

AUTOMATION,
INSTRUMENTATION AND
PROCESS CONTROL DURING
PLANT DESIGN AND START-UP,
PI-DIAGRAMS

20.5.2019

RAMBOLL

SUBJECTS

- Process automation design and specifications
 - Instrumentation design and specifications
 - Process control philosophy
- PI-diagrams
- Instrumentation tasks

PROCESS AUTOMATION DESIGN

Co-operation between process design and automation experts

Process design

- PI-diagrams
- Instrumentation/ equipment lists and specifications
- Overall and unit process control philosophy
- Equipment signalling (I/O, digital bus...)

Automation design

- Design of automation environment
- Specs of technical control system (tech. requirements)

Automation engineering

- Programming of control system
- Supply and installation of automation system
- Testing and start-up

PROCESS AUTOMATION DESIGN

Instrumentation design

Equip unit processes with measurement instruments, take into account:

- Permitting and treatment requirements
- Risk assessment
- Control philosophy
- Operational personnel → automation degree
- Goals for energy and resource efficiency
- Reporting needs
- Available budget
- Maintenance issues and opex

PROCESS AUTOMATION DESIGN

Control concept -design

- 2 design levels: 1) unit process level, 2) single equipment/instrument control loop in automatic mode
- Normal running/start-up/shut-down/emergency shutdown
- Rotation of stand-by units
- Power shut down situations → start-up description under emergency power
- Alerts, process locking specifications
- Start-up of unit processes in sequence
- Calculations: running times, calculated values (circulation %, chemical dosages...)
- Process reporting specifications

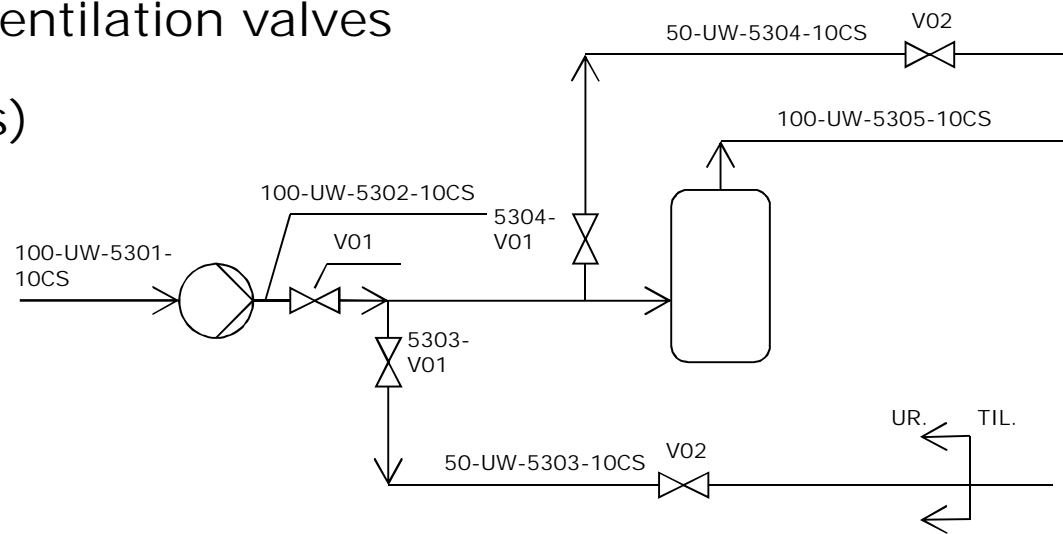
PROCESS AUTOMATION DESIGN

Construction period and Start up -tasks

- FAT-tests
- Simulation of process unit arrangements under construction period
- “Dry and wet tests”, SAT-tests
- Training
 - Process control simulations

PID- PIPING AND INSTRUMENTATION DIAGRAM

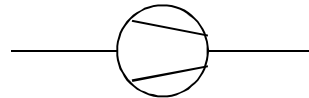
- Overall picture of unit process combination and plant structure
- Incl. all equipment, piping, valves, fittings, measurements, control-loops
- Specified symbols for different equipment
- Draining, cleaning and ventilation valves
- Item numbers (positions)
- Pipe codes and classes
- Delivery limits



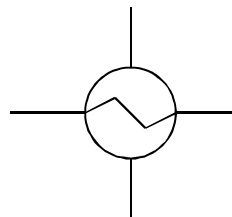
PI D-SYMBOLS

STANDARD SYMBOL REPLACED WITH A SPECIFIC ONE

FLOW DIAGRAM

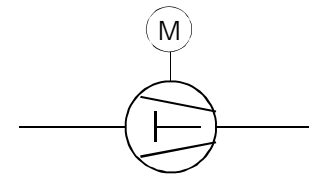


COMPRESSOR OR
BLOWER IN
GENERAL

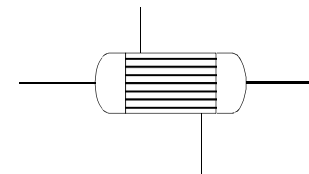


HEAT EXCHANGER
IN GENERAL

PI-DIAGRAM

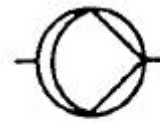
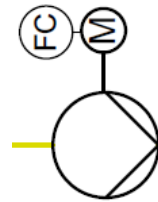


PISTON COMPRESSOR

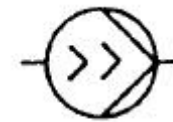


PIPE HEAT
EXCHANGER

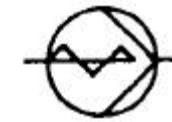
PI D-SYMBOLS



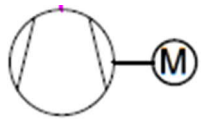
Kalvopumppu



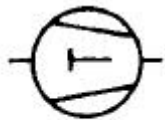
Ruuvipumppu



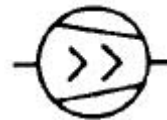
Kierukkapumppu



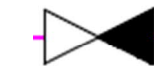
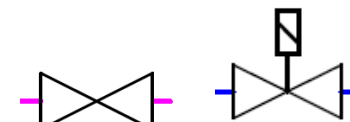
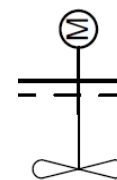
Turbokompressori



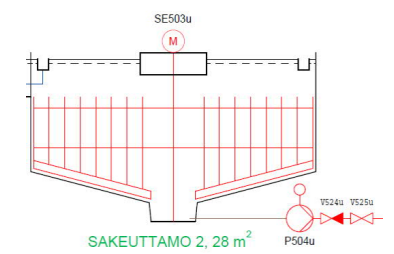
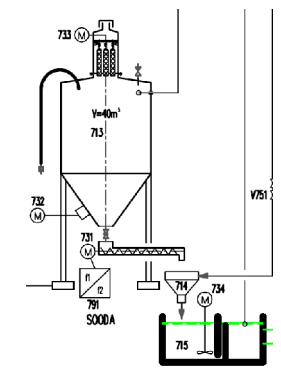
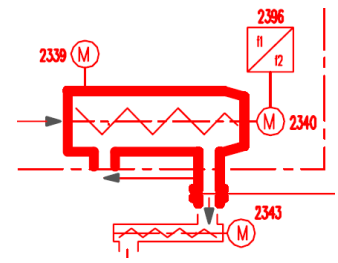
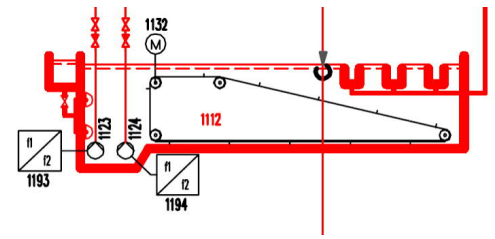
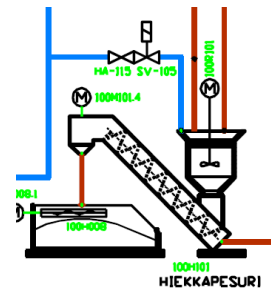
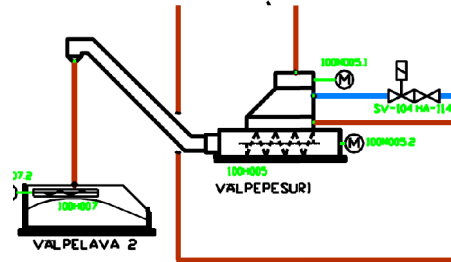
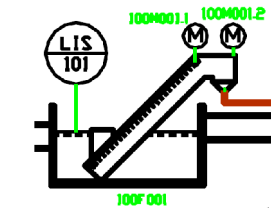
Mäntäkompressori



Ruuvikompressori



PI D-SYMBOLS



PID-DIAGRAM

FIELD INSTRUMENTS:



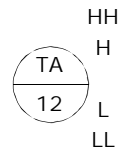
LOCAL INSTRUMENT



INSTRUMENT, REMOTE CONTROL ROOM



INSTRUMENT, LOCAL CONTROL BOARD



ALERTS AND LOCKING LIMITS

PI -DI AGRAM

MEASUREMENTS:

- First letter: what is measured or controlled
- The following letters: Supplementing measurement and specifying operational principle
- Letters in the following order I, R, C, T, Q, S, Z, A

PI -DI AGRAM

MEASUREMENT CODING (SFS4103):

	1. kirjain	2. kirjain	seuraavat kirjaimet
	Mittaussuure	Lisämäärite	Näyttö- tai lähtötoiminta
A	---		Hälytys
B	---		Audiovisuaalinen toiminta
C	---		Säätö
D	Tiheys	Ero	---
E	Kaikki sähkösuureet		Anturitoiminta
F	Virtaus	Suhde	---
G	Pituus tai asento		---
H	Käsiohjaus		---
I	---		Osoitus
J	---	Jaksottainen toiminta	---
K	Aika tai aikaohjelma		---
L	Pinnan korkeus		---
M	Kosteus		Viestin muunto
N	Käyttäjän valittavissa		Käyttäjän valittavissa
O	Käyttäjän valittavissa		---
P	Paine		Testaus, näytteenotto
Q	Laatu		Yhdistäminen, summaaminen
R	Ydinsäteily		Tallennus
S	Nopeus tai taajuus		KytKentätoiminta
T	Lämpötila		Lähetintöiminta
U	Monimuuttuja		Monitoiminta
V	Viskositeetti		Venttiili, toimiyksikkö
W	Paino tai voima		---
X	Määrittelemättömät suureet		Määrittelemättömät toiminnot
Y	Käyttäjän valittavissa		Laskentatoiminta
Z	---		Hätä- ja turvatoiminta (lukitus)

PI - DIAGRAM

MEASUREMENT CODING EXAMPLES:

1. Sampling, clock timered, local contr. panel



2. Pressure measurement,
local device



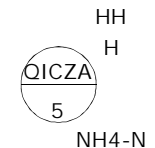
3. Pressure measurement + control in process contr. system



4. Flow measurement, indication, recording, counter



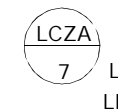
5. Ammonia measurement, indication, control, alarm/locking



6. Pressure switch, alarm in pr. Control system



7. Level measurement, control, alarm/lower, locking/lower



8. Moment switch, alarm in pr. Control system



PI - DIAGRAM

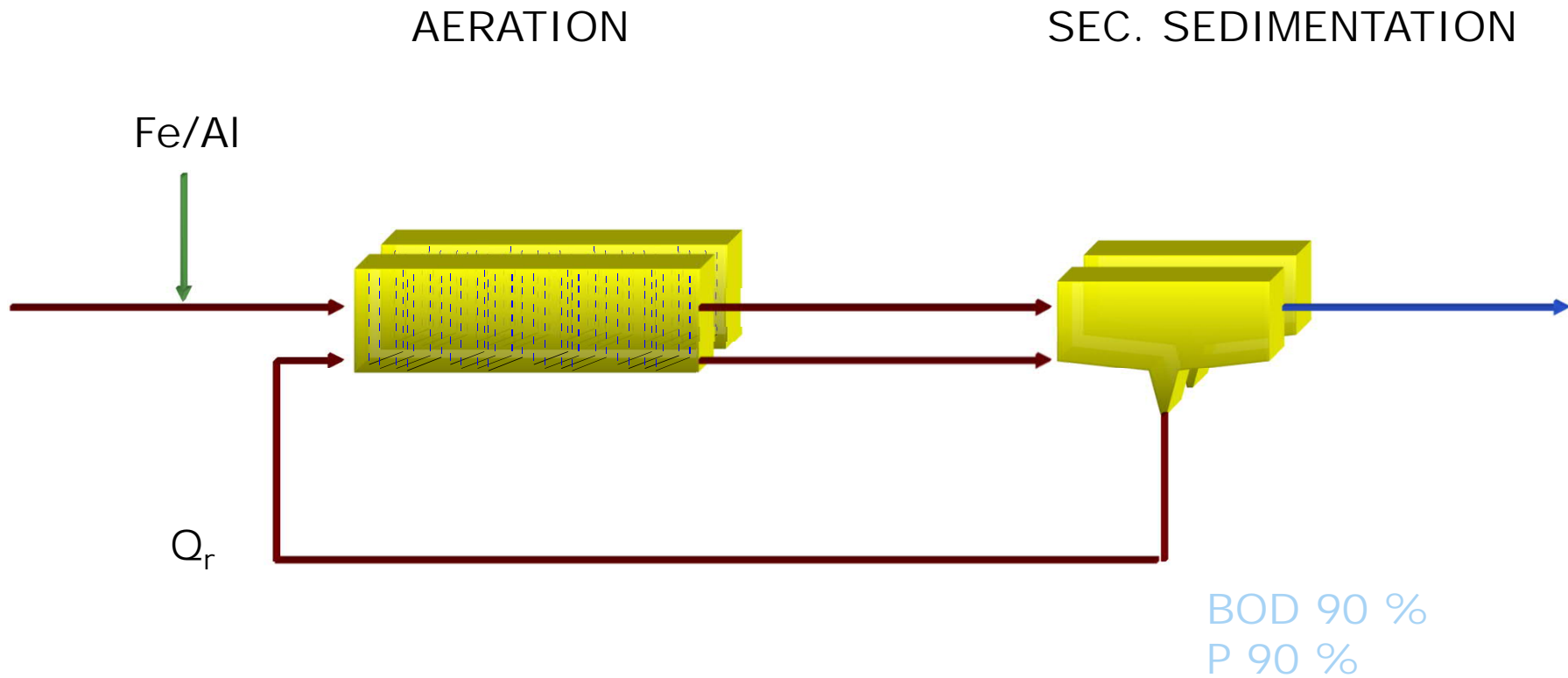
DESIGN TOOLS:

- basic-AutoCAD
- "intelligent" database structured software
 - Cadmill Process, Vertex, AutoCAD Plant 3D PID
 - → symbol libraries (drag and drop)
 - → automated lists of piping, equipment, instruments
 - → common database with mechanical design (2-way updates)

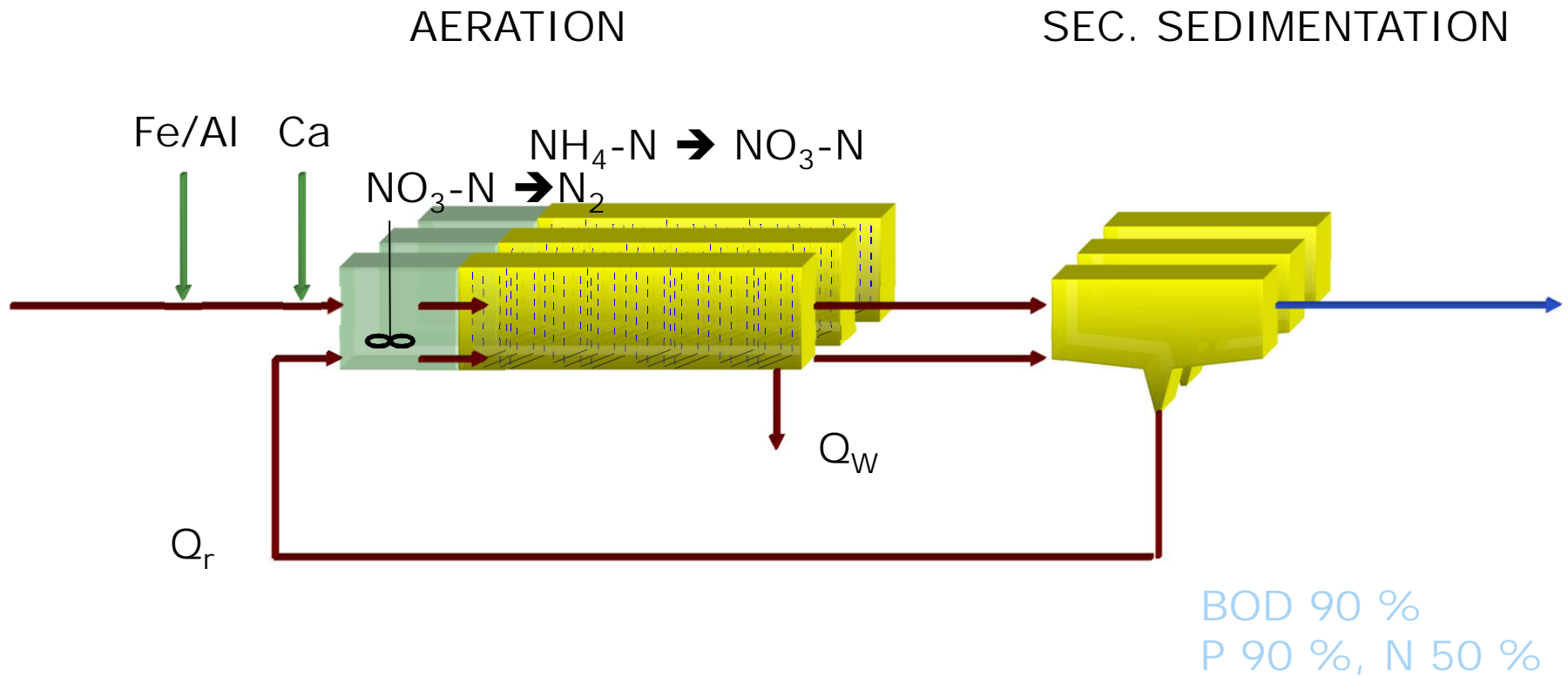
STANDARDIZATION

- *Prosessikaaviot*, standardi SFS 4285, 12.02.1979, Suomen standardisoimisliitto
- *Instrumentoinnin piirrosmerkit. Mittaus-, ohjaus- ja säätötoimintojen perusmerkit*, standardi SFS 4103, 18.11.1985, Suomen standardisoimisliitto
- *Prosessikaavioiden piirrosmerkit*, standardi SFS 4286, 27.06.1988, Suomen standardisoimisliitto
- *Instrumentoinnin piirrosmerkit. Perusmerkit prosessitietokoneita ja hajautettua digitaalista automaatiota varten*, standardi SFS 5018, 25.06.1984, Suomen standardisoimisliitto
- *Prosessi-instrumentoinnin piirustukset ja muut asiakirjat. Laadinta ja luokittelu*, standardi SFS 5098, 06.06.1985, Suomen standardisoimisliitto
- *Tehdassuunnitteluasiakirjat. Prosessikaavioiden ja sijaintia kuvaavien piirustusten laadinta CAD-järjestelmillä*, standardi PSK 5821, 14.06.1999, PSK standardisointi
- Virtaavien aineiden nimet, lyhenteet ja lyhenteiden muodostaminen, standardi PSK 0901, 2001, PSK standardisointi
- Energiateollisuuden identifiointijärjestelmä: KKS (Kraftwerk-Kennzeichen-System).

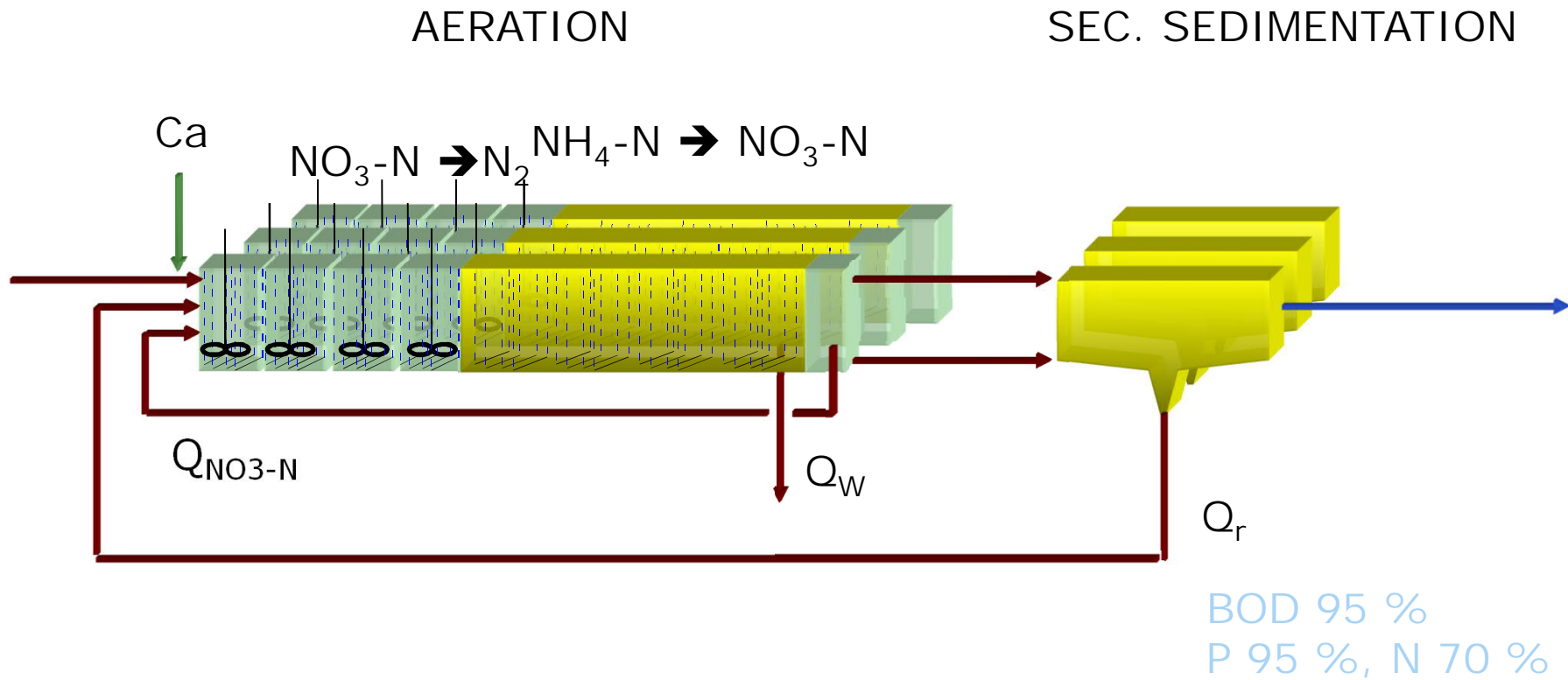
INSTRUMENTATION EXAMPLES



INSTRUMENTATION EXAMPLES



INSTRUMENTATION EXAMPLES



THANKS!

RAMBOLL