

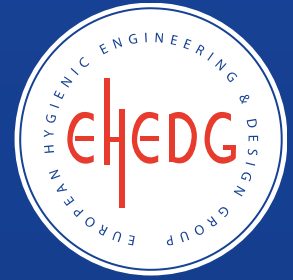


# Classical sensors enhanced for fouling detection and cleaning monitoring

Digitalisation of process instrumentation

# Challenges of fouling monitoring and cleaning validation

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## Impact

- Fouling can be responsible for 10 – 20 % of production costs
- Cleaning can take up to 25 % of operational time

## Initiatives

- **EHEDG Guideline 50**  
Hygienic Design requirements for CIP Installations (2019)
- **GFSI Benchmarking Scopes JI + JII**  
Hygienic Design Management System + HD Risk Assessment (2020)
- **IFS Food 7 chapter 4.10**  
Monitoring of cleaning & disinfection (2021)

# Previous research approaches and technologies for fouling monitoring

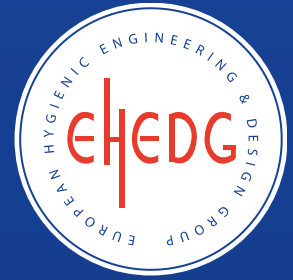
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- **Monitoring Tank Cleaning**
  - Pressure sensors: Alfa Laval
  - Capacitive sensors: GEA, AWH
  - Optical sensors: Fraunhofer IVV
  
- **Monitoring CIP**
  - Spectrometer: Diversey
  - Conductivity + TOC: Letzner
  - Pressure difference: Tetra Pak
  - UV-sensor: Löhrke
  
- **Monitoring fouling of heat exchanger in dairy industry**
  - Ultrasonic sensor: TU Munich, University Hohenheim
  
- **Fouling prevention of biofilms**
  - Ultrasonic system: Hasytec

Listing no claim to completeness

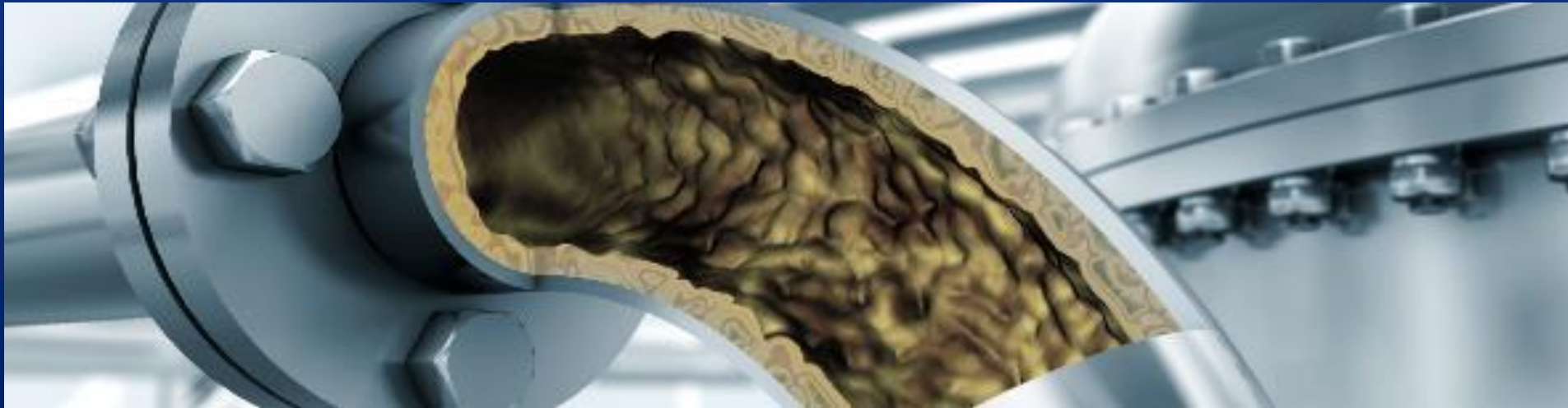
# Customer challenges



Do I have build-up in the process?

Does build-up increase over time?

Can I optimize cleaning times  
(CIP)?



# Fouling and cleaning-monitoring ...

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...with electromagnetic flowmeters

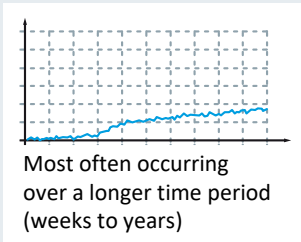


Proline Promag H

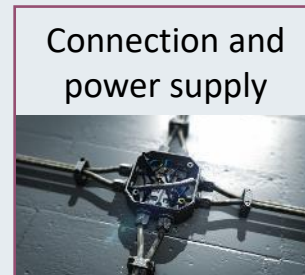
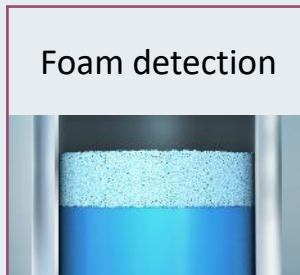
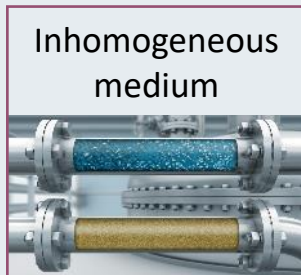
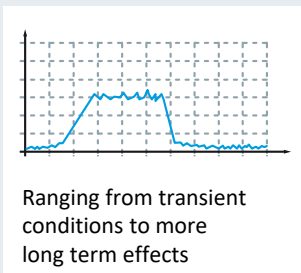
# Use cases - Device and asset condition monitoring and process optimization



## Condition monitoring: negative effects on device or process



## Process optimization: increase the reliability of the measuring point



# How does the build-up monitoring work?

The **electrical conductivity** of a fluid and of a build-up are different.

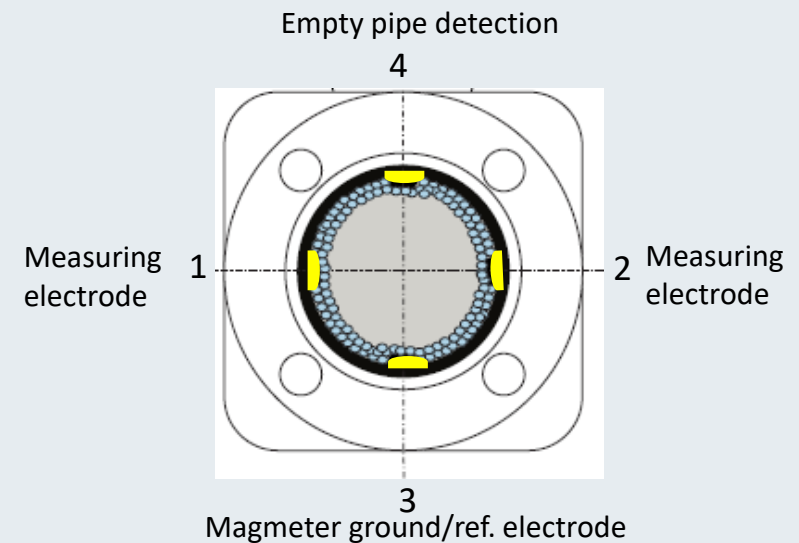
Through an analysis of the **conductivity distribution** within the measuring tube, build-up can be detected

Build-up = 0 %

- No build-up present

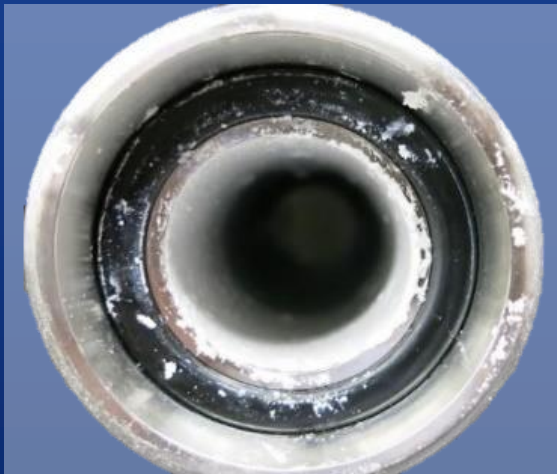
Build-up = 100 %

- Value of the maximum measurable build-up thickness
- The present build-up thickness on 100 % varies depending on the process



# Build-up & cleaning monitoring in e.g dairy industry

## Protein (whey) build-up (Electromagnetic flowmeter)



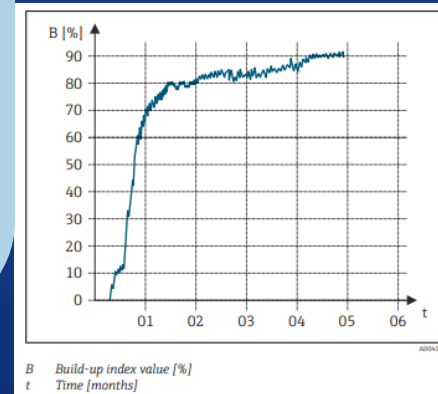
Device after 75 °C  
process temperature, 20 h.



3...4 mm build-up

## Monitoring protein build-up

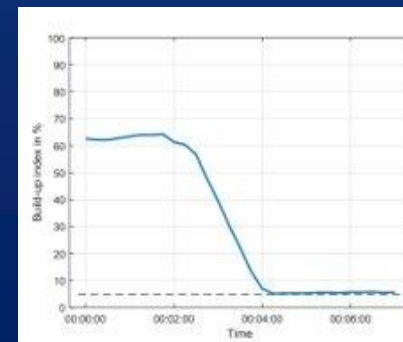
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„Build-up can be detected and a  
threshold can be set to trigger a warning“

## Monitoring cleaning in place (CIP) status

02



„After 4 min. no  
build-up is monitored “



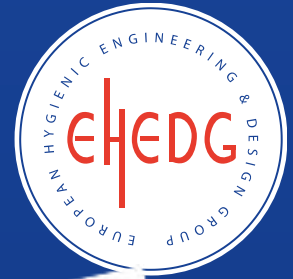
# Industry and application example – approved and tested



Industry	Application	Build-up material	Quality of detection
Water	Thermal water circuit (geothermal power plant)	magnetite	very good
Water	Heating circuits	magnetite	very good
Water	Drinking fountain (water supply)	Iron oxide	good / very good
Wastewater	Sludge (WWTP) Industrial sludge	Undefined sludge (incl. fat )	not sufficient
F&B	Raw juice / syrup (sugar)	oxalate (crystal crust)	good
F&B	Dairy products	protein	good / very good



# Liquitrend QMW43



## Combination of conductive & capacitive measurement

### Conductive Media:

Build-up= relationship between sensor and guard electrode current

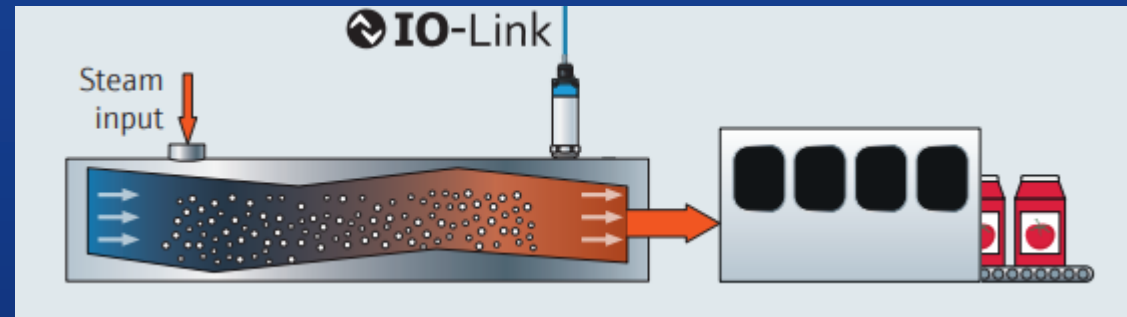
### Non- conductive Media:

Build-up= capacitive signal amplitude of sensor electrode



# Tomato sauce: Build up monitoring and cleaning validation

- **Pasteurisation:** Direct steam injection, 100 °C for several min. in holding tube
- **Challenge:** Build up in pipe reduced flow rate and increased process pressure.  
=> Pasteurisation Process ran the risk of non-conformity according HACCP  
=> Burned product in final product
- **Counteractions:** Concentration of cleaning detergent 1 % => 1,5 %  
=> CIP results still insufficient
- **Reason:** No monitoring of build up and no validation of CIP available



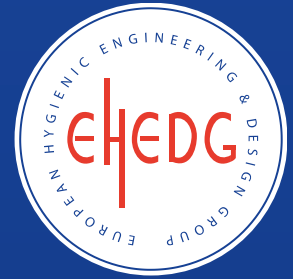
# Tomato sauce: Build up monitoring and cleaning validation



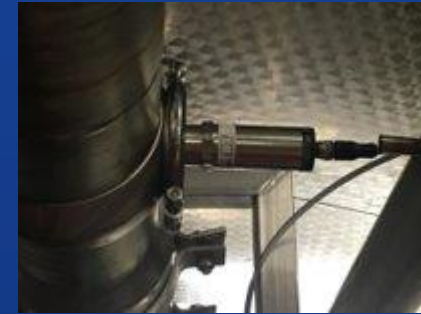
- **Solution**
  - Installation of Liquitrend QMW43
  - Flush mounted in VARINLINE®-housing
  - Middle of holding pipe
- **Results (process optimisation, CIP optimisation)**
  - Frequent starts/stops and changeovers increased build up
  - Process adapted to continuous production

	<b>Before</b> Liquitrend QMW43 Values	<b>With</b> Liquitrend QMW43 Values
CIP cycles/year	50	30
Detergent cost/L	0.06 € (concentration. 1.5%)	0.025 € (concentration 1%)
Volume flow of cleaning	10 m <sup>3</sup> /hr	20 m <sup>3</sup> /hr
CIP cleaning detergent duration	20 min.	20 min.
<b>Cleaning detergent cost/year</b>	<b>9,000 €</b>	<b>4,500 €</b>

# Further application examples



- **Brewery**  
Cleaning validation in hot wort pipe before cooler
- **Softdrink: Ice Tea**  
Cleaning validation (build-up caused by theine)
- **Water circulation systems**  
Build-up monitoring of biofilms



# Things to take into account with Liquitrend QMW43

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- **Signal accuracy < 0.1 mm**  
Very thin build-up will be displayed but starting at 0,1 mm; no details below 0,1 mm
- **Biofilm measurement**
  - Cannot detect thin oil- or dried biofilm with low DC value
  - Very reliable for usual wet biofilms
- **Process connection size: min. 3/4"**
- **Recommended hygienic connection**  
Real flush mounted pipe assemblies
- **Every single application has to be adjusted**



## Build-up Monitoring

...improve your process insights



### Less downtime

Build-up in your process can be monitored and cleaning cycles can be planned accordingly



### Cleaning time optimization

Build-up monitoring gives confidence in your cleaning efficiency.  
Potentially saving of cleaning agent and water



### Higher reliability

Higher reliability of measuring values

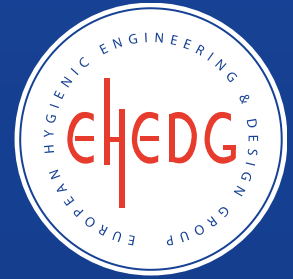


### Confidence

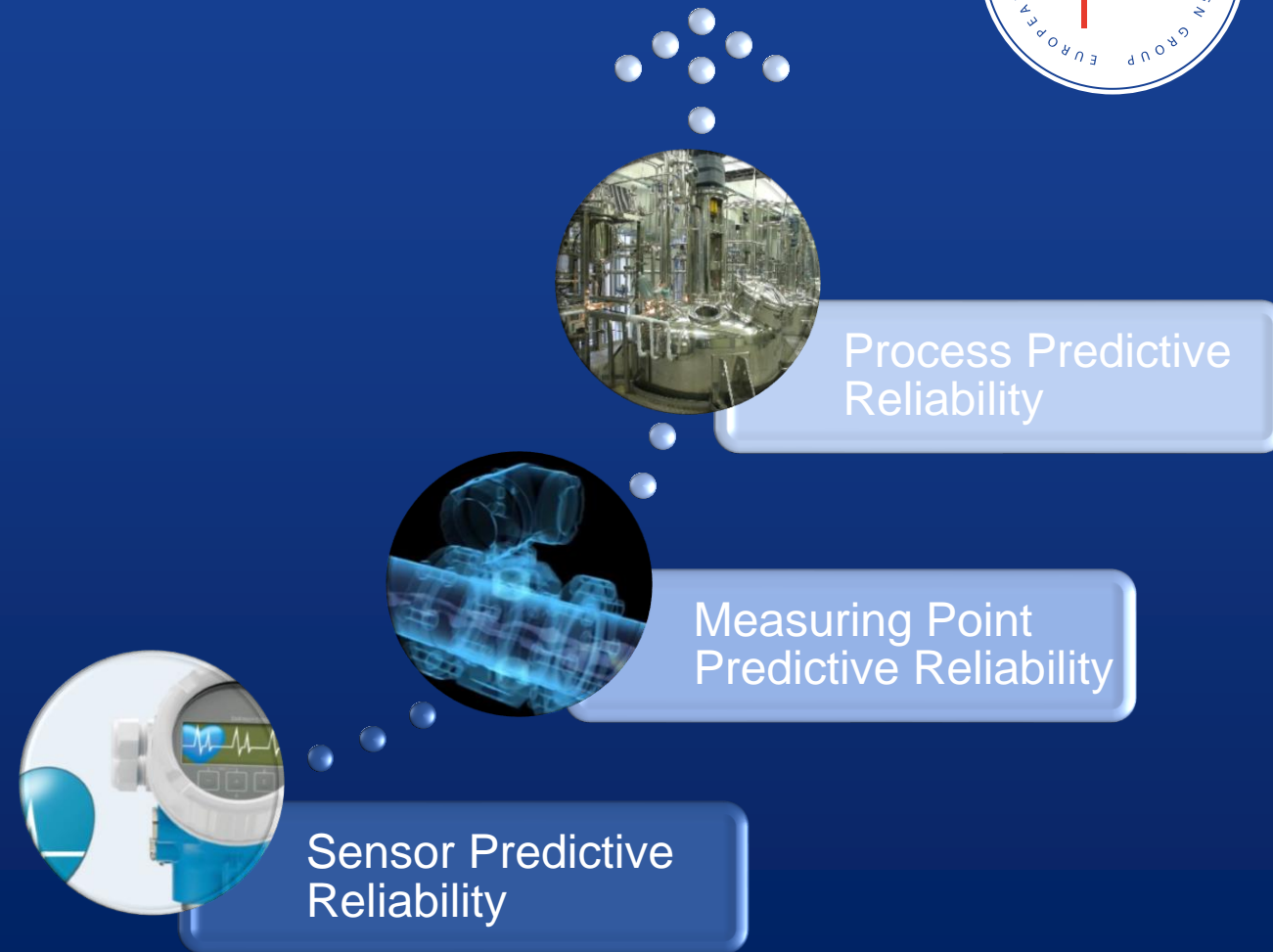
improved process insights



# Future prospects: Predictive Reliability enabled with machine learning



- **How to capture the information?**  
You need digitalisation => connectivity is key
- **How to transfer additional information from field to control level?**  
You need digitalisation
- **Target:**  
To get from the “reactive mode” to the “predictive mode”
- **Artificial Intelligence** and machine learning will open new chances



# Thank you

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## Further information

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