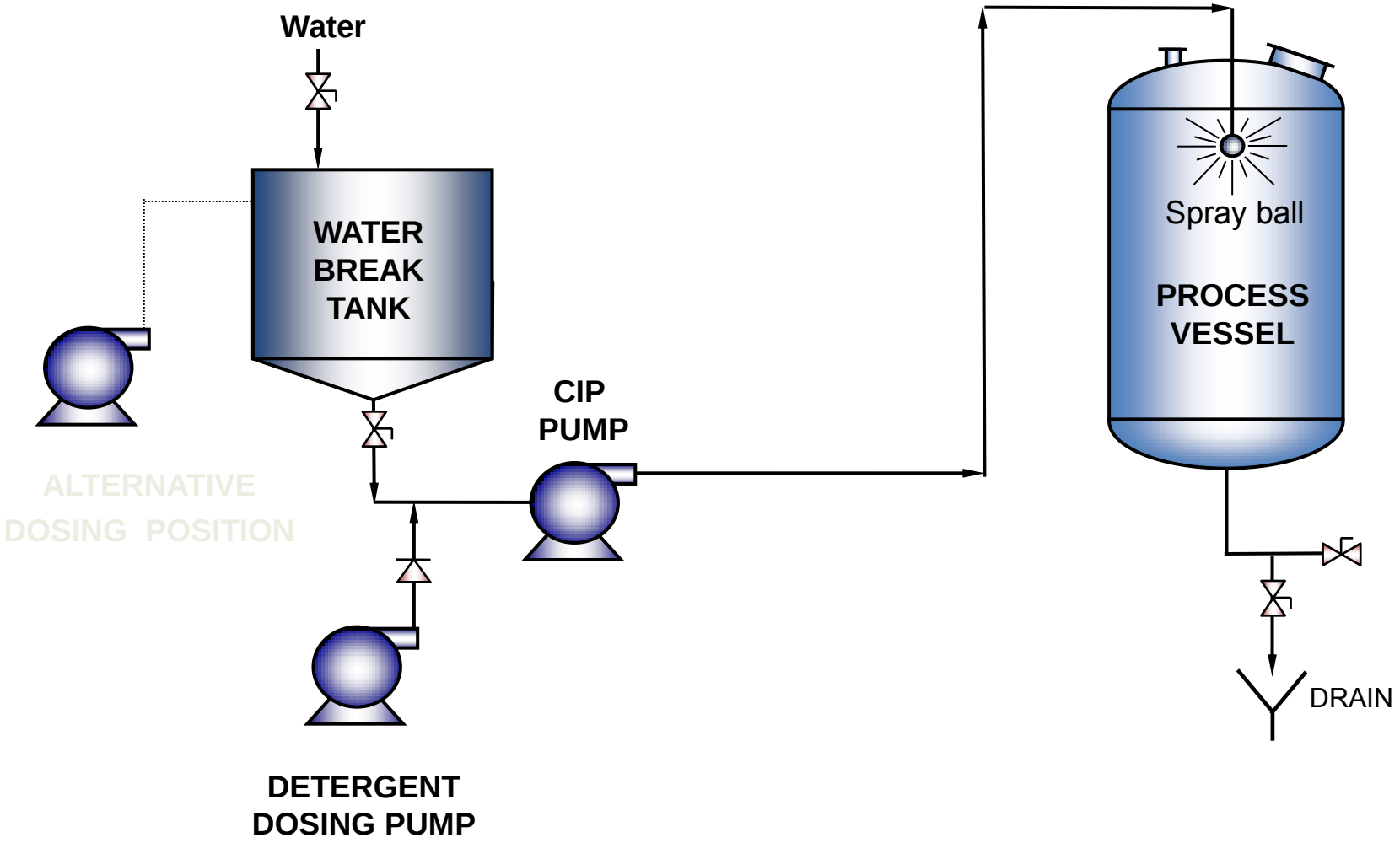
Advantages

- No / Small Capital Investment
- Very Small Vessels
- Cleans Complicated Mixer Systems
- No additional Equipment Need
- Solvent based

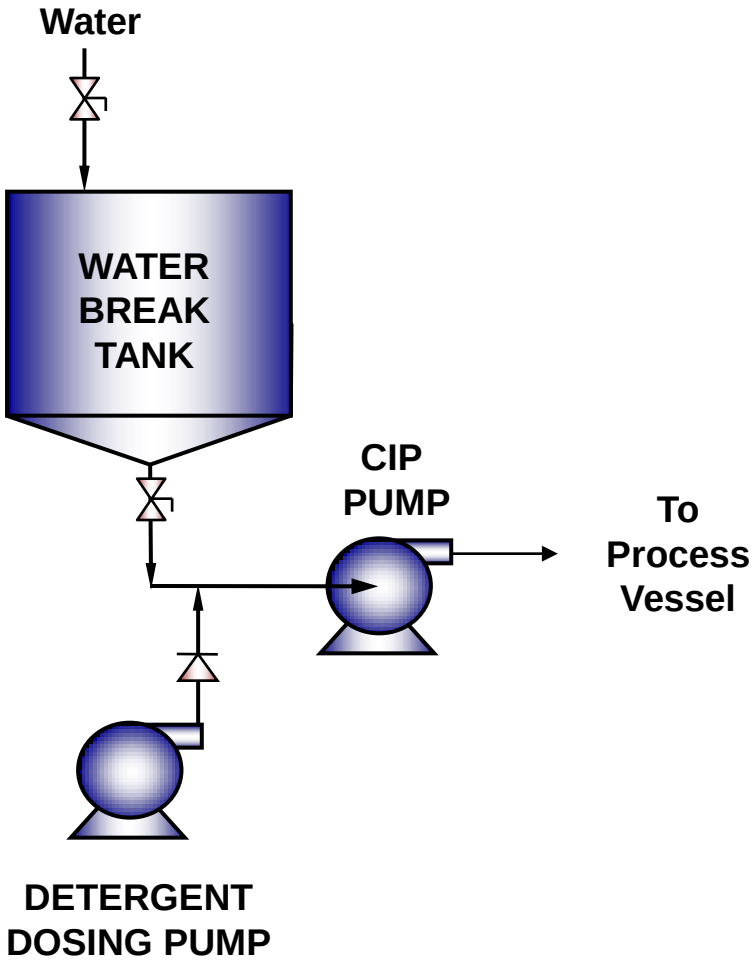
Disadvantages

- High Detergent & Water Usage
- Extended Cleaning Times
- Health & Safety Considerations
- Difficult to Monitor /Validate

Total Loss System



Total Loss System



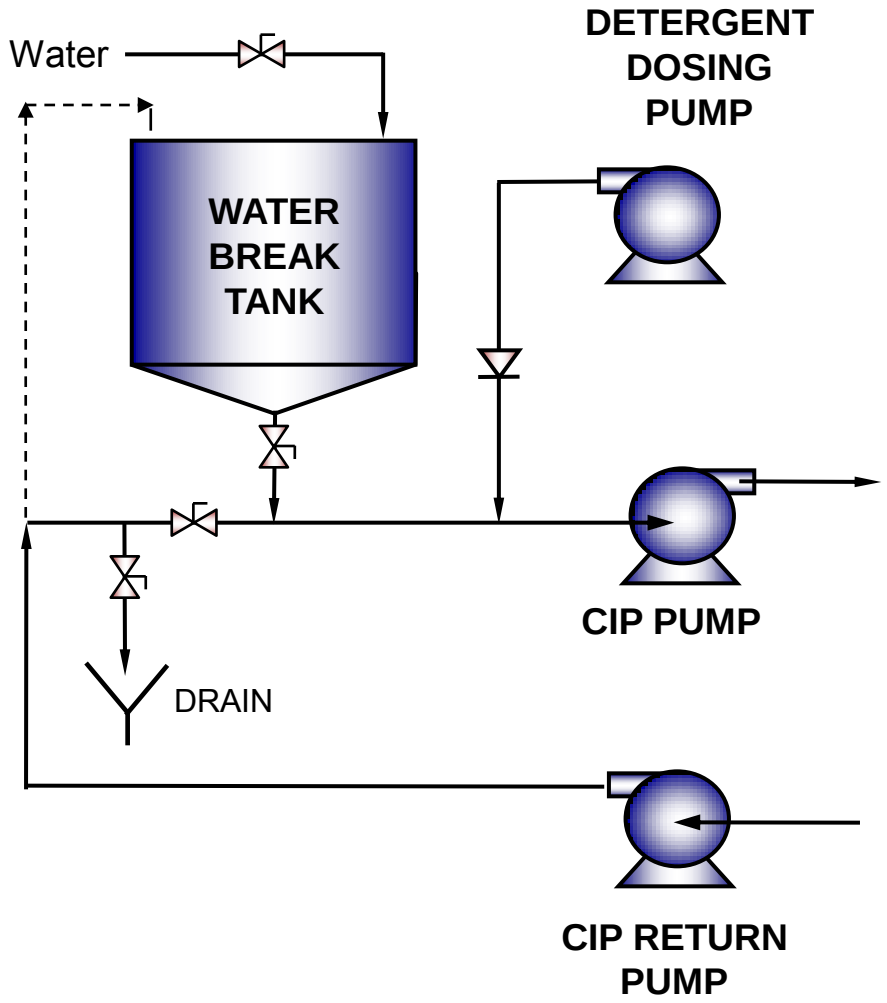
Advantages

- Improved Health & Safety
- Simple Installation

Disadvantages

- High Detergent & Water Usage
- Extended Cleaning Time
- Difficult to Monitor / Validate

Single Use Recirculation System



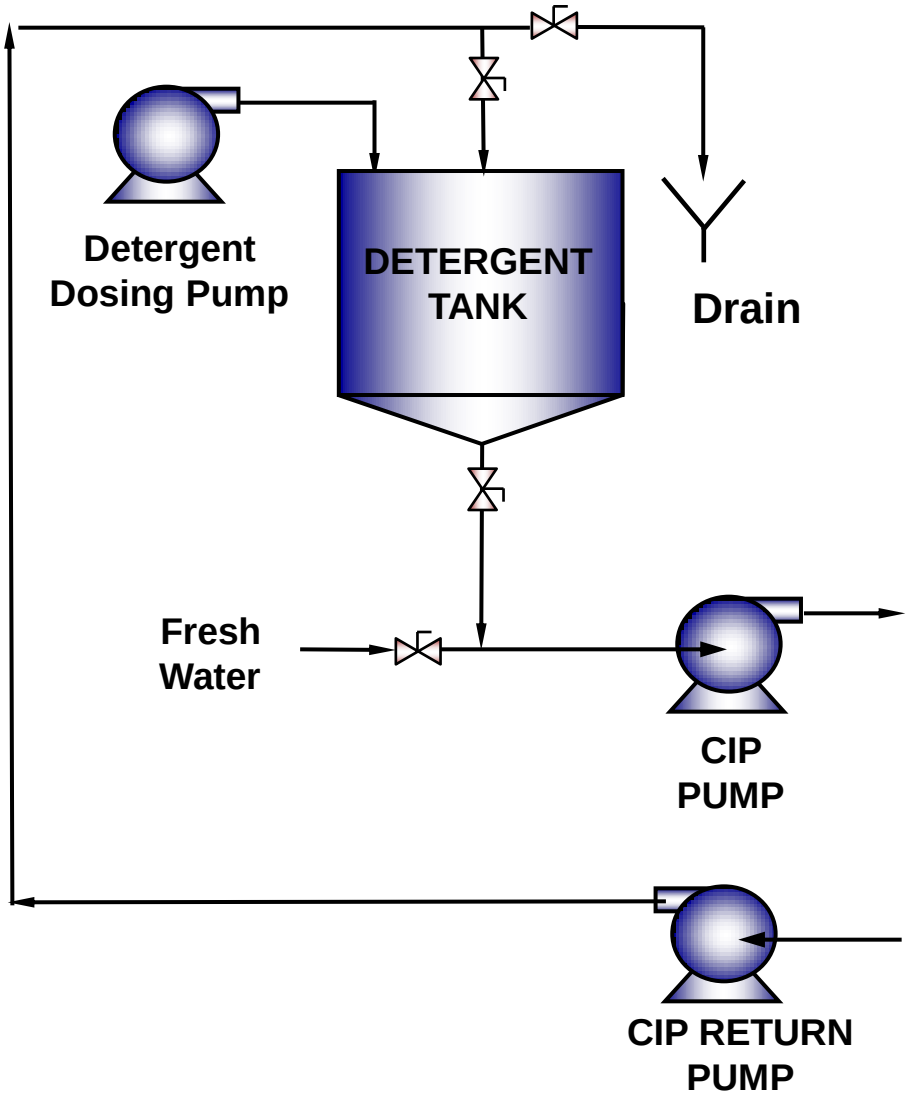
Advantages

- Flexible System
- Lower Cost Installation (than Re-Use)
- Good Economy for Local System
- Small Floor Space
- LOW CROSS CONTAMINATION RISK

Disadvantages

- Not Suitable for Large Centralised Systems

Re-Use System



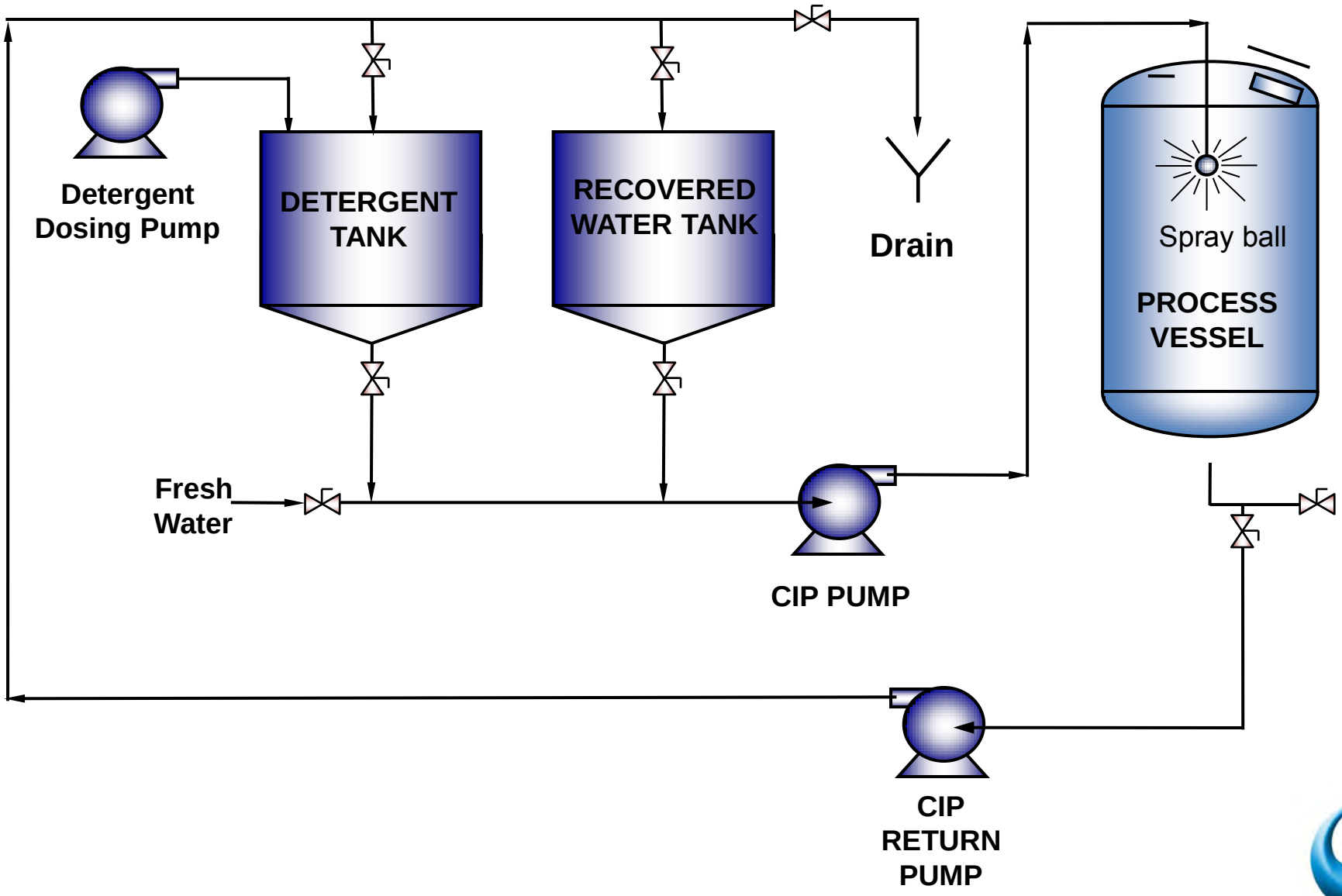
Advantages

- Good Water / Detergent Usage
- Centralised Systems & Controls

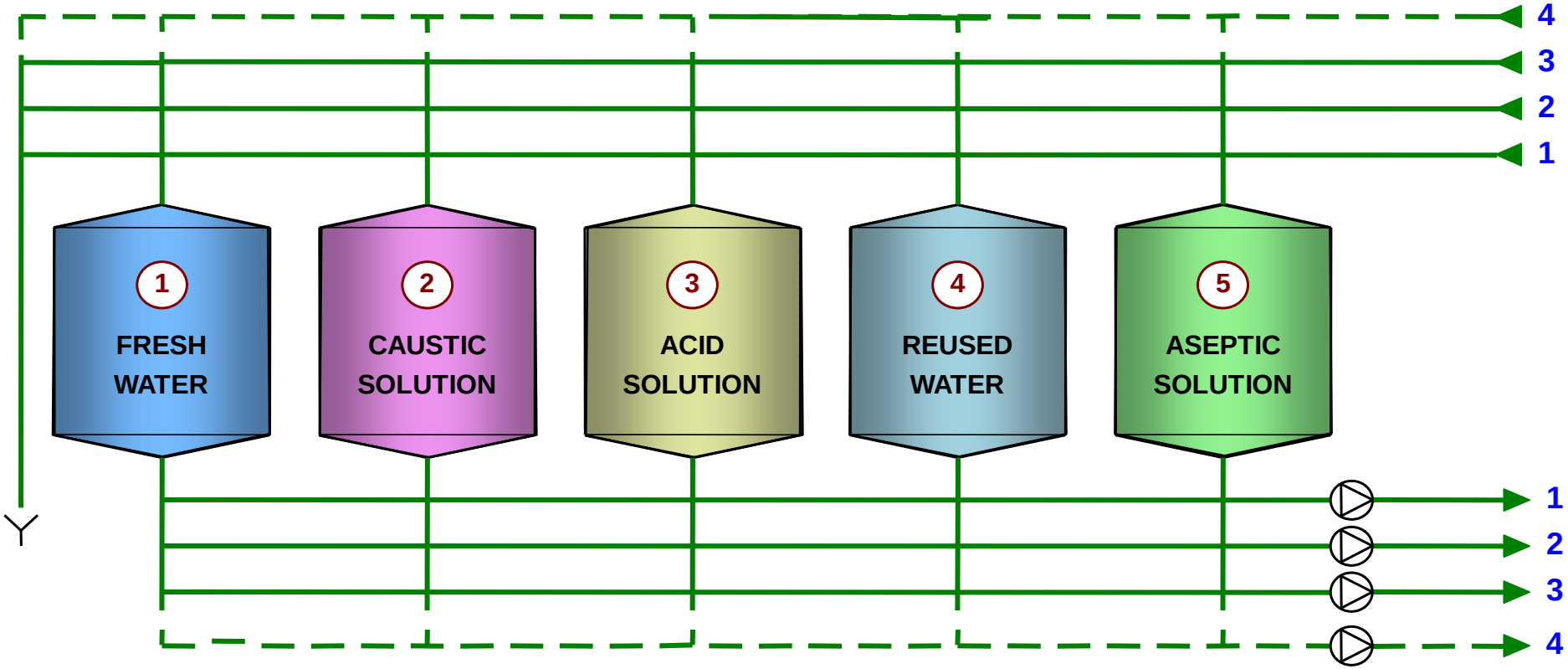
Disadvantages

- Inflexibility
- Higher Equipment & Installation Costs
- CROSS CONTAMINATION RISK FOR DIS-SIMILAR PRODUCTS OR RAW/COOKED CONDITION

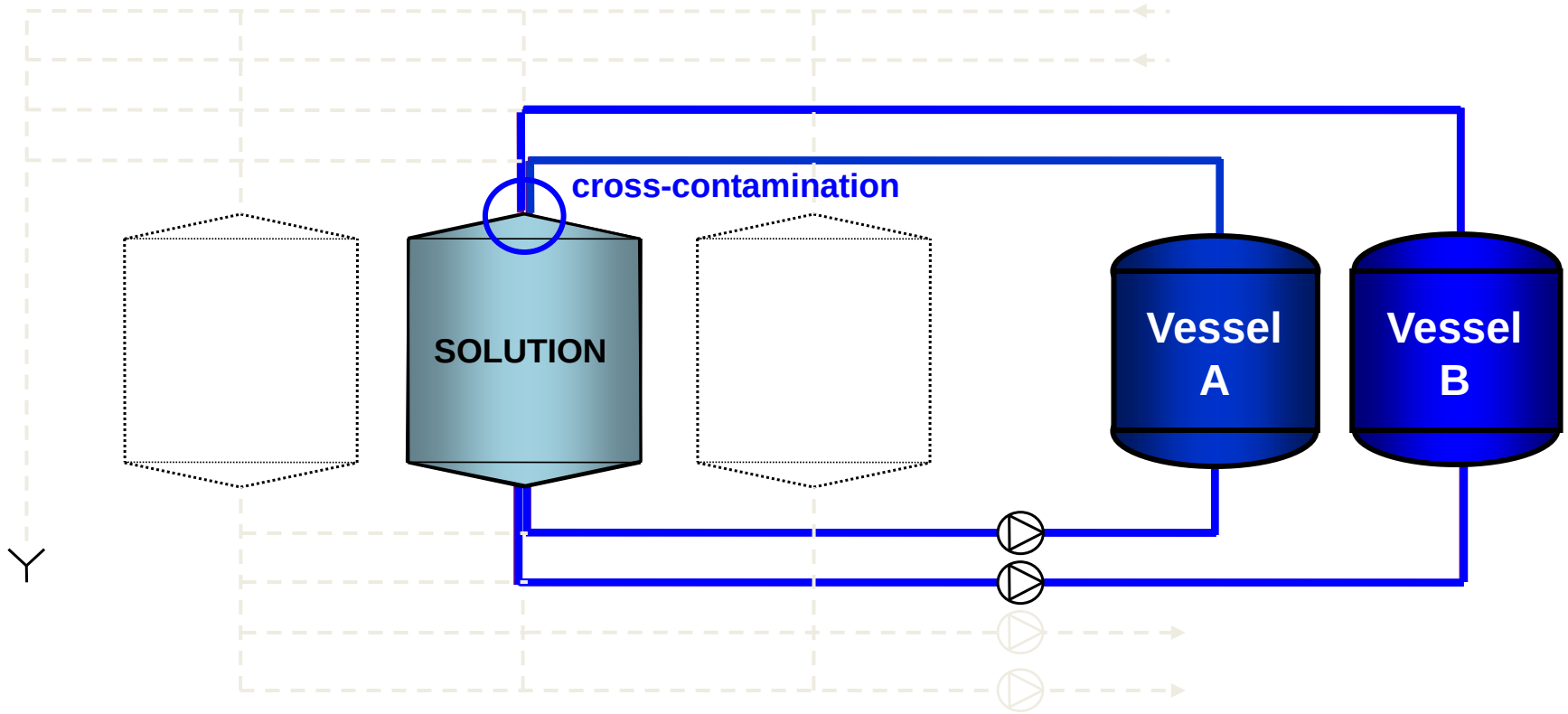
Re-Use System with Recovered Water Tank



Multi-Channel Re-Use System



Multi-Channel System



System Comparisons

	Re-Use	Single Use
Solution Tanks	2 to 5	1 or none
Soln. Temperatures	Fixed	Adjustable
Soln. Concentrations	Fixed	Adjustable
Simultaneous operations	1 to 4 (Multi-channel)	1 only
Flexibility	Poor	High
Cross contamination	High Risk	Small Risk
Investment cost	Higher	Lower
Running Cost	Lower	Higher
MAIN CRITERIA	CLEANING COST	CLEANING QUALITY

System Comparisons (continued...)

Example: 3000 L Storage Vessel, with 100 Lpm Sprayball

1.5% Detergent. 5 min Rinses. 20 min Detergent

SYSTEM	WATER	DETERGENT
Boil Out System	6500 L	45 L
Total Loss	3000 L	30 L
Single Use	1200 L	3 L
Partial Re-Use	1100 L	2 L
Full Re-Use	600 L	2 L

Typical Pharmacuetical CIP Unit

CIP3™ SUITE

Re-use System

Mobile CIP Units

- Reduces Pipework Installation
- Limits to size of unit & Capacity
- Service Requirements
- Heating problems
- Ideal for small cleaning duties

WIP or CIP?

There is no legislative distinction between Clean In Place (CIP) and Wash In Place (WIP), however the general industry view on the terminology is that CIP means a totally automatic cleaning sequence with no manual involvement, whereas as WIP includes some manual intervention. In practical terms CIP requires high levels of validation, against WIP which requires less stringent validation.

Courtesy of Matcon

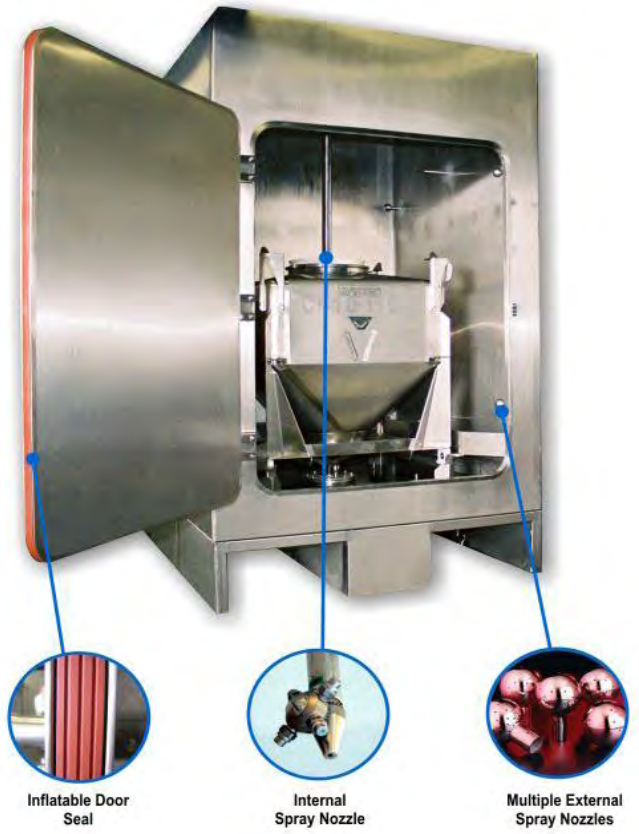
ATEX CIP Considerations

- The introduction of the ATEX directive to include all components that are ATEX certified, mechanical as well as electrical
- The problems with component selection associated with systems that reside continually in an ATEX area
- Can use aqueous or solvent cleaning media
- ATEX rated spraydevices
- Inert atmospheres for spray cleaning

When is a CIP Application not a CIP Application?

Answer: When it is a COP Application.

COP or Cleaning Out of Place is when the equipment is moved to the cleaning equipment prior to a CIP clean



SIP (Sterilisation in Place)

- Sterilization is not to be considered as part of the cleaning process.
- Purpose of Sterilization is to destroy any form of micro-organism.
- Chemical Sterilization

  - Chlorine, hypochlorite, hydrogen peroxide, ozone, peracetic acid
- Thermal Sterilization

  - dry heat, steam, superheated water

Monitoring Systems

Conductivity	To Monitor Strength To Separate Phases
Temperature	In Feed Line to Control In Return Line to Monitor
Flow	In Feed & Return to Confirm Rate
Pressure	In Feed Line for Spray Device In Return for Integrity Testing
Time	From the Control System
Turbidity	In Return Line to Monitor

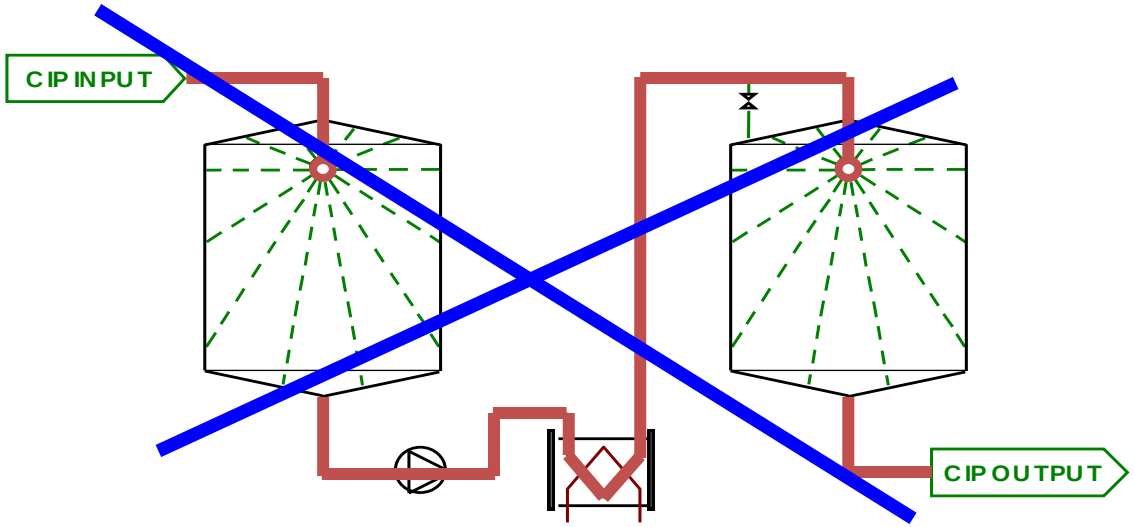
CIP/Process Design

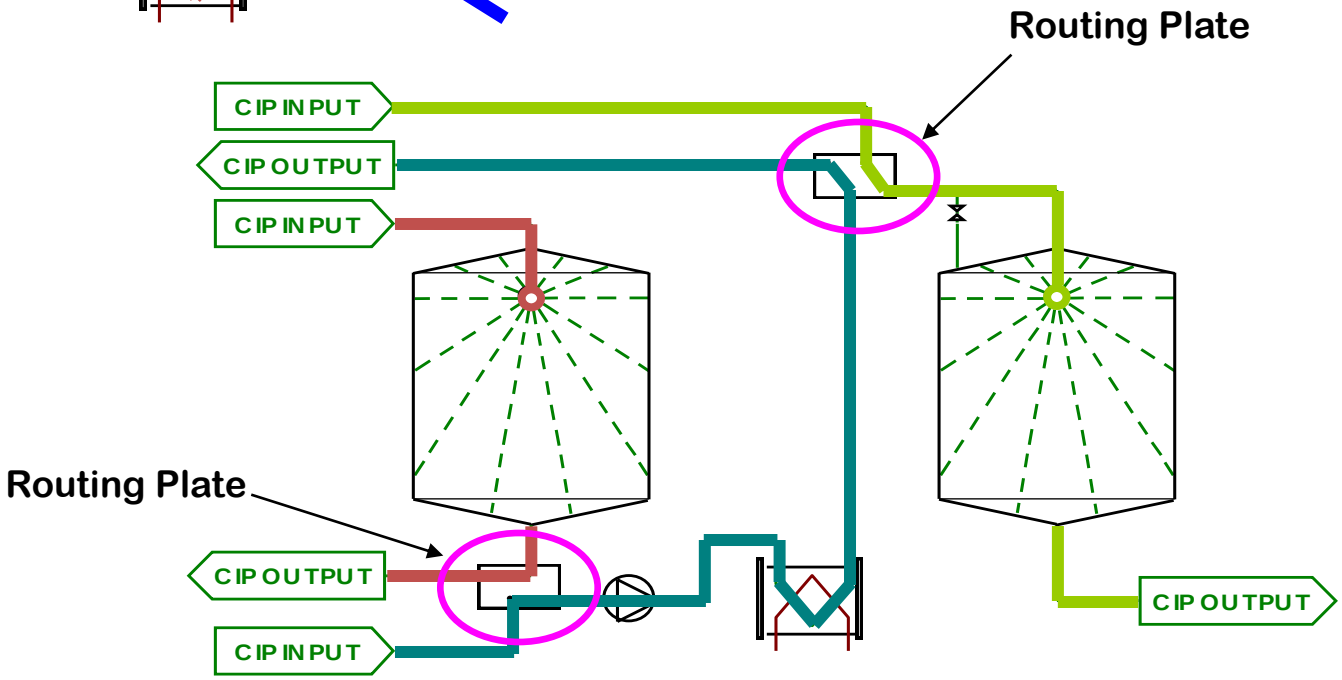
- ‘Cleanability’ of components & fittings used for process installations
- Safety breaks & circuit separation
- Circuit balancing of CIP circuit
- Prevention of ‘dead legs’ in process circuits
- Surface finish of tanks and piping
- Welding techniques

Equipment/System to be cleaned…

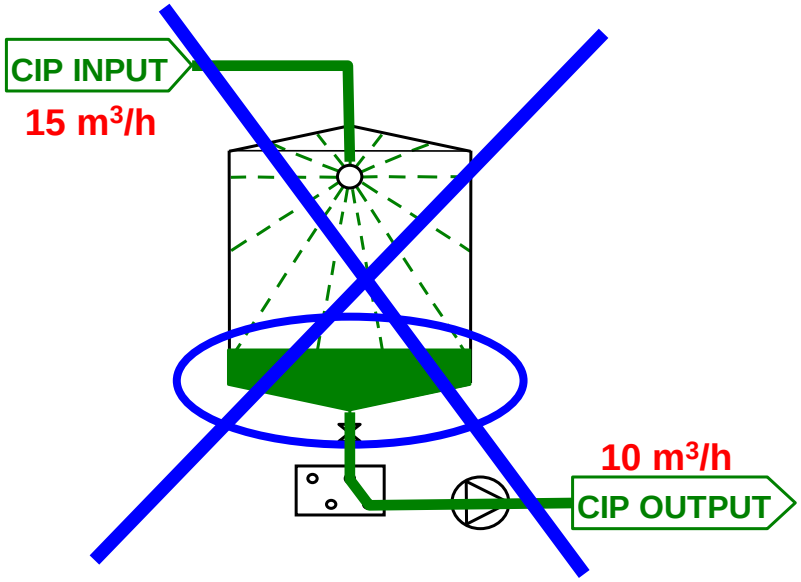
- Made of corrosion-resistant and cleanable materials
- Must confine the cleaning solution
- Must be drainable, with no pockets or ledges
- Any corners should be rounded
- Gaskets & seals – crevice-free, non-absorbent, non-reactive, non-porous (FDA-approved elastomers)
- Minimum interconnecting fittings in piping
- All valves & instruments should be cleanable
- Use of hoses should be minimised

Circuit Separation

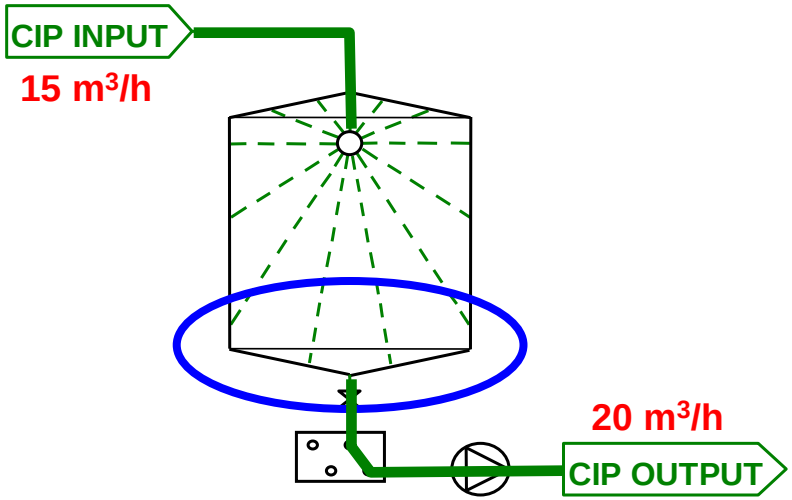




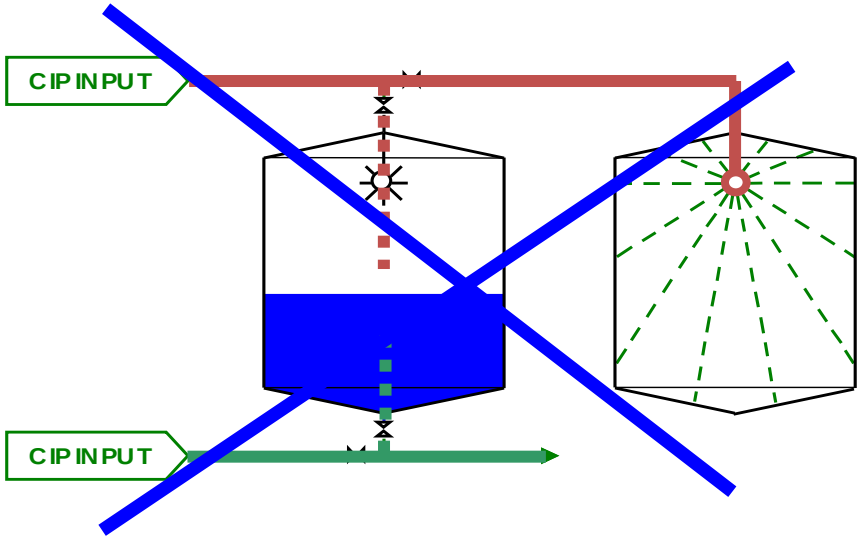
Circuit Balance

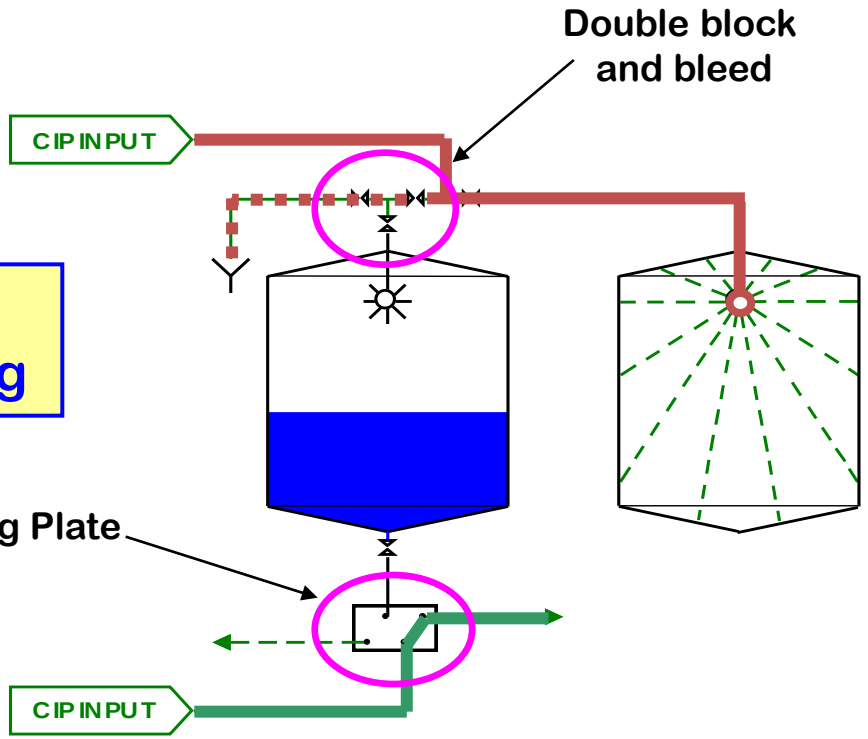


Always have a higher output flow than input flow for CIP



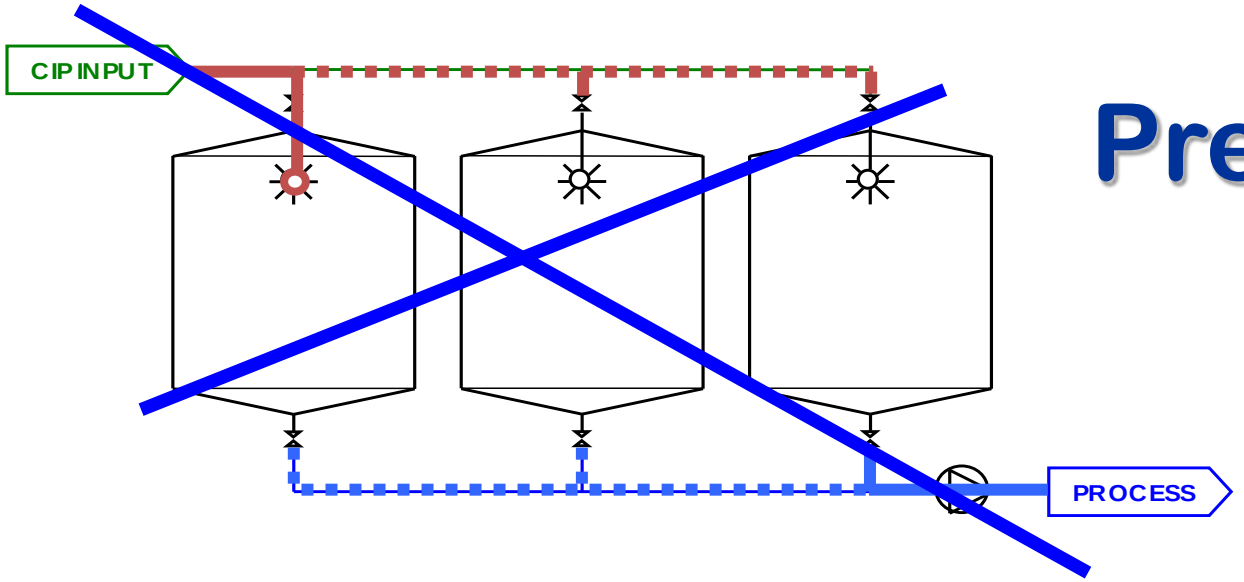
Safety Break System



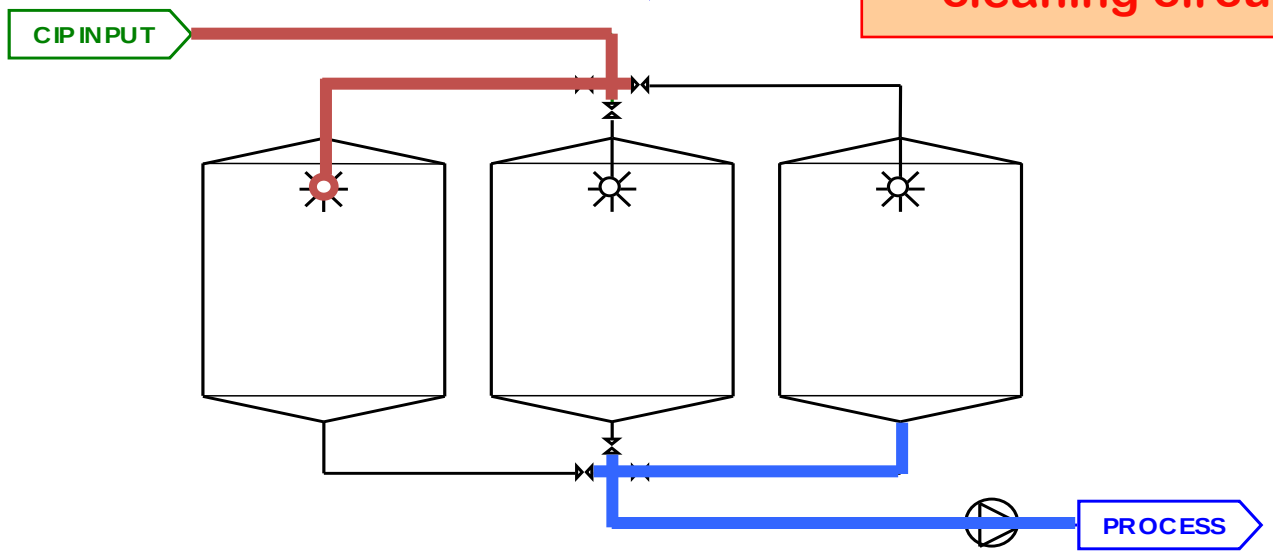


Always have safe separation between process and cleaning

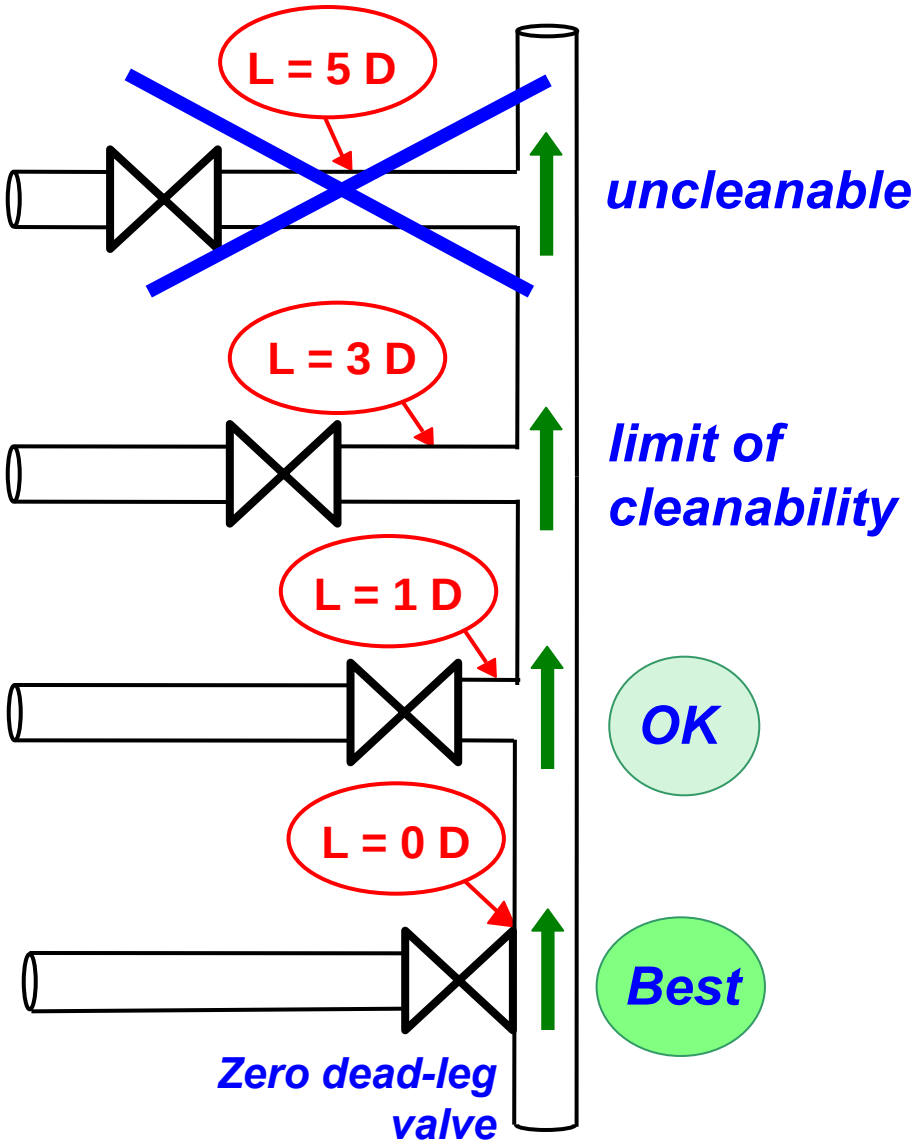
Preventation of Deadlegs

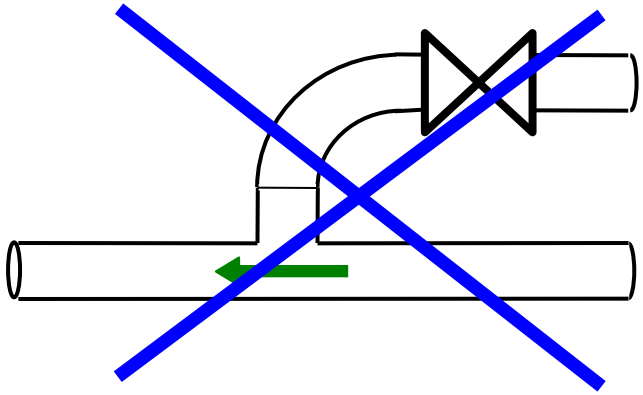


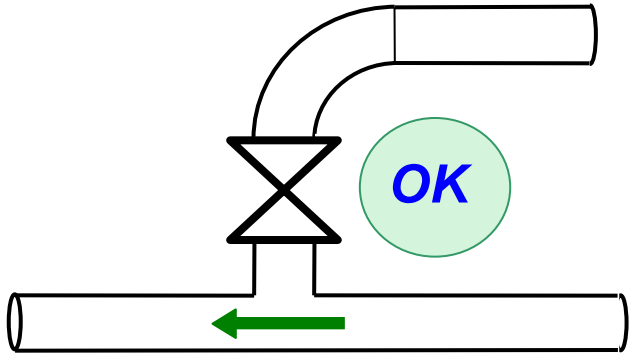
Beware of Dead-legs in the process and cleaning circuits



Dead-legs

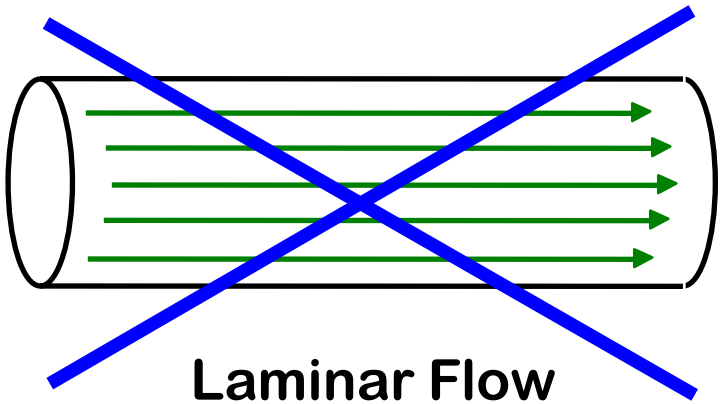

L = 5 D
uncleanable
L = 3 D
limit of cleanability
L = 1 D
OK
L = 0 D
Best
Zero dead-leg valve




OK

Pipework Velocity

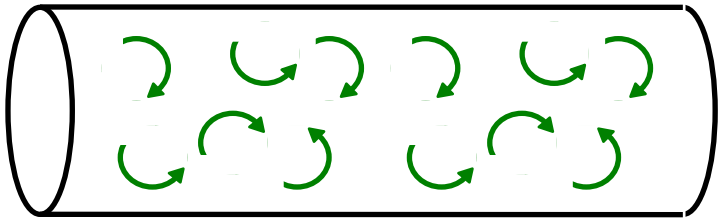
- Mechanical Action



Laminar Flow
(Low Velocity)

Re ⩽ 2300

Ensure sufficient fluid flow velocities in the process and cleaning circuits



Turbulent Flow
(High Velocity)

Re > 3000

Spray Devices – Fixed

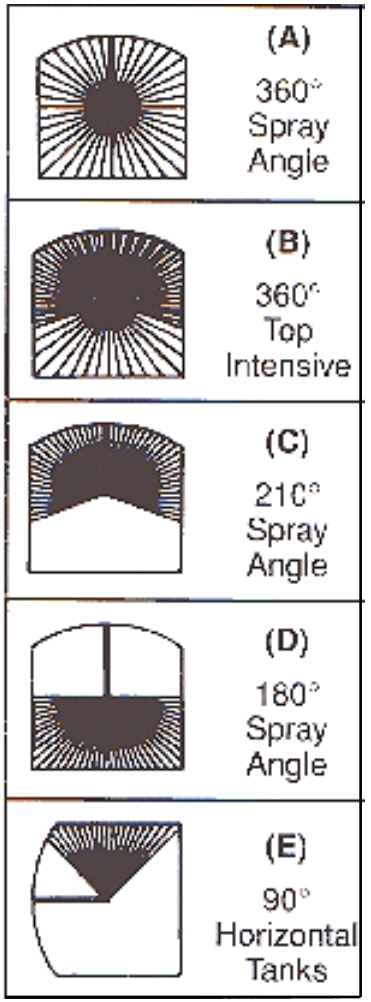
Low Pressure – High Flow

Advantages

- No maintenance
- Special Spray Patterns
- Easier to Monitor
- Less Pump Power

Disadvantages

- Higher Water Usage
- Less Mechanical Action
- Less Bounce Back
- Longer cleaning times



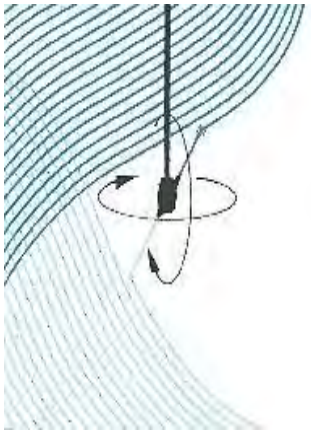
Spray Device – Rotating

High Pressure – Low Flow

Advantages

- Lower Water Usage
- Greater Mechanical Action
- Greater Bounce Back
- Greater Throw Distances

'Turbodisk'



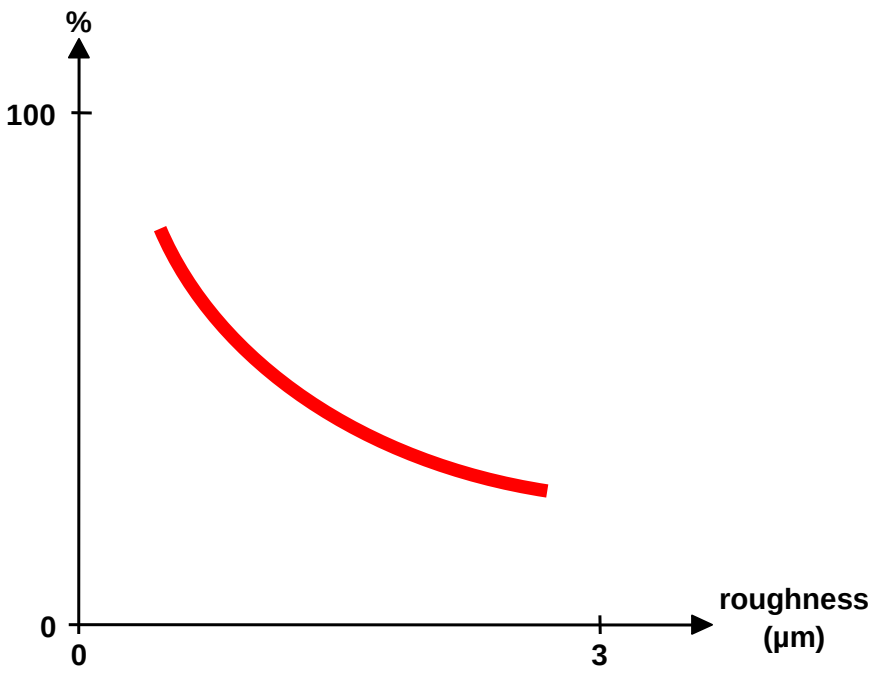
Disadvantages

- Higher Pump Power
- More Difficult to Monitor
- Generally Higher Cost
- More Difficult to "Aim" Spray
- Higher Maintenance

Jets

Slotted

Surface Finish



REDUCTION % OF MICRO-ORGANISMS AFTER A STANDARD CIP CYCLE (relative values)

TIME TO DESTROY 99,9% OF MICRO-ORGANISMS (relative values)

Welding Techniques

Poor Hand Weld

- Difficult to clean
- Drainage problems
- Corrosion

Orbital Weld

Summary of CIP/SIP

- Evaluation of Cleaning Risk
- CIP Unit Selection (Skid Packages)
- Flexibility allowing Customisation
- CIP / SIP / Process Interface from start
- Incorporate Hygienic Design
- Monitoring to Ensure Repeatability

SUNCOMBE
CIP & PROCESS ENGINEERS

Thank You For Your Attention

For More Information Contact Suncombe

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