From formula to Flawless Production:
Preserving Nutrient Value & Premium Taste in Dairy Products

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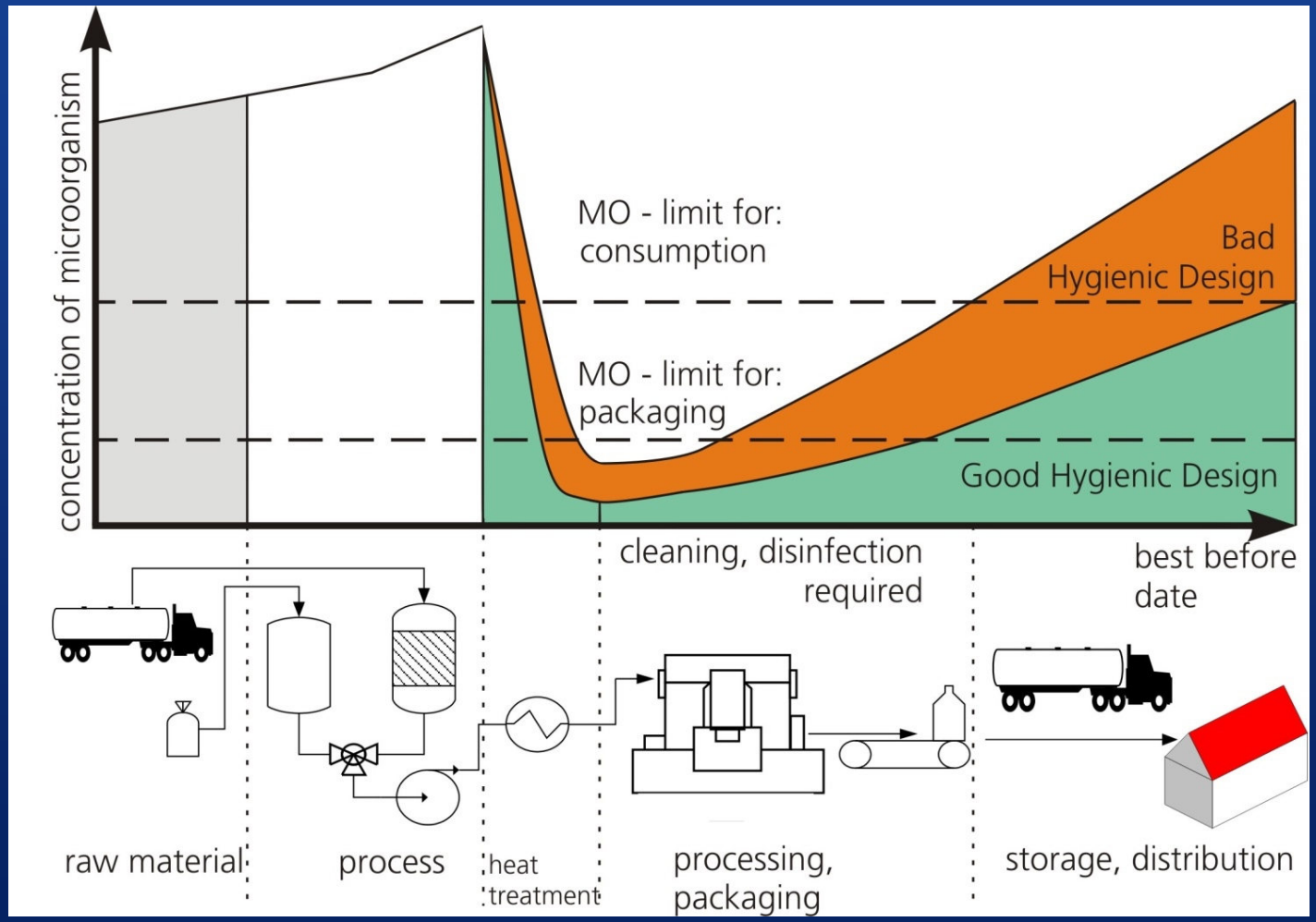
Content

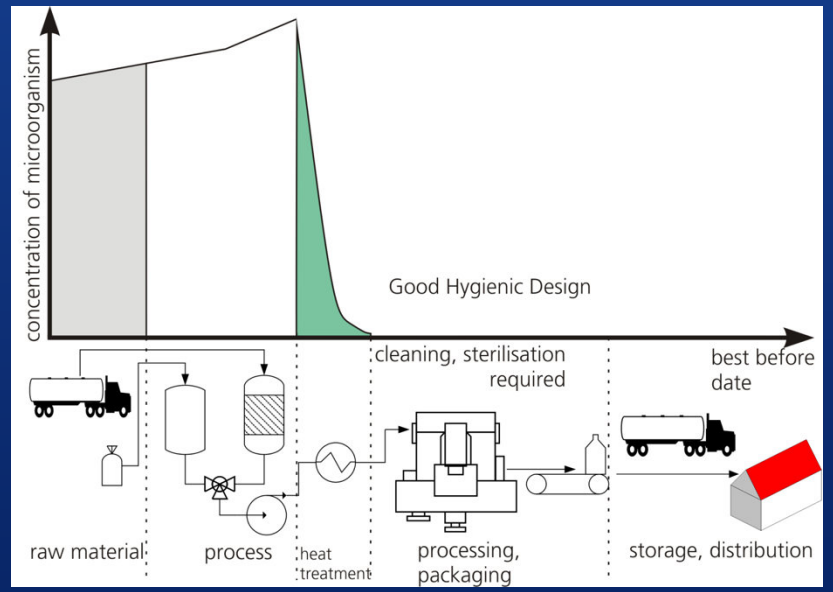
1. Challenges in preserving nutrient value and taste during production scale-up
2. Hygienic process design under EHEDG guidelines to mitigate contamination risks
3. Strategies for delivering safe and strictly label-compliant products

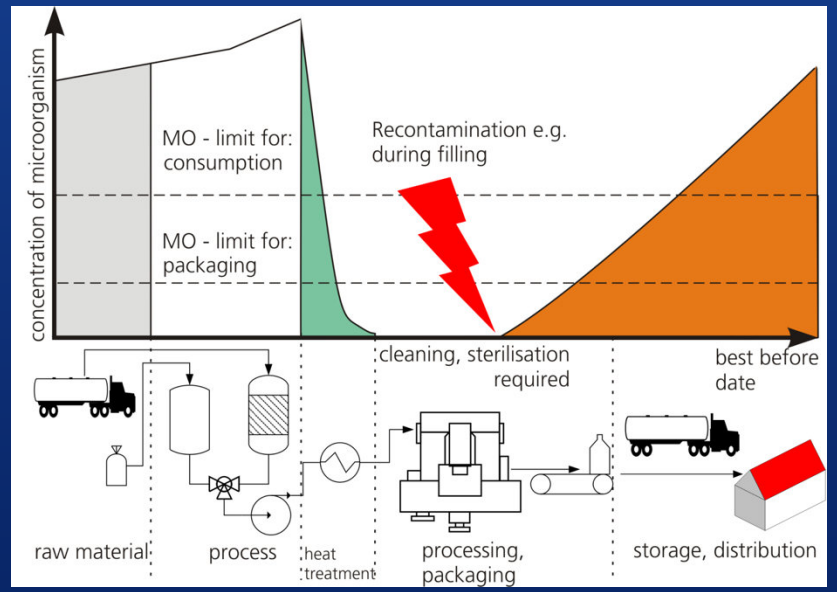
Growth of microorganisms after pasteurisation



Growth after sterilization + recontamination

No Contamination → With Contamination





From lab. scale to production scale

- Batch size ⟶ lab scale .. Pilot scale .. Production scale ?
- Batch size ⟶ batching .. Continuous flow
- Small batch .. Large batch
  - Raw material handling capacity
  - Mixing time is not linear proportional to batch size
  - Quality of mixing different .. Product texture
  - Heating, cooling effect
  - Contact time changed
  - Over cooked

Production scale

- Equipment, Machine sizing
  - Production line design for continues transferring
  - Mismatching capacity
- Product characters do not match to equipment
  - Wrong selection,
  - Oxidation to product
  - Shear force
- Materials handling to stations
  - On time material at equipment
  - Waste management

Production scale

- High productivity efficient
  - Longest running time ?
    - Fouling effect
    - Contaminate risk
  - Shortest heat up / cool down ?
    - Shock load to equipment
    - Stress corrosion, fatigue load
  - Maintenance quality – sensitive to equipment failure
  - Need skilled operators
- Future extension

Material selection – first steps

Materials must be suitable for the intended use!

- 1) The intended use of the equipment must be defined first by the equipment manufacturer or communicated by the processor. This includes the foreseeable misuse, type of food and conditions of contact as well as cleaning methods, cleaning fluids and the operation conditions of the equipment and its components.
- 2) Select materials that are
  - mechanically strong enough
  - corrosion resistant under conditions of intended use
  - temperature resistant
  - wear resistant
  - resistant to scratching or cracking
- 3) Check, which declarations of compliance (DOC) are required.
- 4) DOC‘s for food contact materials must fulfil regulatory requirements of the country or region of installation or final destination of the food product.

EHEDG guidelines to mitigate contamination risks

"A surface is only as clean as the last element it came in contact with"

1. Microorganisms are constantly exchanged between foods and food processing surfaces on contact in a dynamic environment.
2. Cross-contamination can be through DIRECT or INDIRECT contact
3. INDIRECT cross contamination requires:

- One or multiple vectors, e.g. condensation, insects, etc.
- Lapses in GMP enabling transfer from non-food contact surfaces to food or food contact surfaces

Essential Factors for Microbial Growth

- Temperature
- Time
- Initial load
- Water activity (aw = RH/100%)
- Atmosphere (AO2 or ANO2)
- pH
- Nutrients (food)

Inhibitory Factors for Microbial Growth

≠ Inhibitory agents e.g., salt, organic acids
≠ Competing microorganisms

What microorganisms need in order to grow?

The Right Temperature

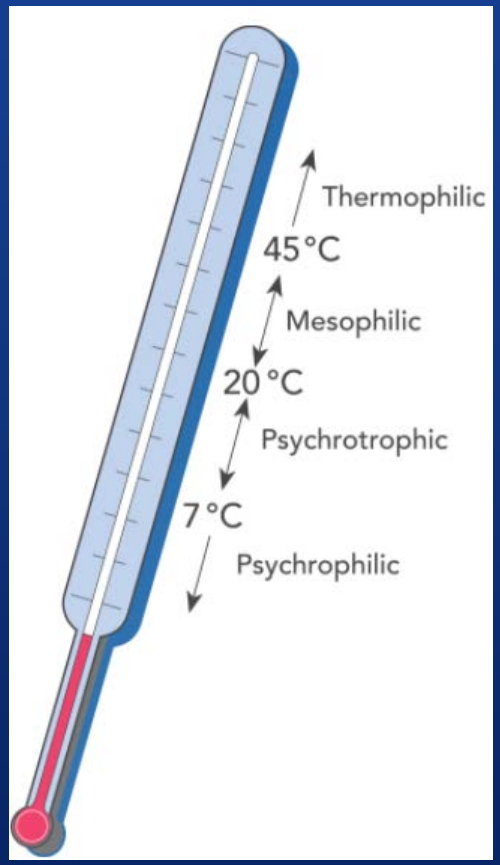
All microorganisms have:

- A temperature below which they cannot grow (Minimum)
- A temperature above which they cannot grow (Maximum)
- A temperature range where growth is fastest (Optimum)

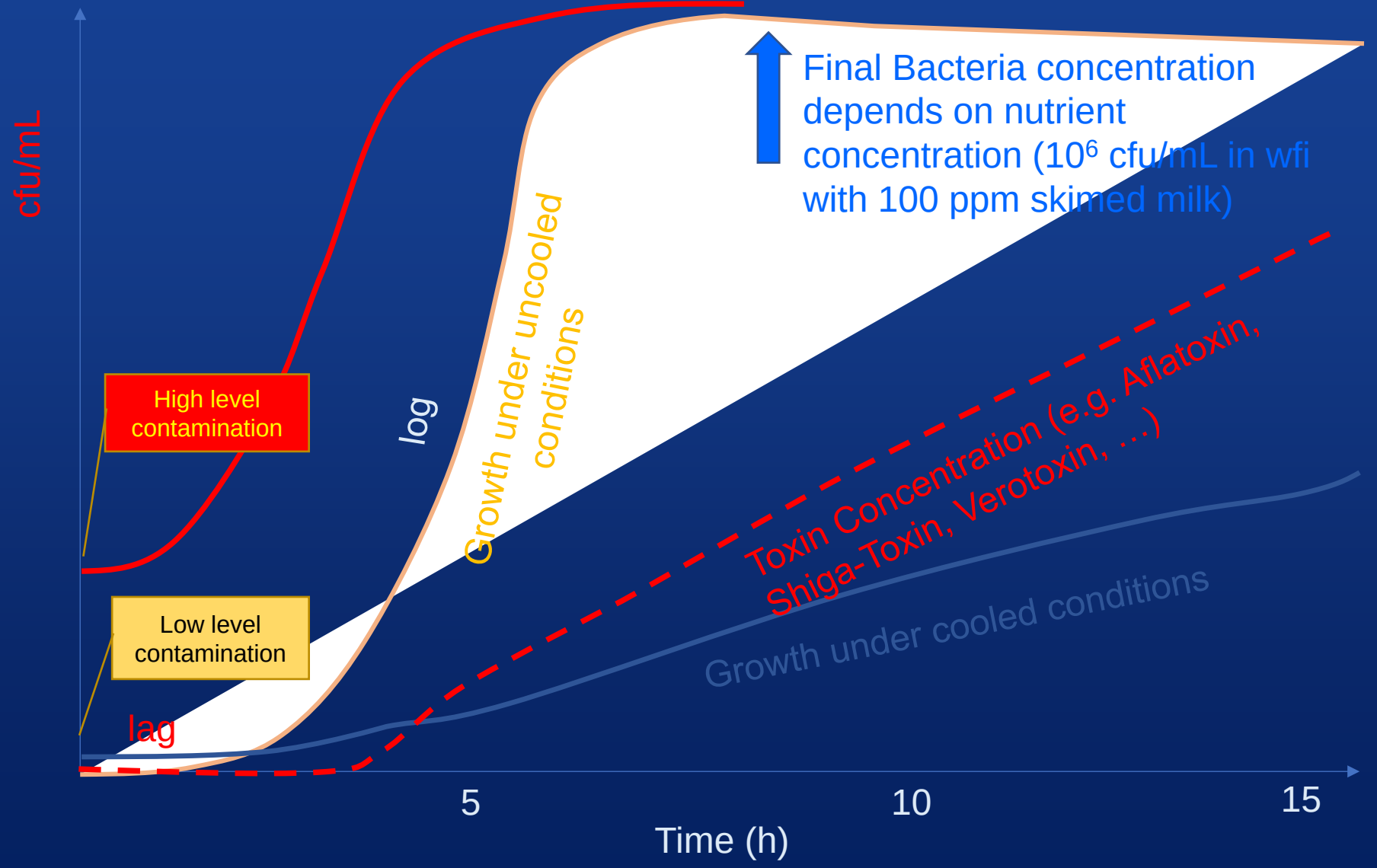
Freezing is not a reliable kill treatment

Elevated temperatures kill:

- Destruction is temperature & organism specific
- Type of heat, i.e. moist or dry



Microbial Growth



What microorganisms need in order to grow?

NUTRIENTS & WATER

NUTRIENTS AND WATER ARE A MUST FOR EACH LIVING ORGANISM, INCLUDING MICROORGANISMS

NUTRIENT PROFILE IS SPECIFIC FOR EACH GROUP OF MICROORGANISMS

SOME MICROORGANISMS PREFER THE SAME THINGS AS PEOPLE

Concepts of Hygienic Design

Simplicity, Accessibility, and Maintainability to facilitate thorough cleaning and reducing contamination risks

Design for Cleanability

- allow for easy access to all surfaces that require cleaning, thereby reducing the time and resources needed to maintain high hygiene standards.

Material Selection

- Non-porous, corrosion-resistant, and easy-to-clean materials can significantly contribute to maintaining hygiene and reducing contamination levels.

Minimizing Contaminants

- Strategies to minimize contaminants involve designing to reduce crevices and dead spaces where residues throughout the process.

Photo by Crystal Kwok on Unsplash

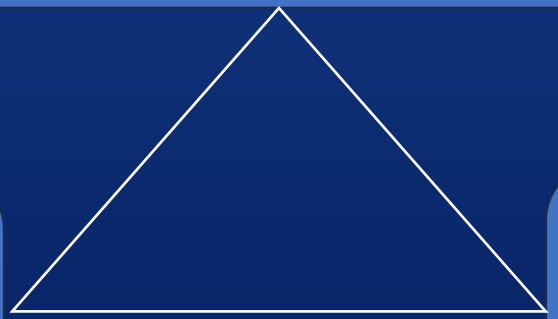
Impact of Hygienic Design

Effective cleaning integrated approach

Equipment & Facilities Design

- Construction material, surface finish
- Hygienic Design Criteria
- Line layout
- …

Hygienic design is a prerequisite for efficient and sustainable cleaning



Influence of Process Design on Soil

- Soil characteristic & amount
- Run Length

Cleaning Process

- Time
- Temperature
- Mechanical action
- Detergent type and concentration

Hygienic Design

Hygienic design is essential for *preventing* contamination, *reducing* waste, and *improving* efficiency throughout food production.

… HOW to get a through understanding of HD…

Challenges in Implementing Hygienic Design

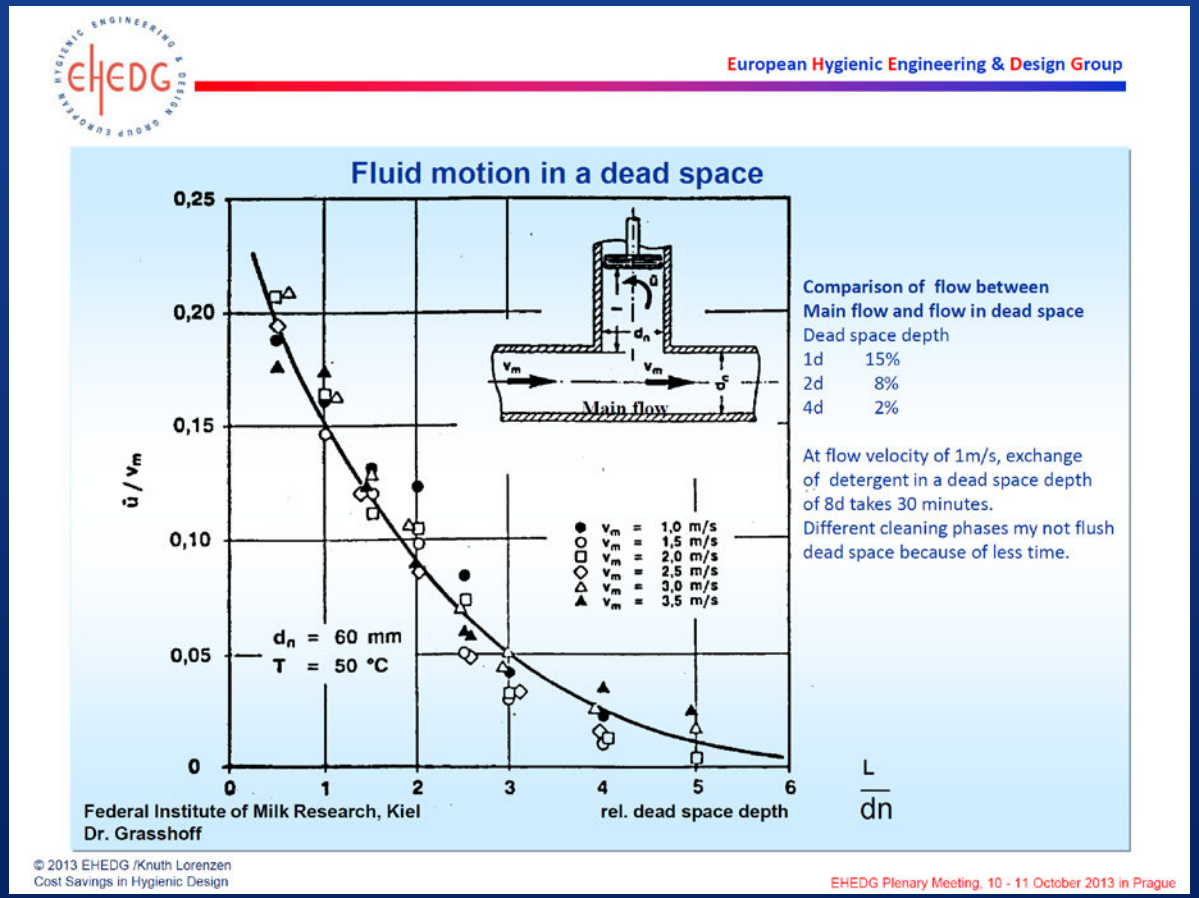
Cost Considerations

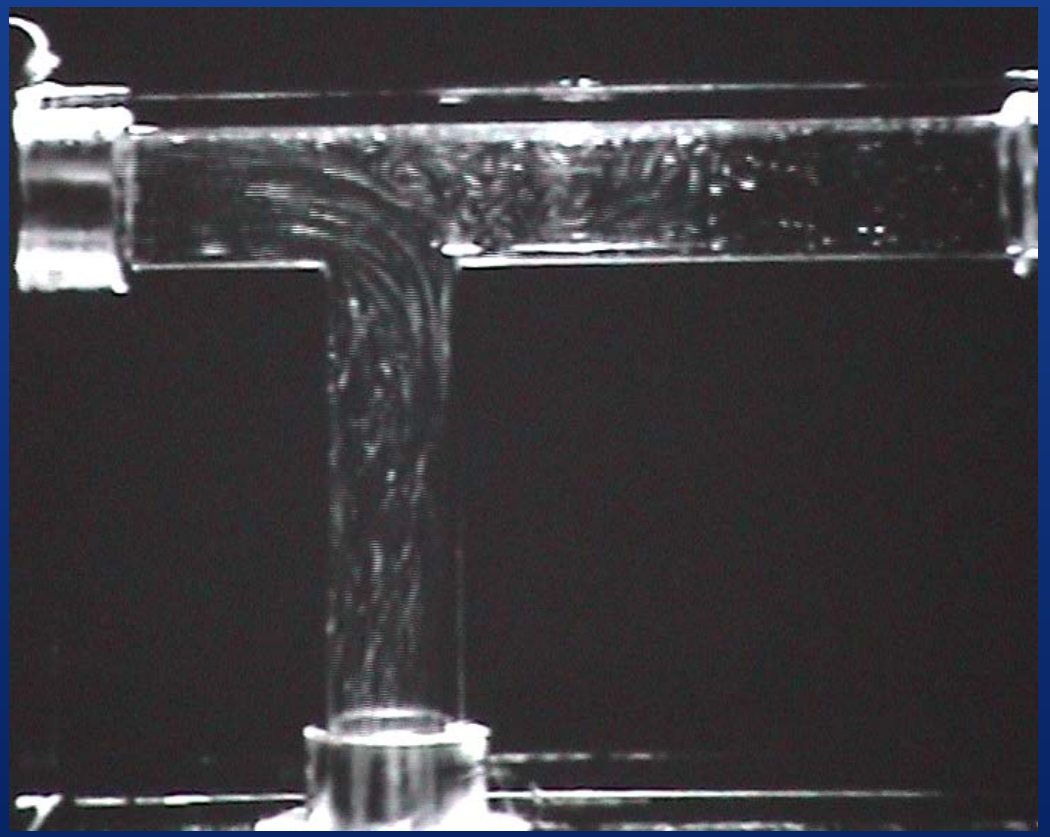
The initial investment in hygienic design practices may be high, but the long-term savings due to reduced waste and improved efficiency can justify this expenditure.

Cultural and institutional resistance within industries can impede the adoption of hygienic design practices. Overcoming this requires demonstrating clear benefits and providing

Technical challenges can arise, particularly in existing facilities where retrofitting design principles involves complex renovations and adjustments.

Challenges in Implementing Hygienic Design

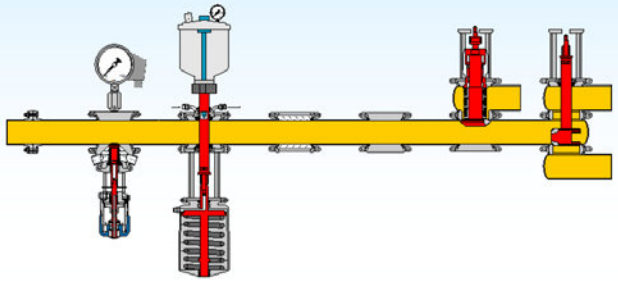




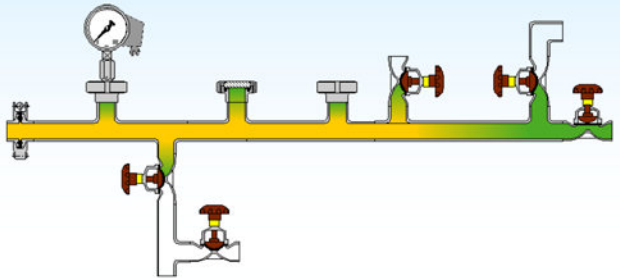
Challenges in Implementing Hygienic Design

European Hygienic Engineering & Design Group

Analysis of potential savings for the food industry
by comparing the latest state of art of hygienic design versus
T-piece designs, that use hygienically risky components



STATE OF THE ART



THE COMMON WAY

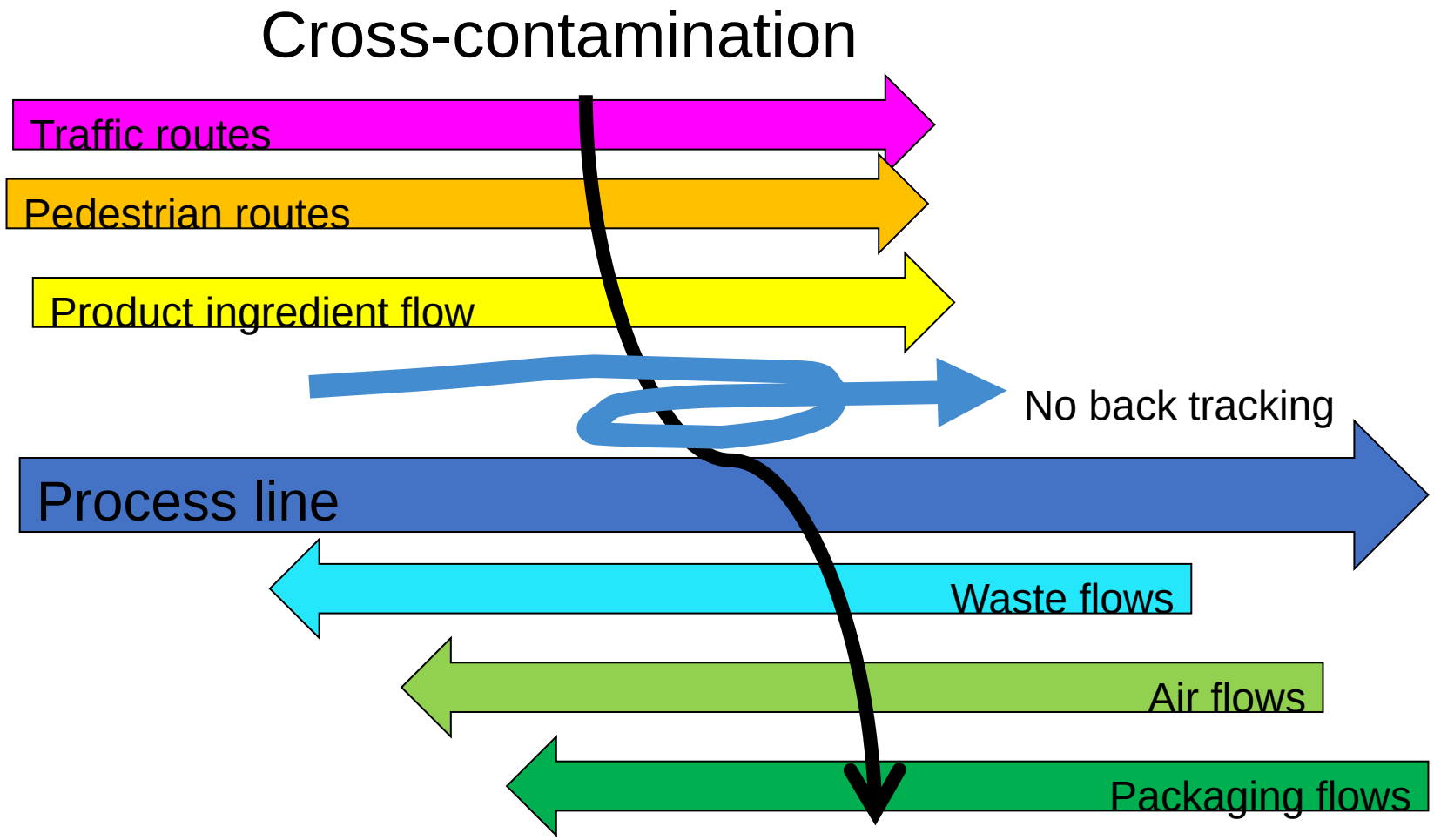
To reduce the risk of undesired microbial growth, effective CIP is vital. This can be achieved only by hygienically designed components which are germ-free after CIP.
Non-hygienic legacy designs are responsible for up to 20% of GMP claims.
The cleaning process is essential for the food safety and is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

Cost Savings in Hygienic Design
EHEDG Plenary Meeting, 10 - 11 October 2013 in Prague

Main Flows

Layout

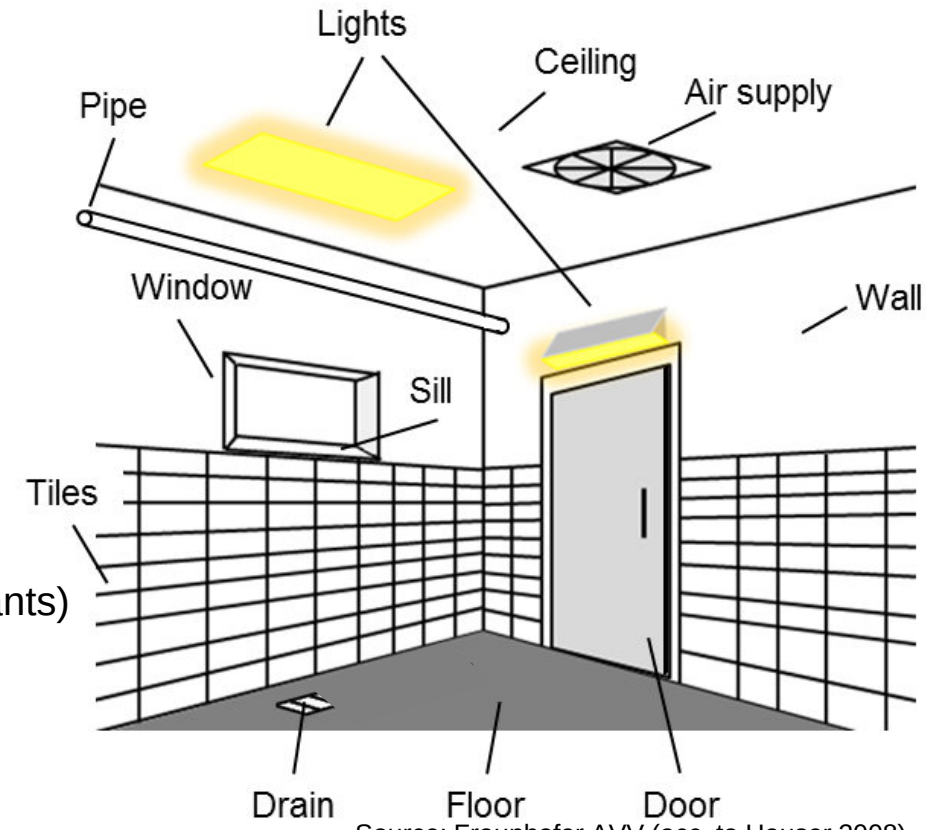
Process flow



Production rooms

Overview production room surfaces

- 3 main classes of walls / surfaces
  - Floors
  - Vertical walls
  - Ceilings
- Openings
  - Windows, doors, stairways
- Utilities
  - Light sources, pipes, wires, air ventilation, boards, (HD-plants)



Source: Fraunhofer AVV (acc. to Hauser 2008)

Contamination routes

- Humans are the No.1 contamination source in the process

Forehead – 100-1000 /cm^2

Nasal fluid – app.10 million /g

Hands – 10000-100000 /cm^2

Groin – 1-20 million /cm^2

Scalp – approx.1 million /cm^2

Saliva – approx.10 million /g

Armpit – 1-10 million /cm^2

Feet – 10^6 /cm^2

Faeces – more than 10^8 /g

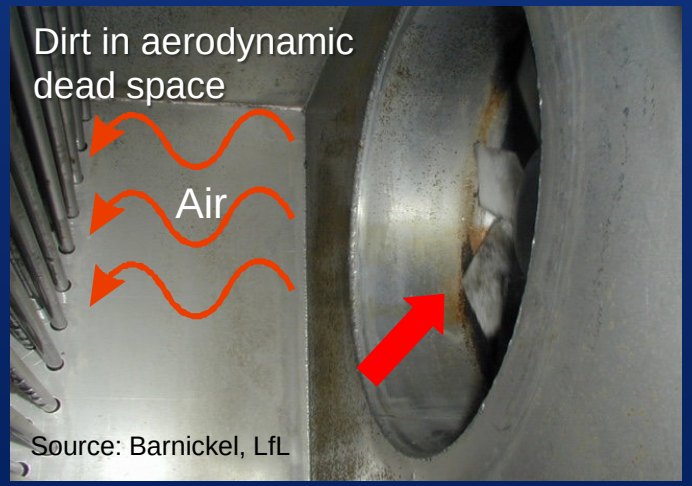
Air: Grade A: <1cfu/m^3; Grade E: < 500cfu/m^3 (EC Guide to GMP, Revision Annex 1, 2003)
Potable water (22°C): 100 cfu/ml

Contamination routes

Air and aerosols as transport vehicles

Airborne Contaminants

- Environmental air
- Compressed air
- Transport air
- Aerosols, e.g., cleaning



High-pressure sprays

Contamination routes

Water and hoses as transport vehicle.

- Fresh water hoses
- All installed taps must be in regular use
- Residual water in hoses, tubes and taps to be emptied before use
- Keep hoses stored off the floor and clean if on dirty floors
- Undertake regular maintenance checks of hoses and fittings – biofilms can form in worn or perished fittings


Source: Barnickel, LfL


Source: Lowry Food Consulting

Contamination routes

Liquids as transport vectors

- Cooling water, fluming water
- Condensate / wet films left on surfaces after cleaning
- Stagnant water or liquid drops
- Lubricants, coolants, signal transfer liquids

EHEDG guidelines Doc.1

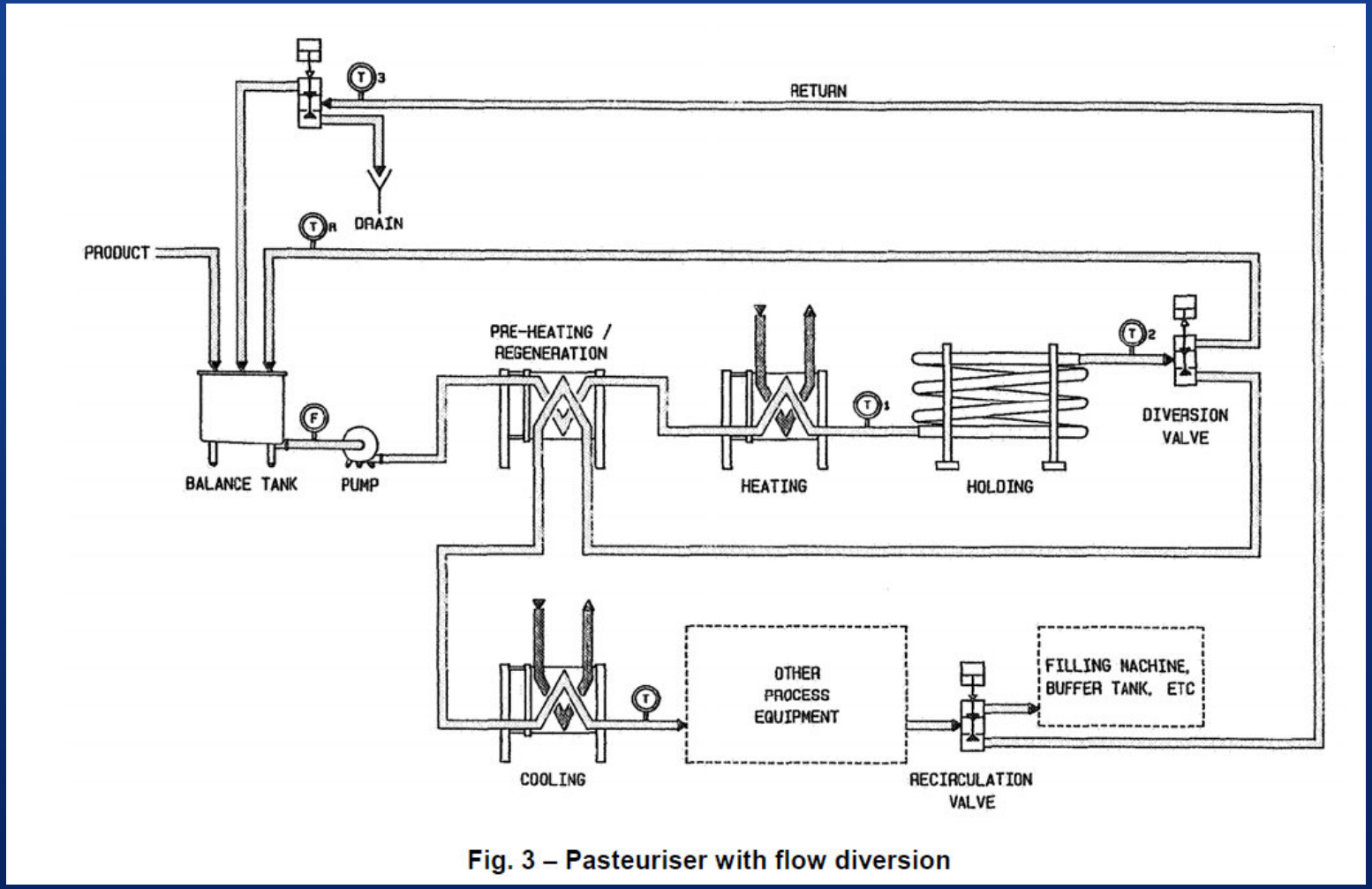


Fig. 3 – Pasteuriser with flow diversion

EHEDG guidelines Doc.1 – Direct steam injection

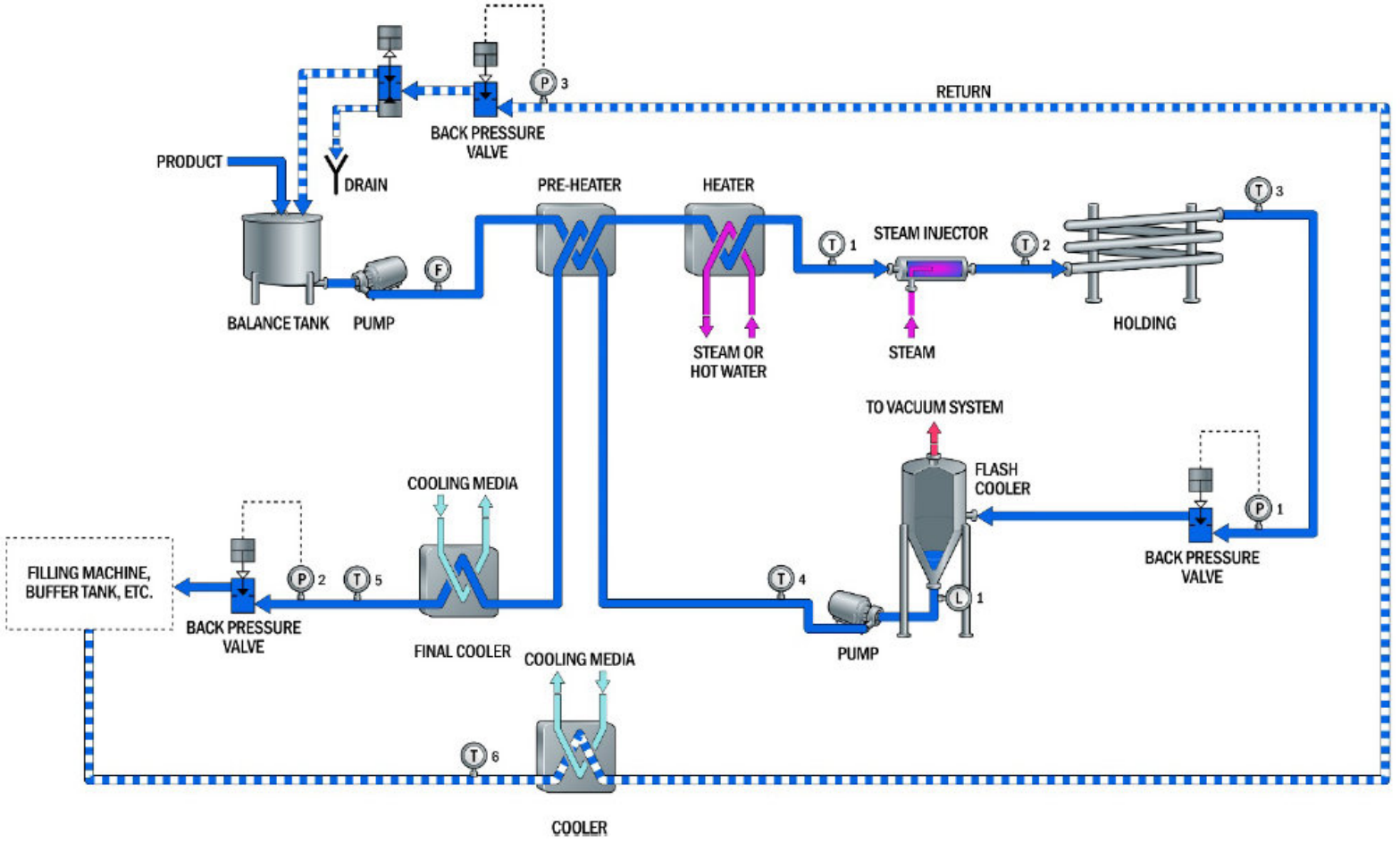


Fig. 1 – Direct system – steam injection

Challenges in Implementing Hygienic Design

Pipe welding quality

- Excessive colouration, visible defects in the weld surface, lack of fusion, excessive penetration, root convexity, meandering weld beads as well as varying widths of the cap layers are indications that further examination is advisable
- The limited operation distance of endoscopic equipment can be compensated by providing suitable inspection access points around a pipework system

Plant Automation to reduce risk & human errors

Plant quality factor

Plant design

- ❑ Processing & Capacity of plant + future extension
- ❑ Plant layout in hygienic design + process flow
- ❑ Building & Utilities

Installation & Construction

- ❑ Good engineering practice
- ❑ Good skill technician & Supervision

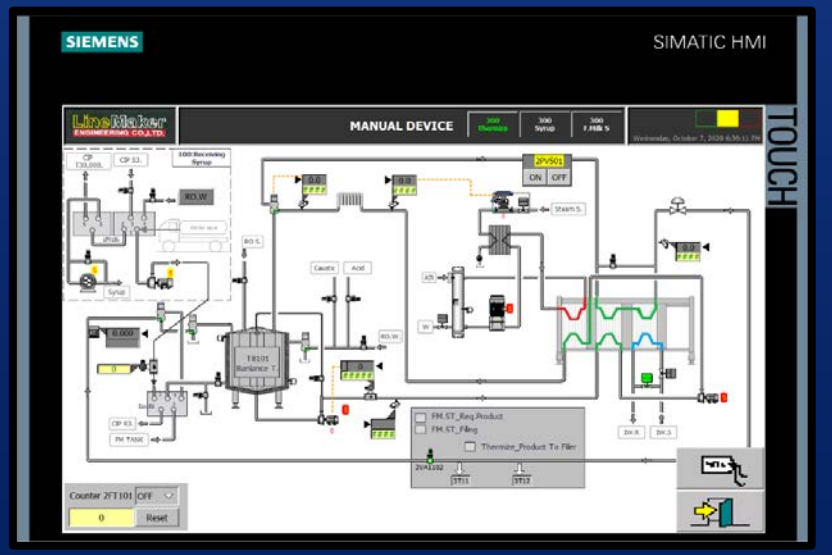
Operation & Maintenance

- ❑ GMP, HACCP

Plant Automation to reduce risk & human errors

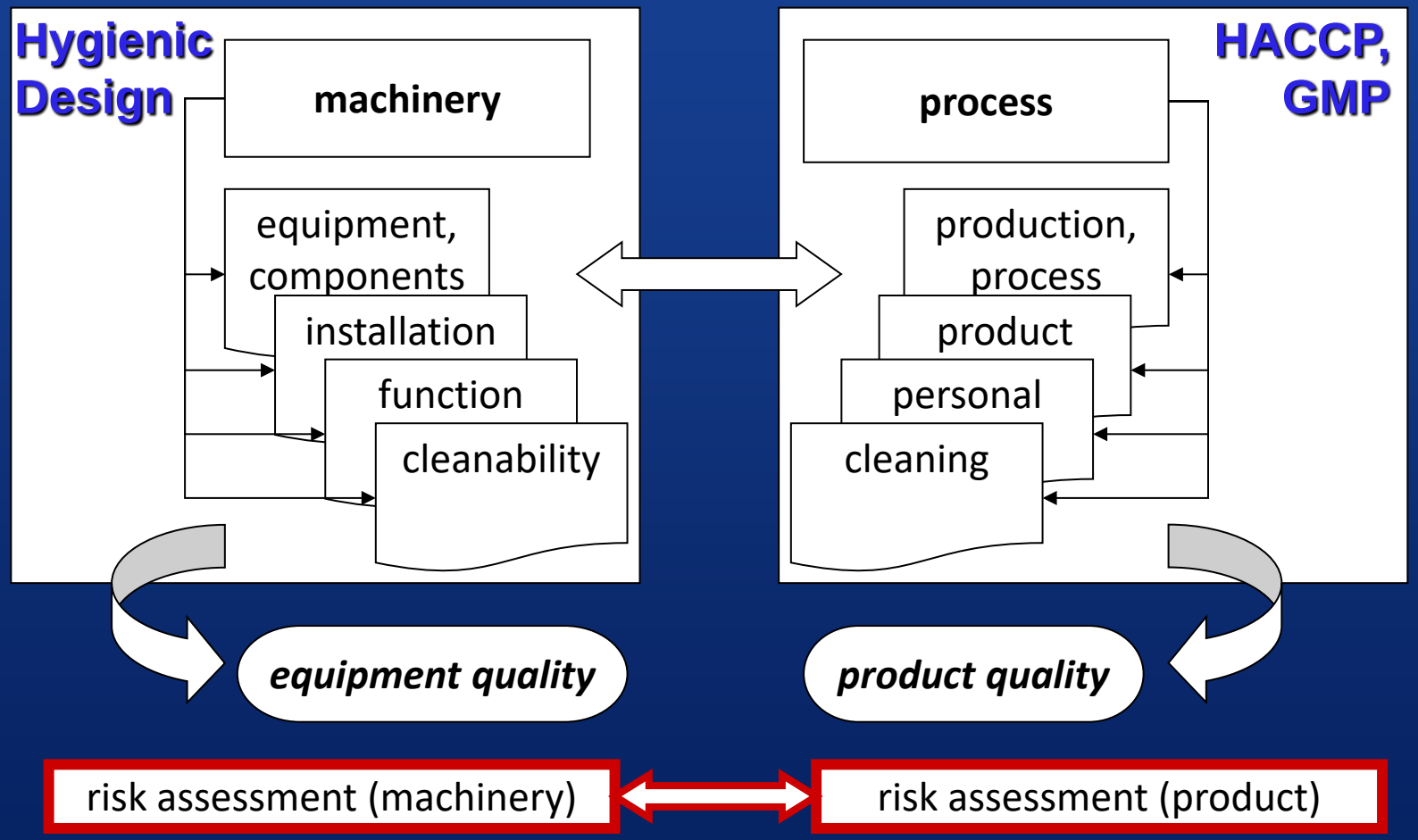
Level of Automation.

- On-off, PID controller
- PLC local unit controller
- SCADA
- SCADA + ERP .....



Plant Automation - SCADA

Risk Management with Hygienic Design



EHEDG Product Portfolio

Guidelines

30+ Working Groups and
50+ published documents

https://www.ehedg.org/guidelines-working-groups/guidelines/guidelines

Testing & Certification

300+ certified equipment

https://www.ehedg.org/testing-certification/certified-equipment/

Training & Education

Hygienic design training,
online and in-person

https://www.ehedg.org/training-education/certified-course-attendees/certified-course-attendees

THANK YOU – Questions?