DEMEAU

Demonstration of promising technologies to address emerging pollutants in water and waste water

WA2: Hybrid Ceramic Membrane Filtration in Water Treatment

Pilot tests at WWTP Almelo

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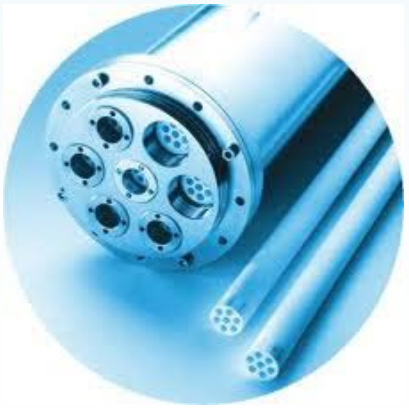
WP22 Hybrid ceramic membrane systems (KWR, FHNW)

• HCMS offer improved rejection of dissolved compounds and optimal control of fouling of membrane fouling (Lab-scale study in TECHNEAU.

• WP22 aims at investigate the potential of HCMS at pilot scale and to optimize the overall performance for the removal of emerging contaminants.



Hybrid Ceramic Membrane Filtration

- Coagulation-CMF
- PAC-CMF
- IX-CMF
- O3-CMF

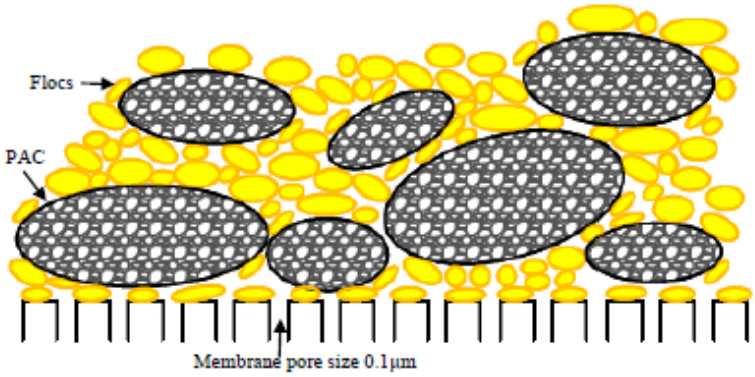


Figure 34: Possible formation and structure of PAC cake layer fouling on continuous with backwash channel

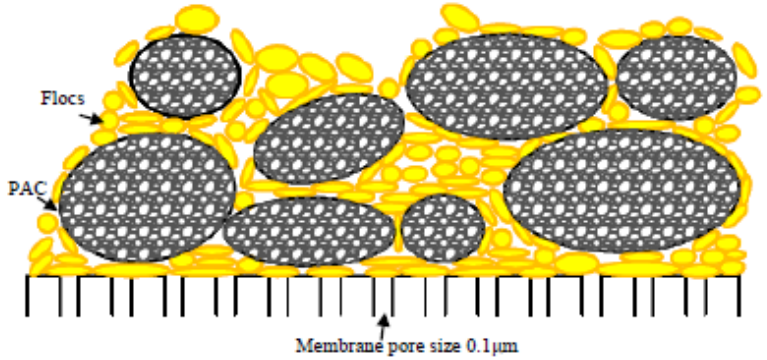


Figure 35: Possible formation and structure of PAC cake layer fouling on continuous without backwash channel

Pilot locations

- WWTP Almelo (The Netherlands)
- WWTP Basel (Switzerland)

WWTP Almelo

WATERSCHAP vechtstromen

- Design capacity: 5200 m^3/h
- Process:
  - mechanical pre-treatment (screening, grit removal)
  - activated sludge treatment operated (sequencing-batch-reactor)
  - nutrient removal by nitrification-denitrification and simultaneous phosphorous removal by precipitation

WWTP Almelo effluent quality (2014)			
Parameter	Mean	St. dev.	n
N total (mg/L)	6,19	4,61	57
P total (mg/L)	1,73	1,19	57
COD (mg/L)	33,7	8,45	50
BOD(mg/L)	2,32	1,50	50

PAC-CMF pilot at WWTP Almelo

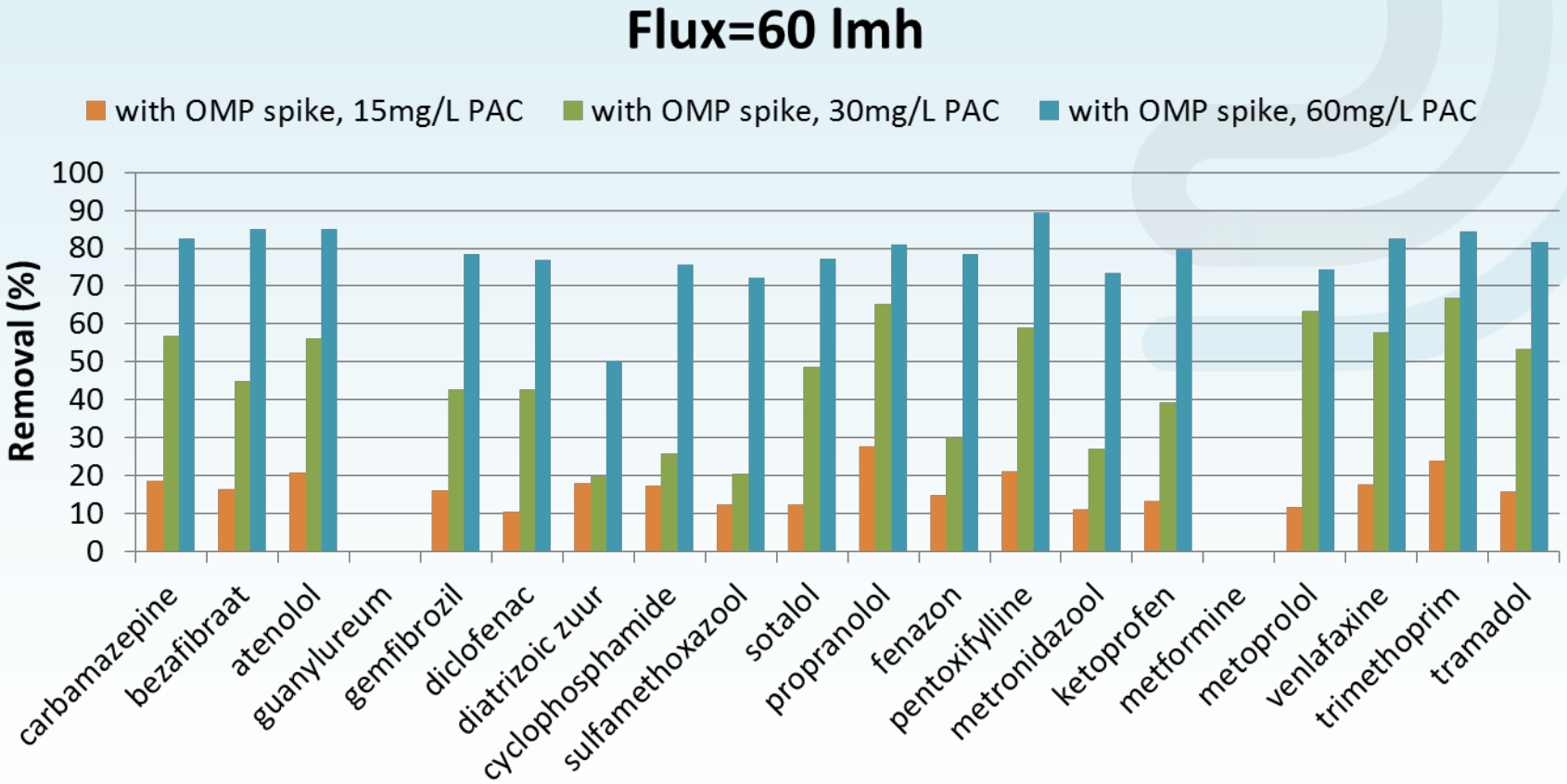
Membrane area	:	2x 0,4 m^2
Nominal pore size	:	0,1 µm
Operation	:	dead-end

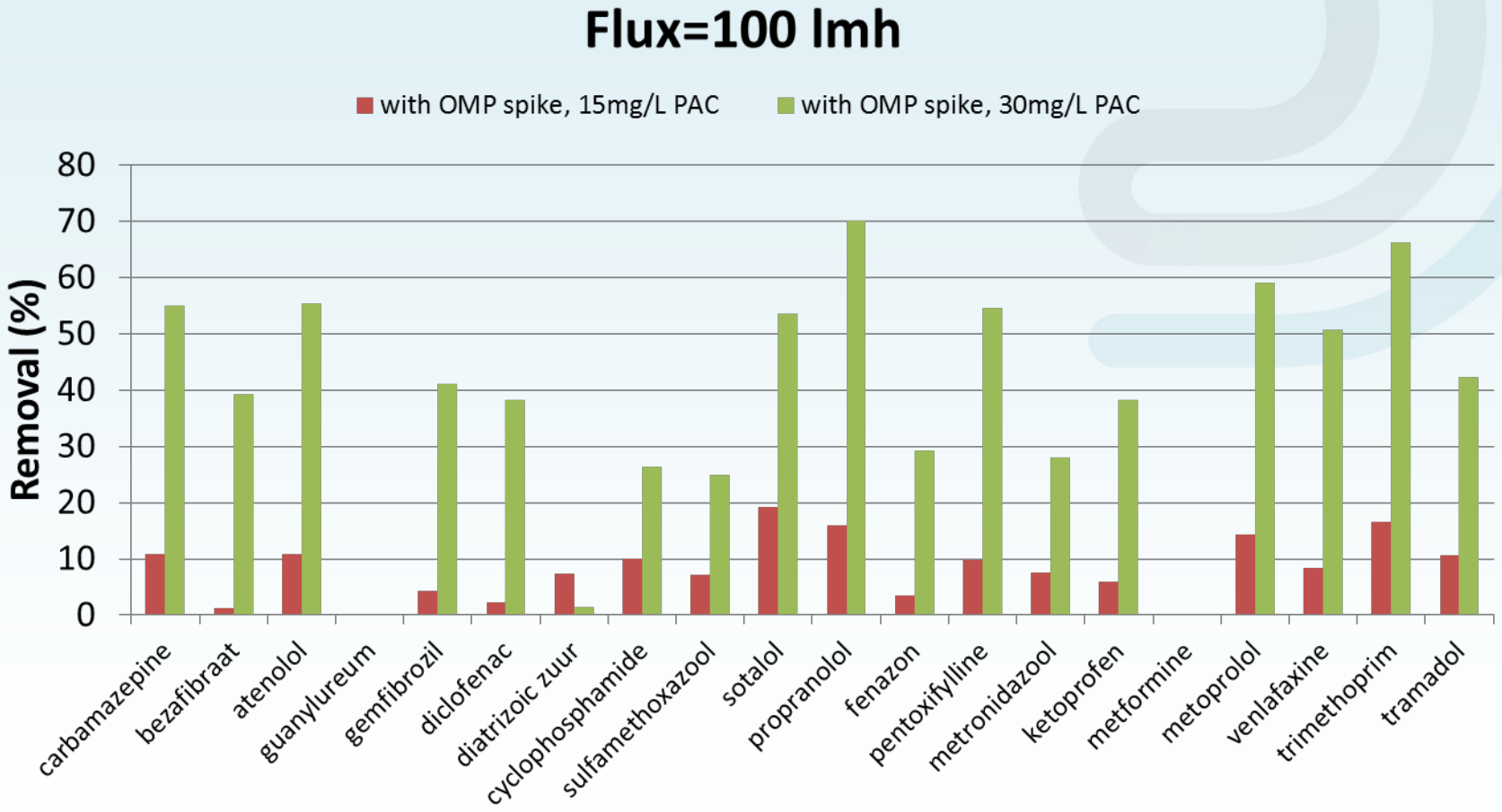
- Experiments: (1) OMP removal (2) Operational stability
- WWTP effluent + OMPs = Feed pilot plant.
- Cocktail of OMPs dosed, each ≈1µg/L.
- PAC dose (mg/L): 0, 15, 30, 60 [precoat mode]
- BW: pressurized (5 bar) with permeate and air
- CEB: BW with permeate and NaOCl

Filtration time	15 min
Filtration flux	60,80,100, 120 L/(m^2·h)
BW frequency	4 times per hour
BW time	<5 sec
CEB frequency	1 time per 6 hour
Chemicals used	NaOCl (12,5 wt%)
Soaking time	5 min

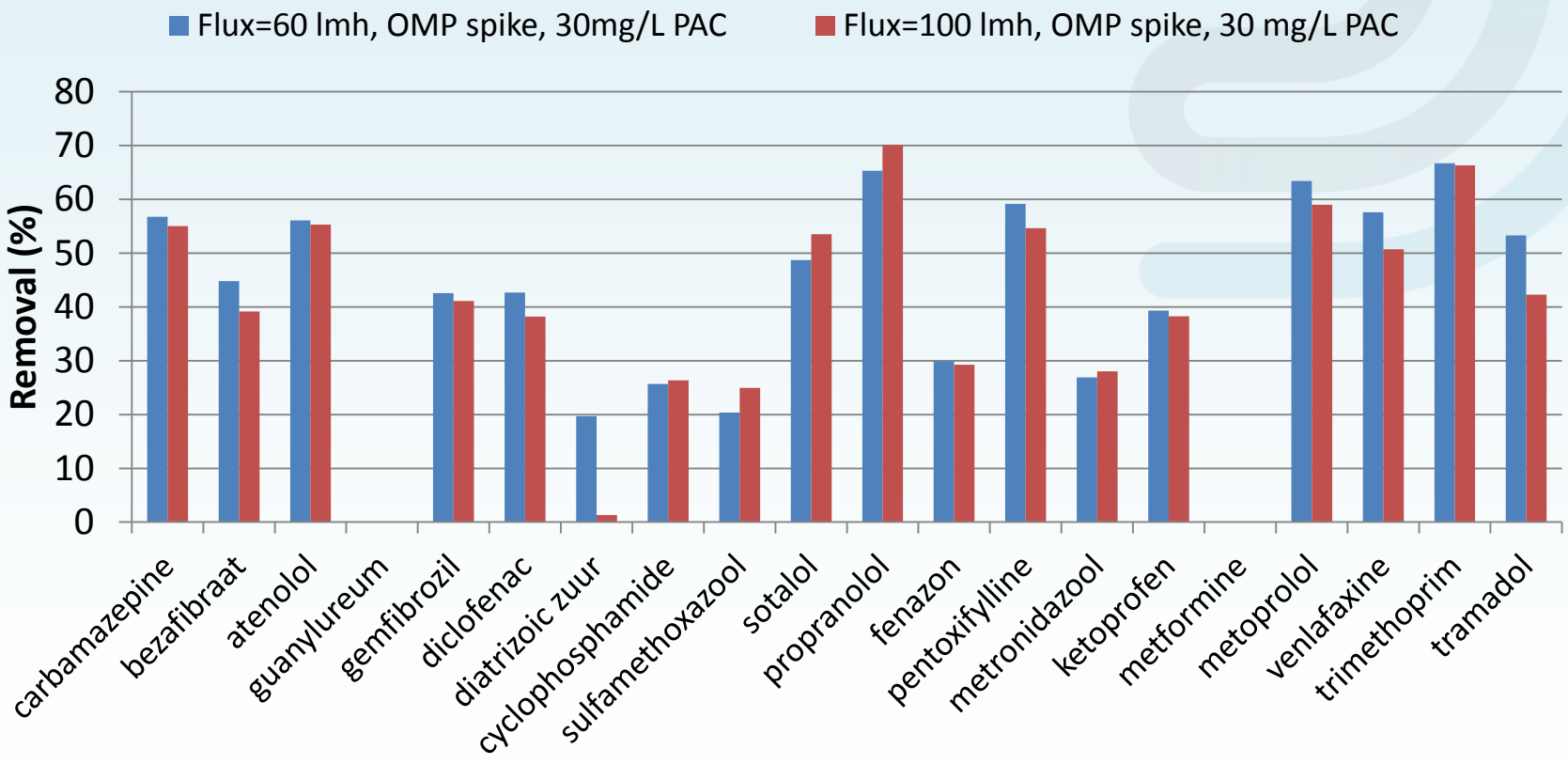
OMPs dosed	µg/L
metoprolol	0,936
gemfibrozil	0,953
sotalol	0,901
tramadol	0,951
carbamazepine	0,962
venlafaxine	0,881
diclofenac	1,027
atenolol	0,972
propranolol	0,849
trimethoprim	0,973
sulfamethoxazool	0,980
ketoprofen	0,999
bezafibraat	0,918
diatrizoic zuur	1,019
metronidazole	1,005
fenazon	0,996
cyclophosphamide	0,797
pentoxifylline	0,970

Removal of OMPs

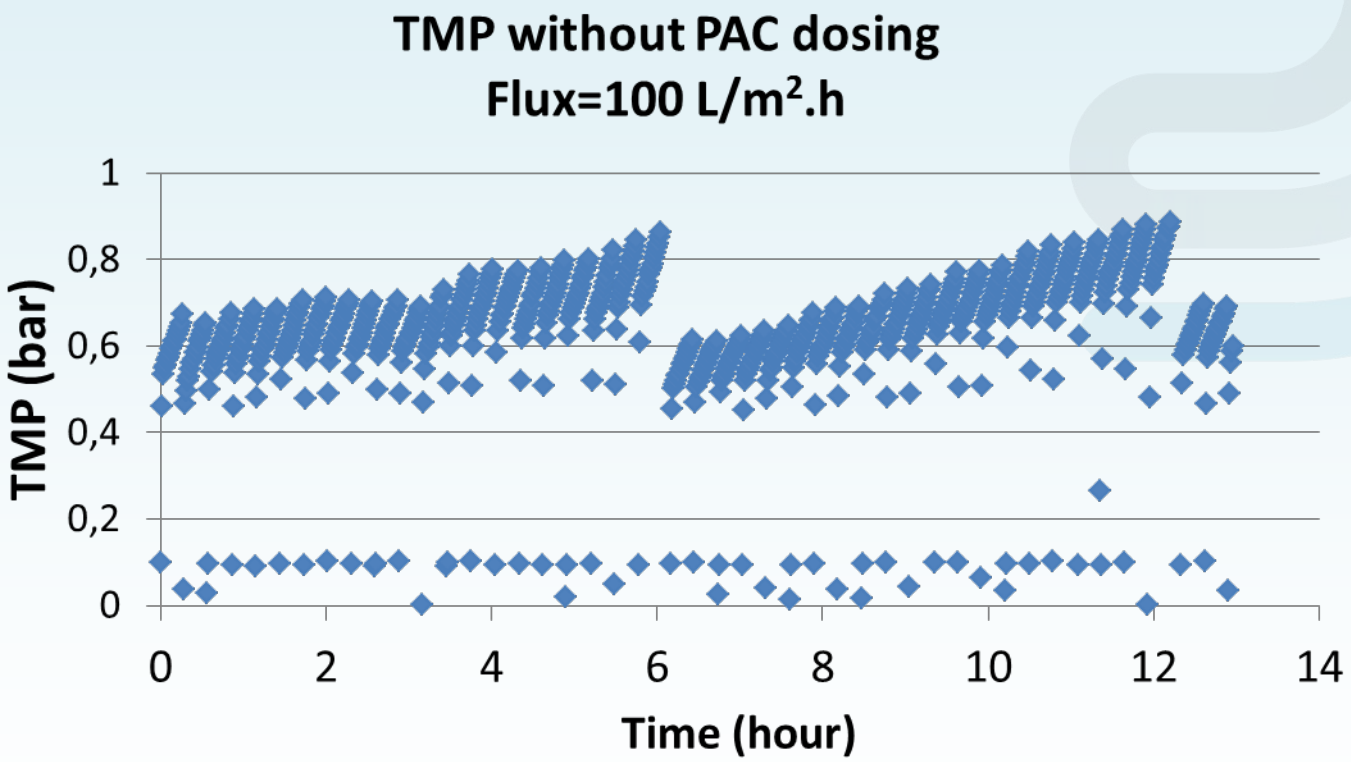


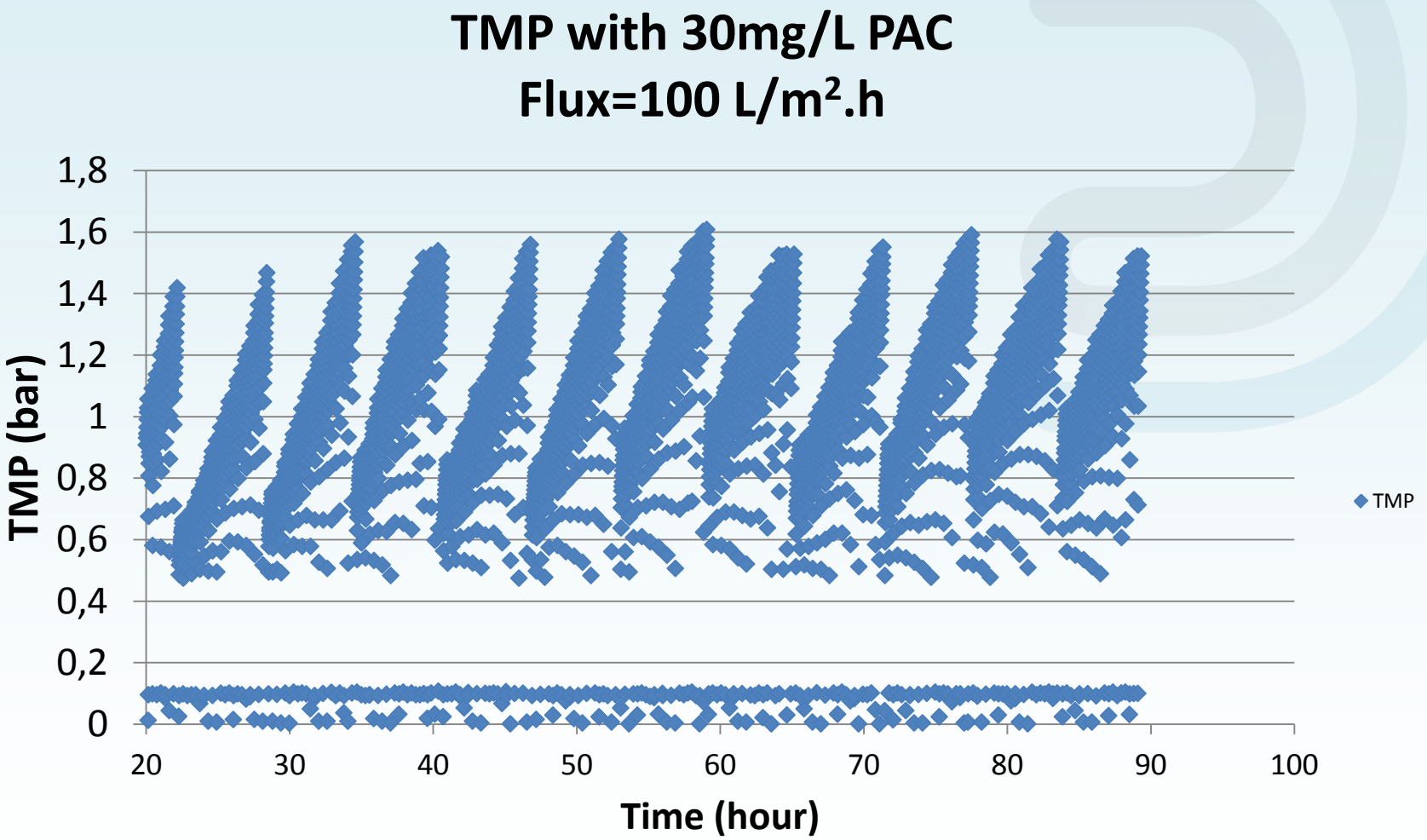

Flux=100 lmh
with OMP spike, 15mg/L PAC
with OMP spike, 30mg/L PAC
Removal (%)
80
70
60
50
40
30
20
10
0
carbamazepine
bezafibraat
atenolol
guanylureum
gemfibrozil
diclofenac
diatrizoic zuur
cyclophosphamide
sulfamethoxazool
sotalol
propranolol
fenazon
pentoxifylline
metronidazool
ketoprofen
metformine
metoprolol
venlafaxine
trimethoprim
tramadol

Effect of flux on OMP removal at 30 mg/L PAC dose



Process stability




TMP with 30mg/L PAC
Flux=100 L/m².h
TMP (bar)
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
20
30
40
50
60
70
80
90
100
Time (hour)
TMP

Conclusions

- Removal increases with PAC dose, as expected. However, it is not proportional to PAC dose.
- Precoating PAC on membrane surface increased average TMP.
- At 30mg/L PAC, the OMP removal was similar at flux=60 lmh and 100 lmh.
- CEB with NaOCl effectively recover the TMP.
- At 30mg/L PAC dose and flux=100 lmh, HCMF process remained stable for more than 5 days.

Thanks for attention !