Long-term stability of membrane bioreactors on chemical waste water

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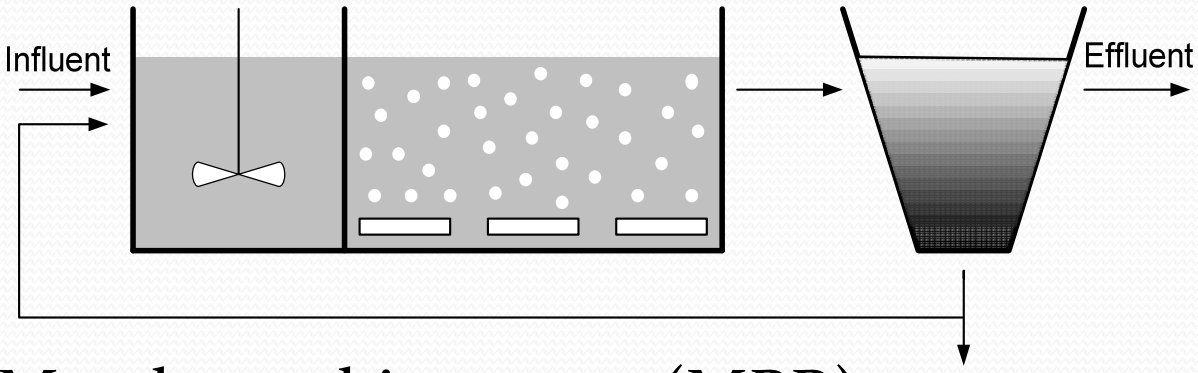
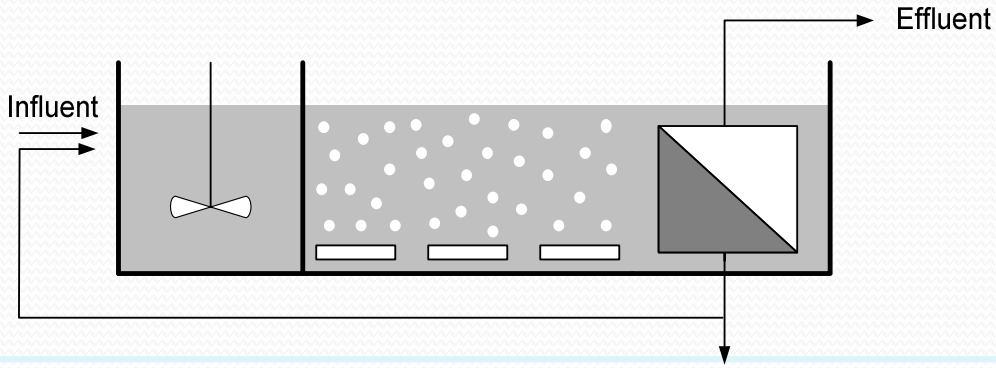
Introduction

- Conventional activated sludge process (CAS)



- Membrane bioreactor (MBR)



- Higher effluent quality
- Smaller footprint

Aim of the pilot study

- Feasibility of using MBR technology at chemical Waste Water Treatment Plant (WWTP) to
  - Increase capacity
  - Improve effluent quality => possibility for re-use?

- Evaluate the application limits of MBR process on chemical wastewater with regard to
  - Process reliability and stability
  - Membrane compatibility with chemical wastewater

Selected test site: BASF Antwerp





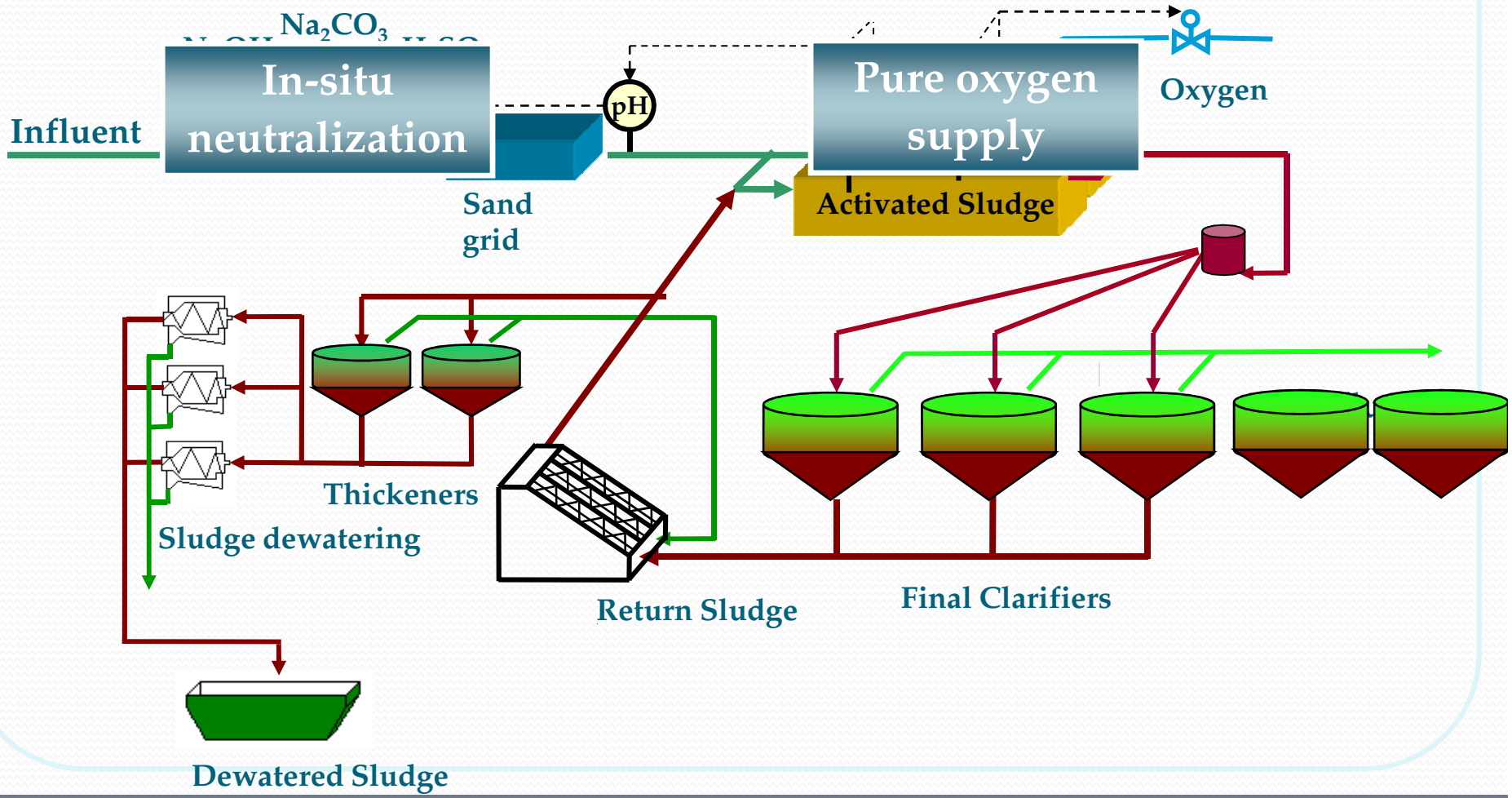

Chemicals	Plastics	Performance Products	Functional Solutions	Agricultural Solutions	Oil & Gas
Inorganics	Performance Polymers	Acrylics & Dispersions	Catalysts	Crop Protection	Oil & Gas
Petro-chemicals	Poly-urethanes	Care Chemicals	Construction Chemicals		
Intermediates		Paper Chemicals	Coatings		
		Performance Chemicals			

Integrated production site

BASF Antwerp

BASF Group

Selected test site: BASF Antwerp

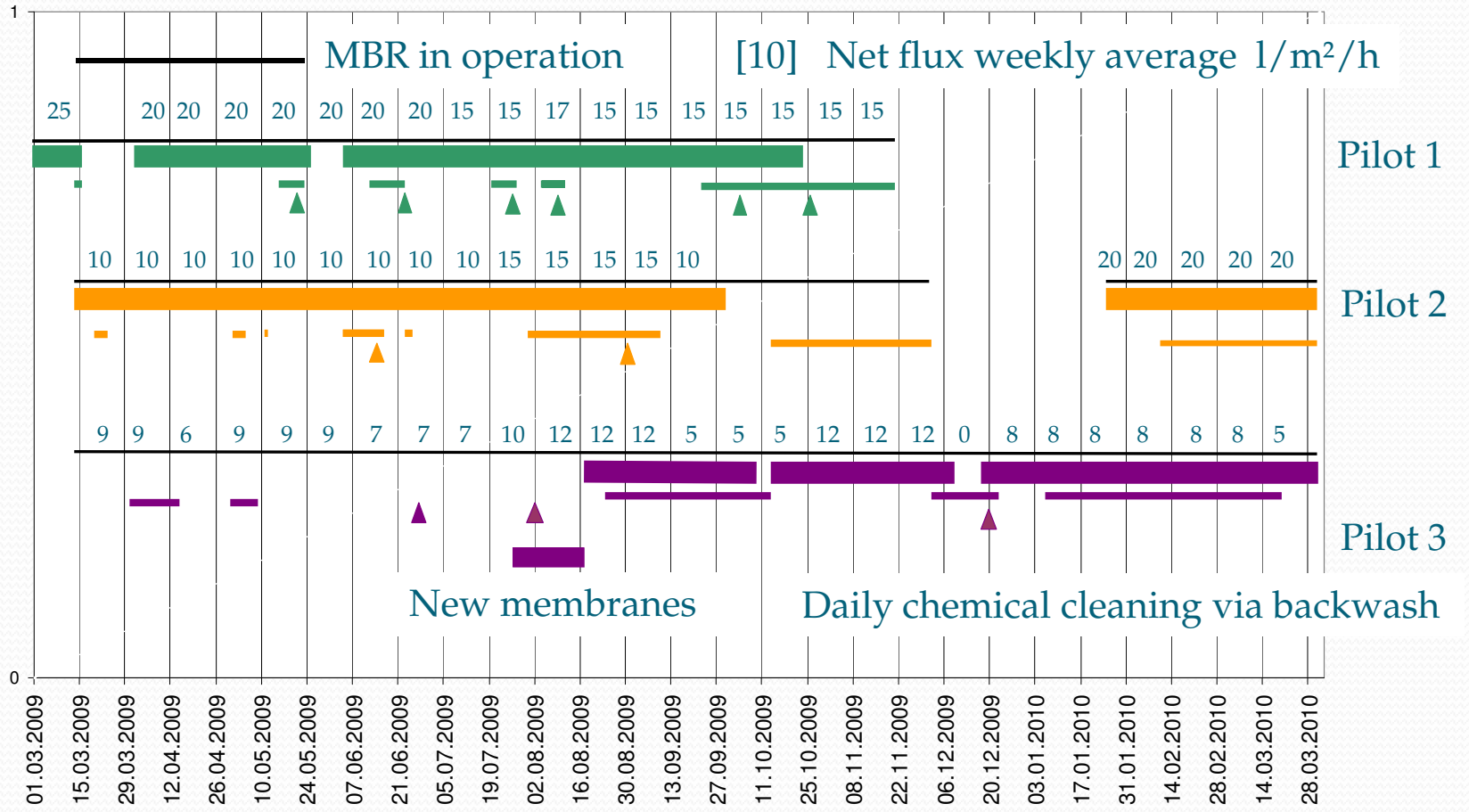


Approach

- Due to site specific constraints: 3 parallel filtration tanks coupled to aeration basin
- 1 year of parallel pilot trials
- General information

	Pilot 1	Pilot 2	Pilot 3
Membrane material	PVDF	PVDF	PES
Surface area	37.6 m^2	28 m^2 → 9.8 m^2 (since 15.5.09)	100 m^2
Membrane configuration	Hollow fibers	Flat sheet	Flat sheet
MLSS in filtration tank (g/l)	6 - 12	6 - 10	6 - 12

Performance comparison of MBR pilots



Reliable operation w/o mechanical problems

TMP > 200 mbar

Chemical Cleaning

Special findings Pilot 1

- Reliable operation from March 09 until September 09
- Flux 10 – 20 l/m²/h during period of stable operation
- Waste water events in June and August caused increase of TMP and irreversible fouling
  (4 chemical cleanings required)
- Irrecoverable fouling on September 09
- Hollow-fiber rupture caused by heavily sticking material caused shut down of MBR

Special findings Pilot 3

- Many mechanical problems pilot unit (aerator, pumps, etc.) leading to sludge sticking between flat sheets
- Membrane replacement required due to crinkels: allowed only 6 month with reliable operation
- Low flux < 10 l/m²/h and rather high TMP during period of stable operation
- Scaling of membrane surface detected
- Waste water event in December caused 2 weeks shut down of MBR unit

Special findings Pilot 2

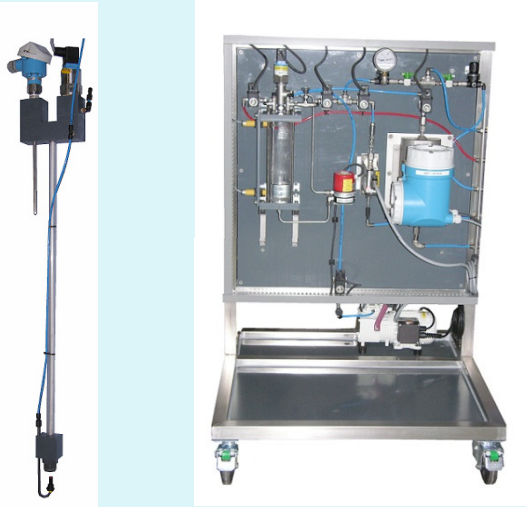
- 2 phases of reliable operation
  - Phase 1: March – September 09
    - Flux 10 – 15 l/m²/h
    - Waste water events in June and August caused increase of TMP and irreversible fouling (2 chemical cleanings required)
  - Phase 2: January – March 10
    - Unstable membrane performance with unpredictable recovery
- **Supplier does not recommend MBR application!**

Supporting fouling measurements

Parameter	Pilot 1	Pilot 2	Pilot 3
VFM_{rev} (%)	45 14	44 14	42 17
VFM_{irrev} (%)	16 9	16 12	15 9
TTF (s)	36 17	34 10	33 8
CST (s)	26 25	23 8	25 20
MLSS (g/L)	8 ± 3	9 ± 3	8 ± 2
Floc size (µm)	38 ± 6	39 ± 3	39 ± 3
Proteins (mg/L)	21 ± 5	21 ± 5	21 ± 7
Carbohydrates (mg/L)	7 ± 5	6 ± 4	6 ± 2
UVA	0.6 ± 0.2	0.6 ± 0.1	0.5 ± 0.1

Similar fouling indicators correlate with each other but no links with on-line permeability

VFM
VITO Fouling Measurement



(ir)reversible fouling value (0-100%)

see Huyskens et al. (2009)

Conclusions

- 6 months of reliable operation
- Stable fluxes varied between 8 – 20 l/m²/h
- Cause of irreversible and irrecoverable fouling are wastewater constituents/variability <> sludge quality
  - Rather high cleaning frequency
  - Sometimes unpredictable recoveries
  - Known fouling indicators have limited relevance

→ *Test results underachieved the expectations for a stable and reliable long-term full-scale application*

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