

# The effect of activated carbon and membrane filtration in the removal of pharmaceutical products in hospital wastewaters

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# Organic micropollutants (OMPs)



**Heterogeneous  
group**

**Concentrations  
of ng/L to  $\mu$ g/L**

**Bioaccumulation**

**Estrogenicity  
Toxicity**

**Priority list of  
Water  
Framework  
Directive**

# OMPs

Ionization

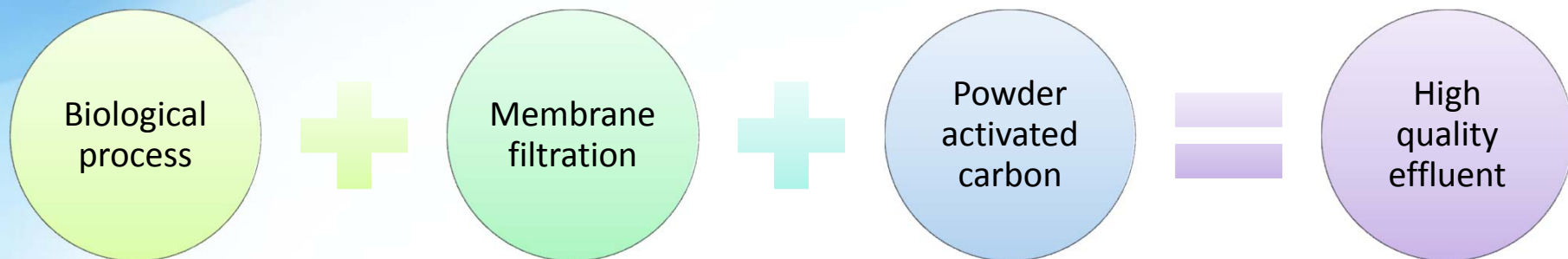
Sorption

OMPs	Therapeutical group	S (solubility, $mgL^{-1}$ )	H (Henry constant, $\mu g\ m^{-3}\ air/\mu g\ m^{-3}$ )	pKa (dissociation constant)	Log Kow (octanol-water coefficient)
<b>Ibuprofen (IBP)</b>	Antiinflammatory	21	$6.1\ 10^{-6}$	4.9-5.2	3.4-4
<b>Naproxen (NPX)</b>	Antiinflammatory	16	$1.4\ 10^{-8}$	4.2	3.2
<b>Diclofenac (DCF)</b>	Antiinflammatory	2.4	$1.9\ 10^{-10}$	4.1-4.2	4.5
<b>Sulfamethoxazole (SMX)</b>	Antibiotic	610	$2.6\ 10^{-11}$	1.8-5.2	0.9
<b>Trimethoprim (TMP)</b>	Antibiotic	400	$9.8\ 10^{-13}$	6.6-7.2	0.9-1.4
<b>Erytromycin (ERY)</b>	Antibiotic	1.4	$2.2\ 10^{-27}$	8.9	2.5-3
<b>Roxithromycin (ROX)</b>	Antibiotic	0.02	$2.0\ 10^{-29}$	9.2	2.8
<b>Carbamazepine (CBZ)</b>	Neurodrug	17.7	$4.4\ 10^{-9}$	7	2.4-2.9
<b>Estrone (E1)</b>	Estrogen	3.6	$1.5\ 10^{-9}$	10.4	3.9-4
<b>Ethinylestradiol (EE2)</b>	Estrogen	11.3	$3.3\ 10^{-10}$	10.5-10.7	3.7-4

# Biological reactor + PAC

- Aerobic conditions ↑ removals
  - Nitrifying conditions enhance biodegradation
- Membrane configurations more effective
  - High Solid Retention Time promote biodegradation

Compounds, such as CBZ or DZP, are recalcitrant in biological process



# Lab-scale reactors

## Microfiltration MBR

- Flat sheet (0.45  $\mu\text{m}$ )



## Ultrafiltration MBR

- Hollow fiber (0.045  $\mu\text{m}$ )



Hydraulic retention time	1 d
Organic loading rate	0.3 g/L d
Nitrogen loading rate	0.03 g/L d
Total suspended solids	2-5 gVSS/L

OMPs concentration: 1-20  $\mu\text{g/L}$   
PAC addition: 250 mg/L (3 times)

*Pure aerobic conditions*

# Conventional parameters

	Microfiltration MBR		Ultrafiltration MBR		Physical biomass characteristics
	Before PAC addition	After PAC addition	Before PAC addition	After PAC addition	
NH <sub>4</sub> removal (%)	97	98	98	99	
D removal (%)	96	97	97	99	
Filterability	High	Very high	Low	High	
Permeability	High	Very high	High	Very high	
Particle size (µm)	77	88	42	44	



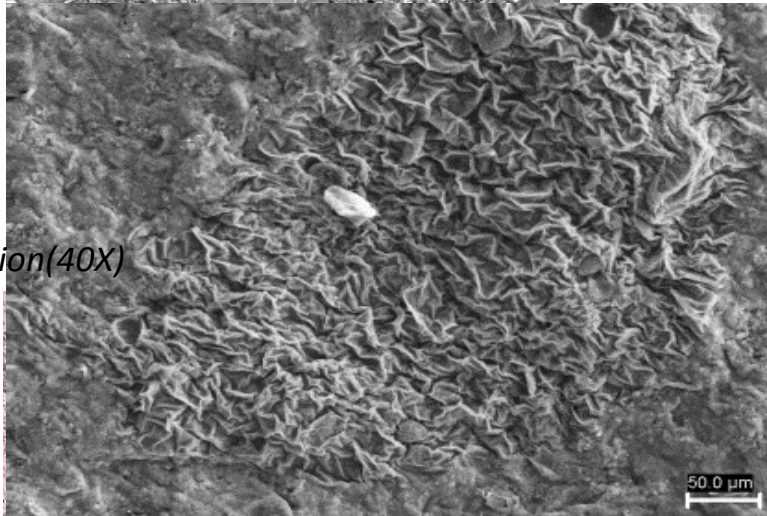
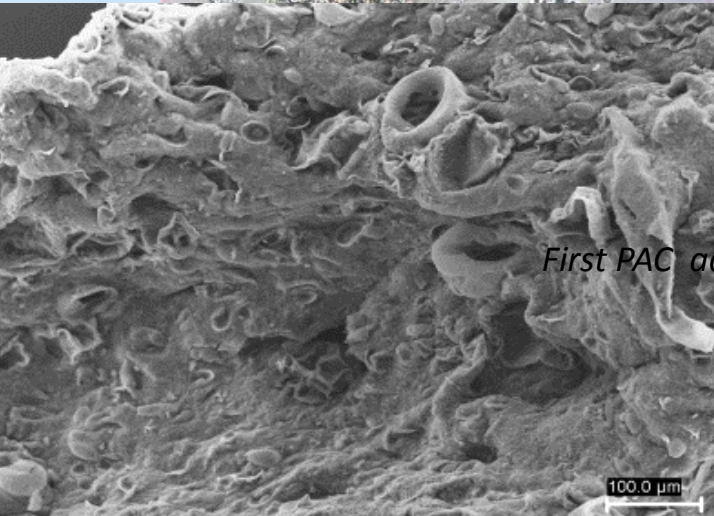
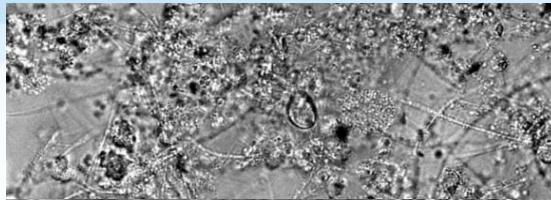
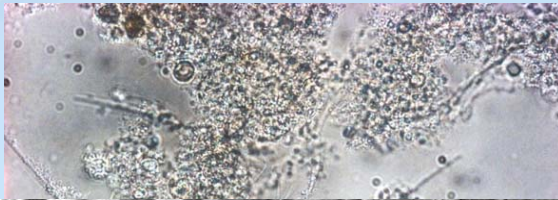
Powder activated carbon (SEM Image)

Merit® W25 (Cabot)

# Microbiological characterization (biomass)

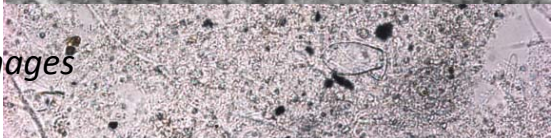
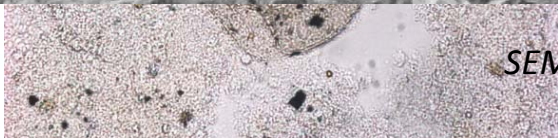
Microfiltration MBR

Ultrafiltration MBR

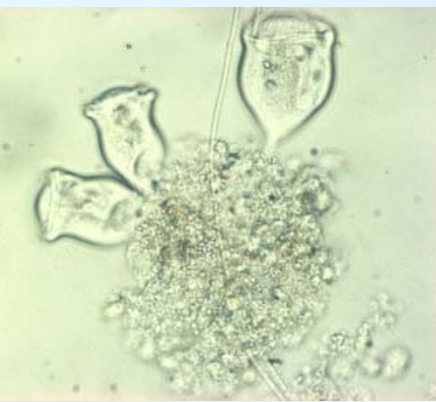


*First PAC addition (40X)*

*SEM images*



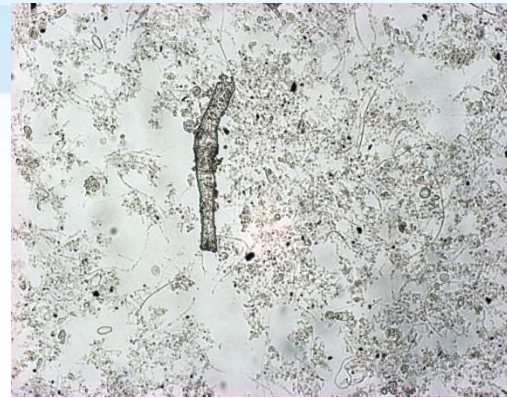
# biological characterization (biomass)



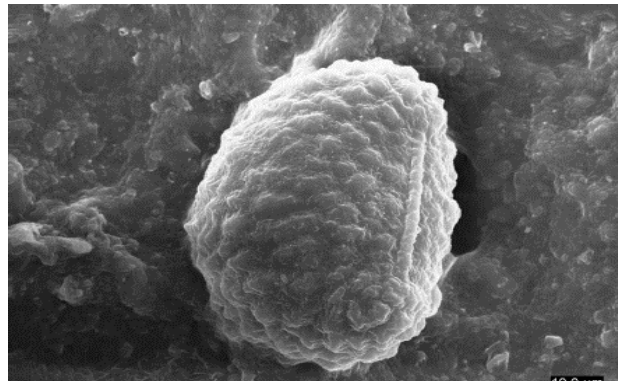
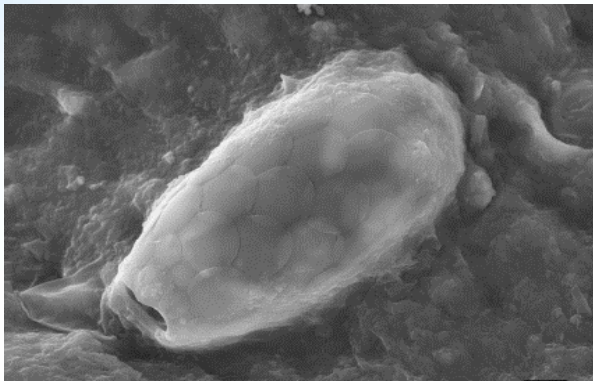
*Chlorella polypinum* (40X)



*Aspidisca lynceus* (40X)

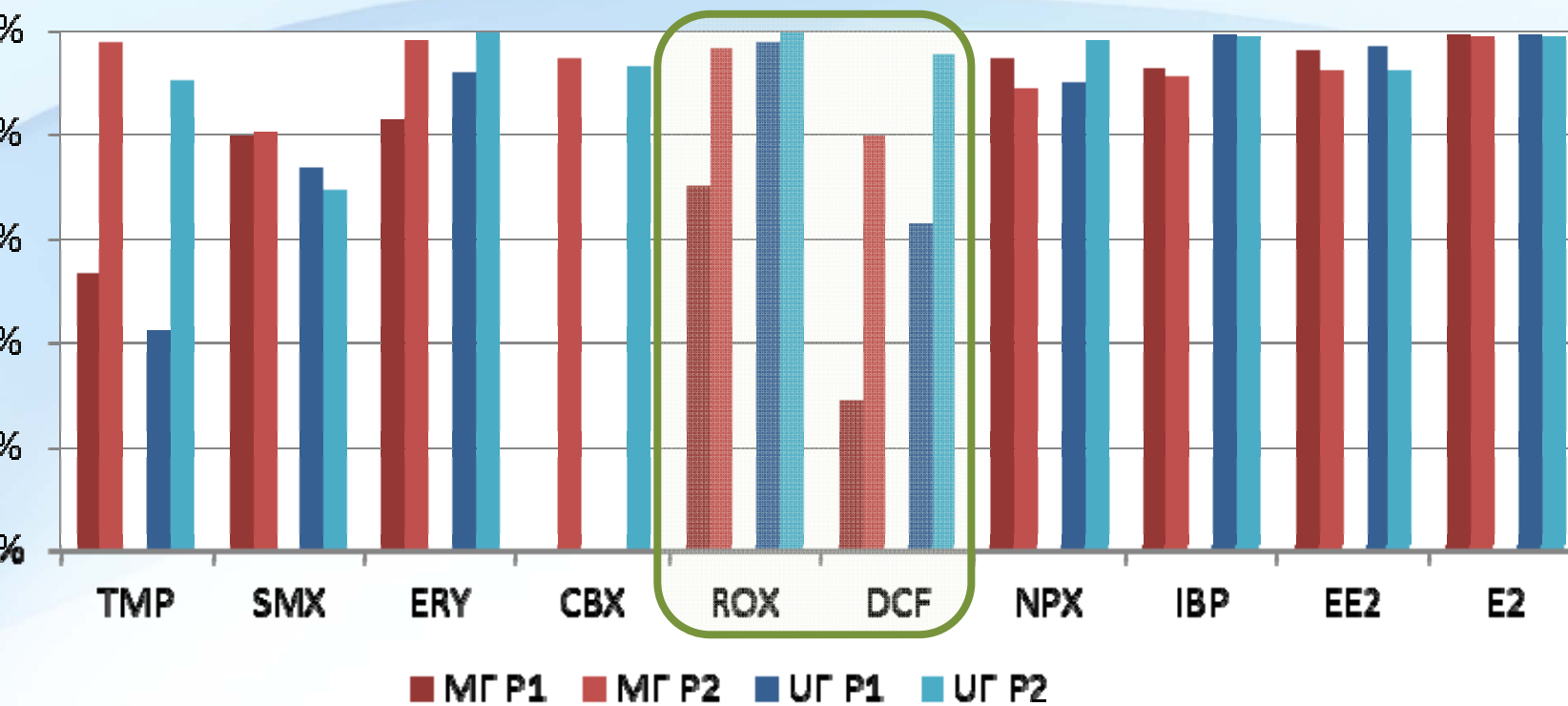


*Spirilo* (10X)



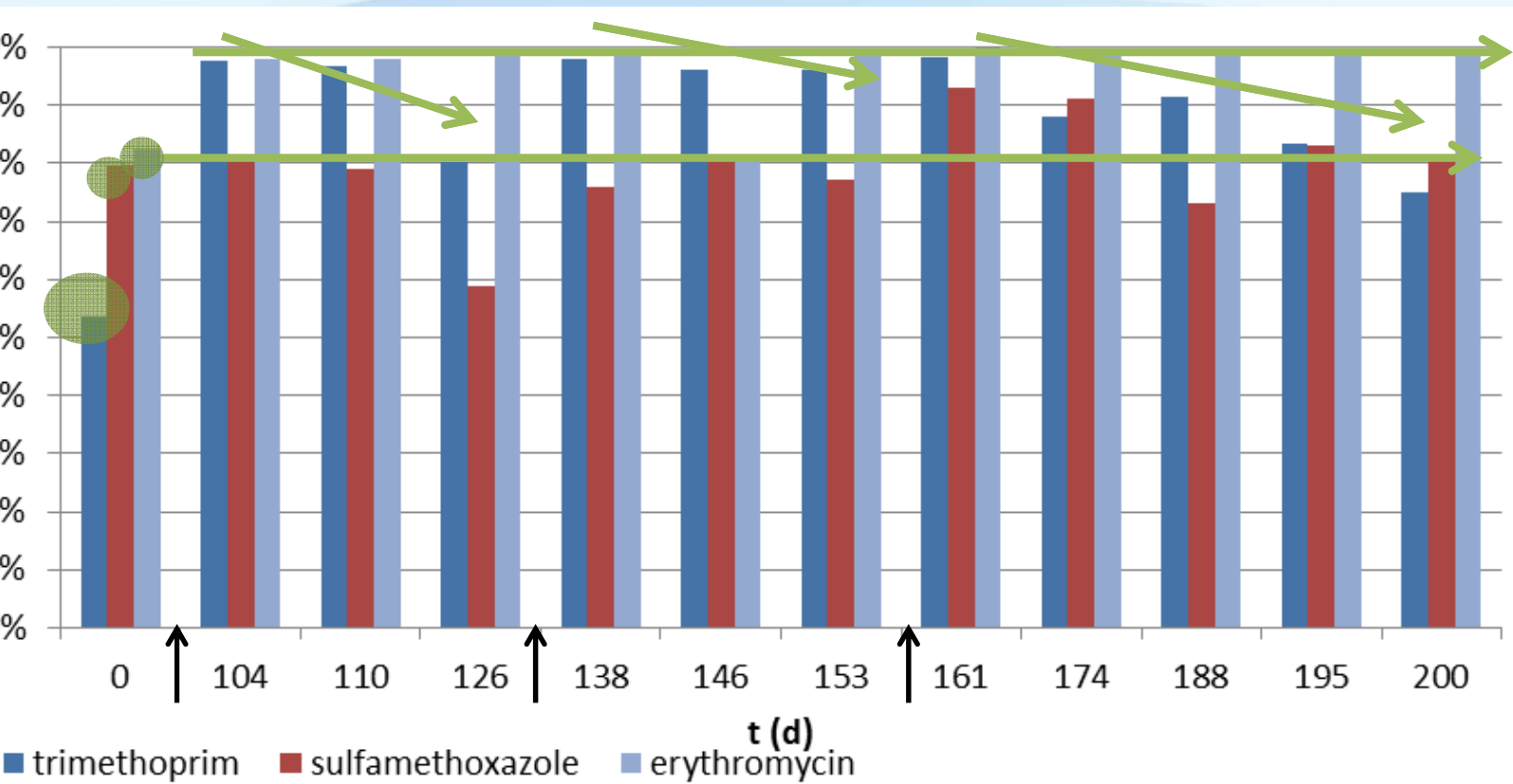


## Effect of the membrane configuration



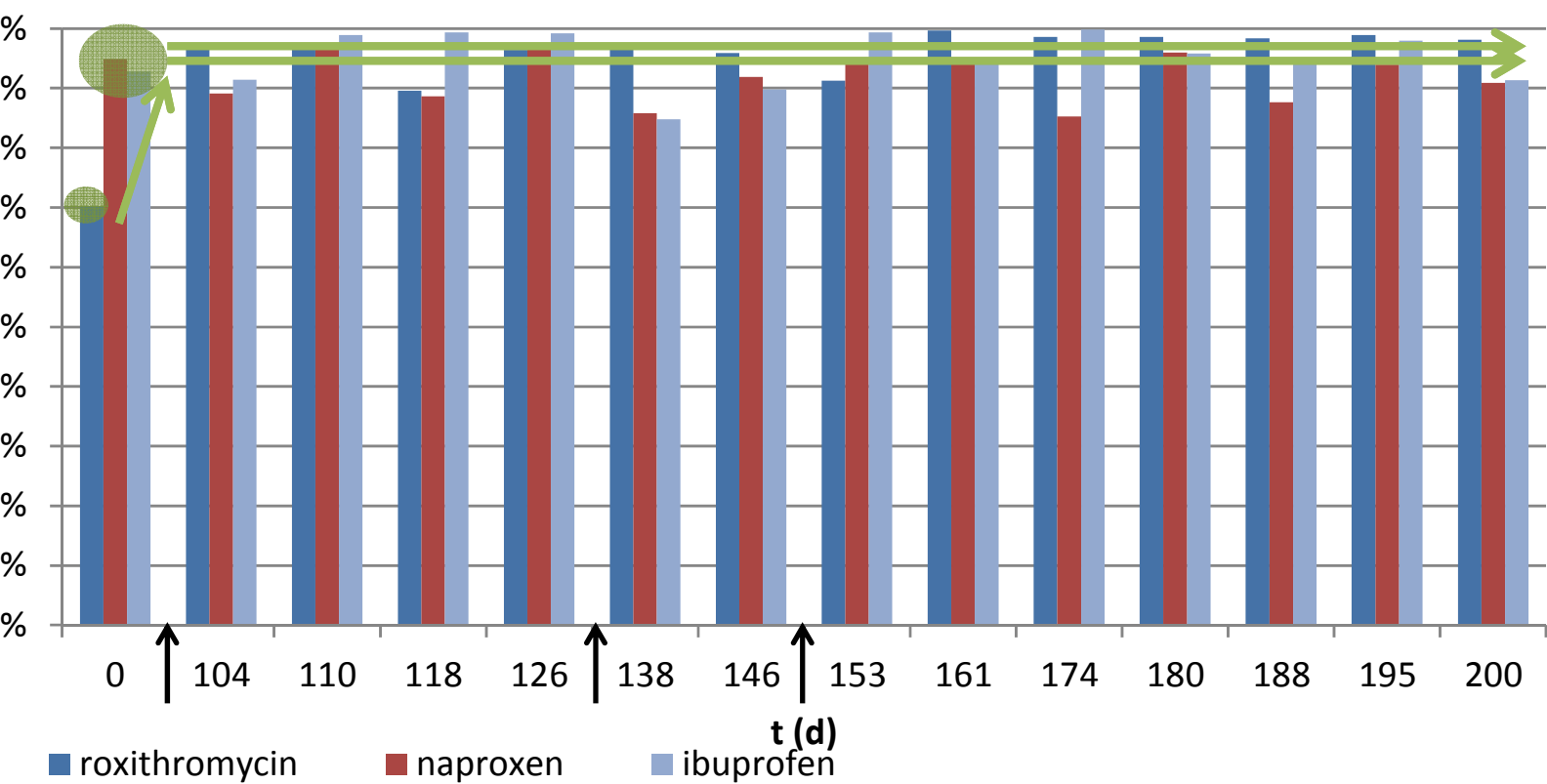
No influence of the membrane configuration in OMPs removal:

# Effect of PAC addition



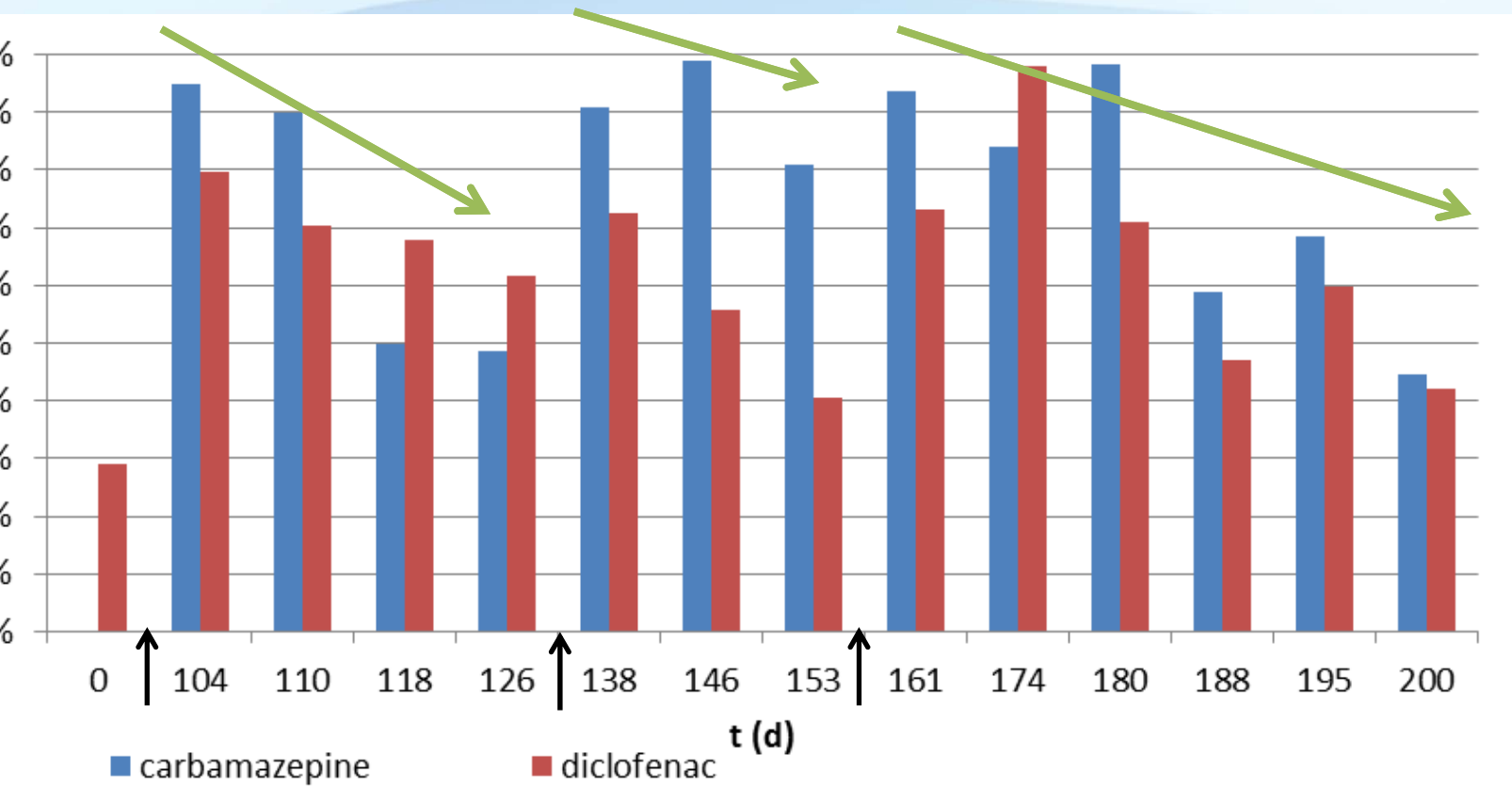
SMX: biotransformation

# Effect of PAC addition

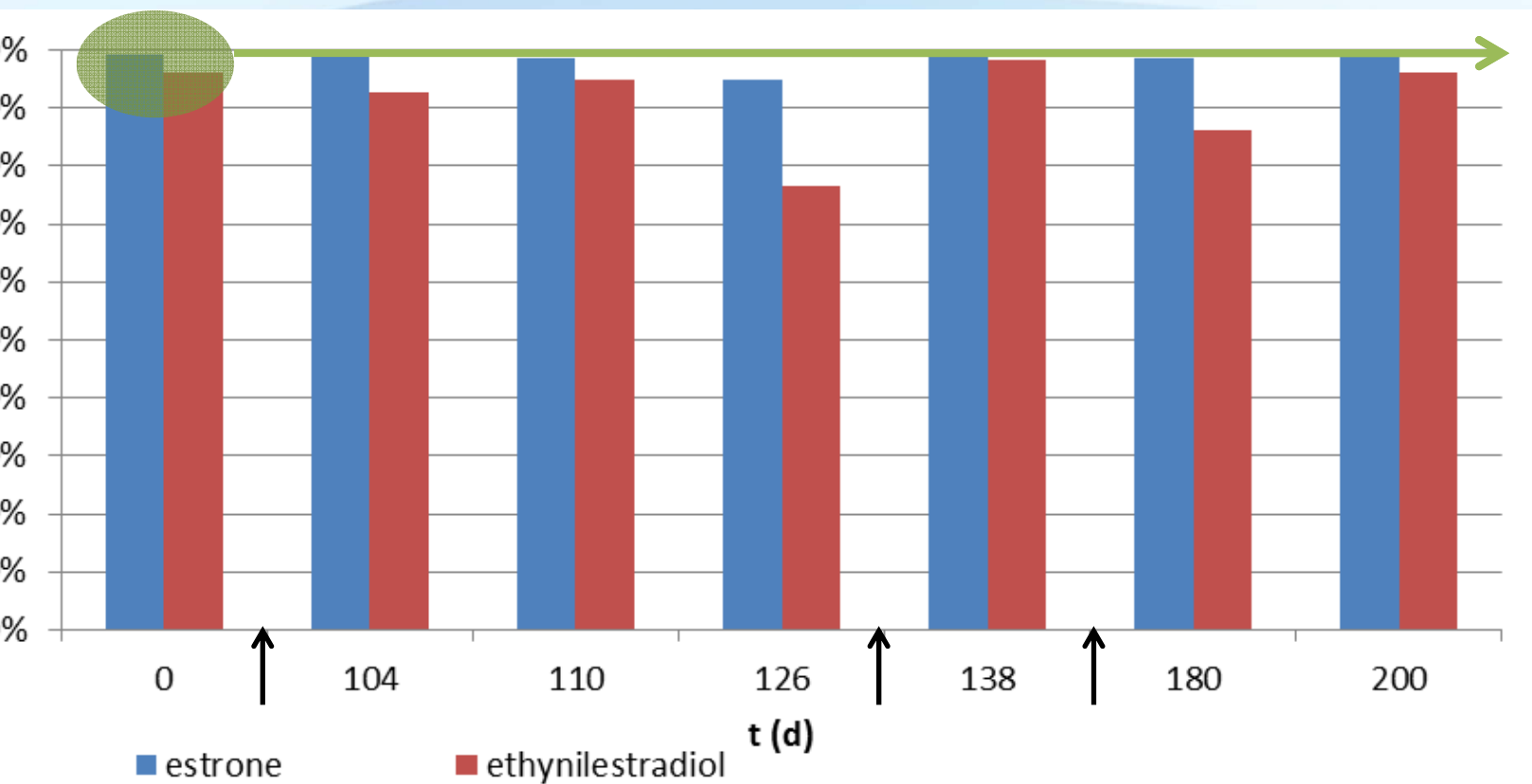


IBP NPY: biotransformation

# Effect of PAC addition

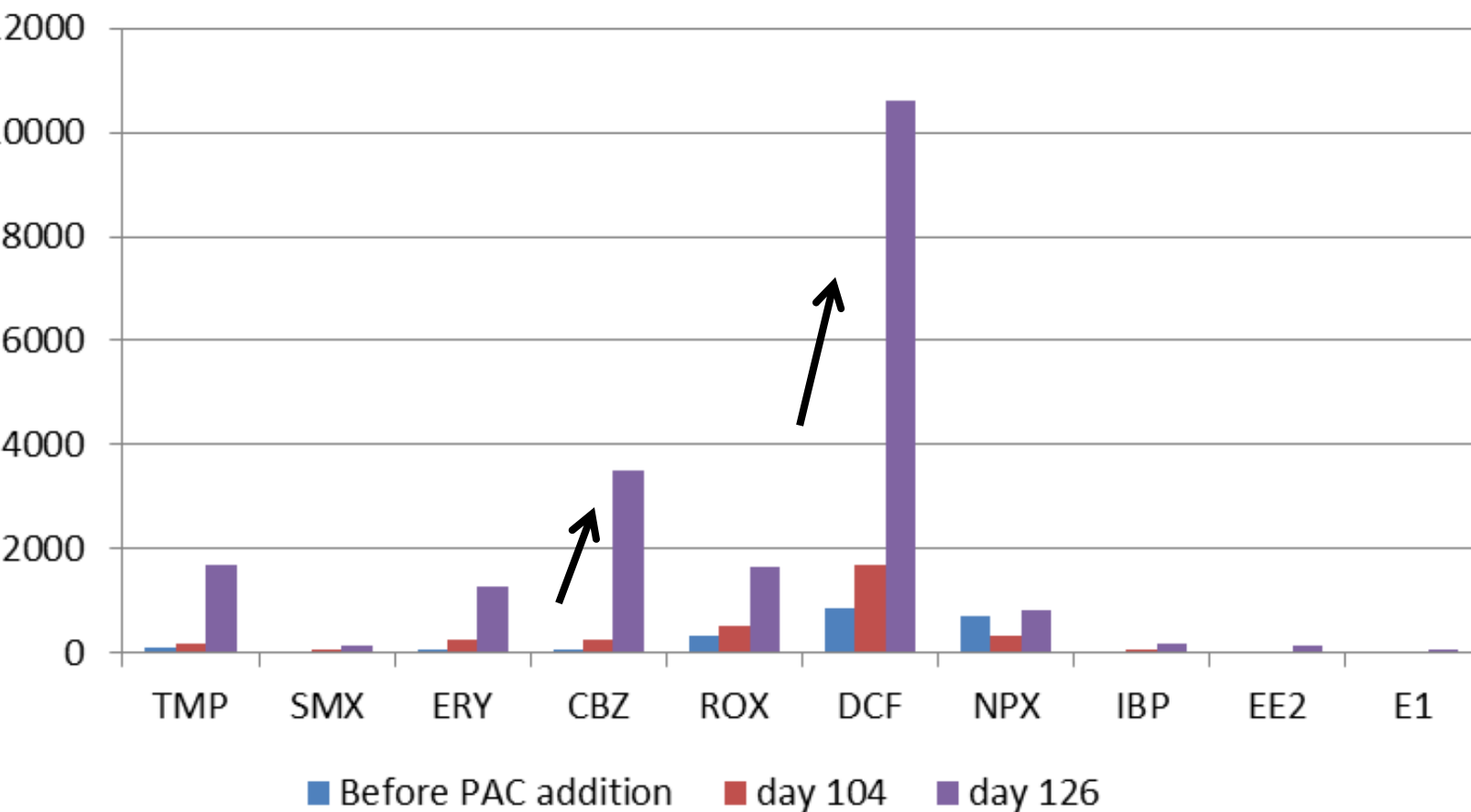


# Effect of PAC addition



E1 EE2 biotransformation

# MPs concentration is solid phase



## Conclusions

Organic matter degradation and nitrification above 95% were achieved in both MBRs.

Properties of the sludge enhanced after PAC addition.

Influence of the type of membrane only on the removal of DCF and ROX.

High removal efficiency achieved for the whole set of compounds with periodical PAC addition

	Sorption onto PAC	Biotransformation
NPX, IBP, SMX, E1, EE2	-	++
CBZ, DCF	++	-

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DE GALICIA**

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A decorative graphic consisting of several overlapping, semi-transparent blue shapes that create a sense of movement and depth. The shapes are primarily located on the left side of the slide, extending towards the center.

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membrane filtration in the removal of  
pharmaceutical products in hospital  
wastewaters**

**Thanks for your attention**