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ADSORPTION KINETITCS OF 3-(4-METHYLBENZYLIDENE) CAMPHOR ON MICROPLASTICS IN WATER

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Maja Vujić[1], Aleksandra Tubić[1*], Vasiljević Sanja[1], Jelena Molnar Jazić[1], Tajana Simetić[1], Malcolm Watson[1], Jasmina Agbaba[1]

[1]University of Novi Sad, Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Republic of Serbia

1 INTRODUCTION

- Microplastics (MPs)
  - plastic particles smaller than 5mm in size
  - ubiquitous in the environment, being found in marine sediments, marine and continental waters, terrestrial and agricultural environments
  - interact with polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and pharmaceuticals
- Ultraviolet (UV) filters
  - have unique photochemical properties
  - are the key ingredients in sunscreens, cosmetics and other personal care products in order to protect human skin from direct exposure to UV radiation
- 3-(4-methylbenzylidene) camphor (4-MBC)
  - one of the most commonly used organic UV filters
  - efficiently absorbs UV-B radiation
  - toxicological and adverse effects of 4-MBC; exhibit estrogenic, antiestrogenic, androgenic and antiandrogenic activities; it has been identified as an endocrine disruptor

2 MATERIAL AND METHODS

- Types of MPs: granulated polyethylene (PEg), polyethylene tetraphthalate (PET) and polypropylene (PP) and polylactic acid (PLA)
- Matrix: syntetic water
- Initial concentration of 4-MBC: 10 μg/L
- MPs mass: 40 mg
- Contact time: 1, 2, 3, 4, 5, 6, 24, 48, 72 and 96 h
- Mixing rate 150 rpm
- 4-MBC was analyzed by GC/MSD, after liquid-liquid extraction
- Kinetic models: The Lagergren pseudo-first order kinetic (PFO), pseudo second-order kinetic (PSO), Elovich and Weber-Morris models

4 CONCLUSION

- The adsorption kinetic of selected UV filter onto commercially available MPs mainly followed the PSO model indicating that monolayer adsorption which is controlled by chemical process.
- Multilayer adsorption occurs on the surface of selected biodegradable MPs.
- Weber-Morris model pointed out to multi-stage adsorption process, revealing that intraparticle diffusion is a limiting factor for the adsorption process.
- **MPs can act as a carrier of 4-MBC if it get released into the environment.**

3 RESULTS AND DISCUSSION

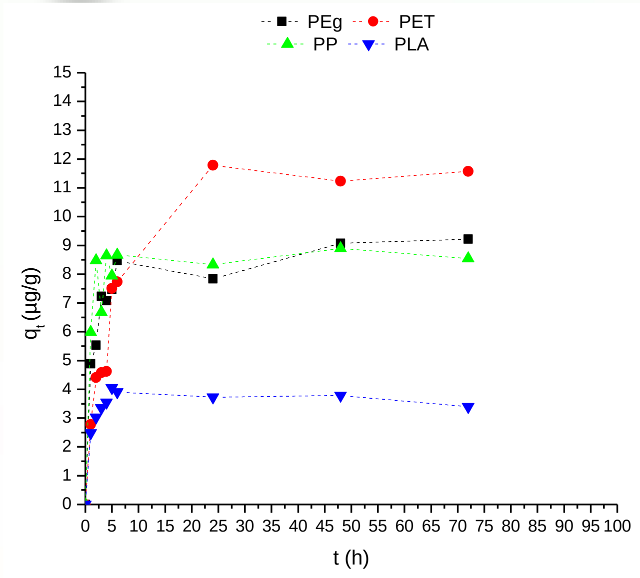

Figure 1. Experimental data (n =2, mean value ±SD) for adsorption kinetics of 4-MBC on PEg, PET, PP and PLA

- The adsorption equilibrium between 4-MBC and selected MPs was achieved after:
  - PEg, PP and PLA - 6 h
  - PET - 24 h.
- The 4-MBC has different adsorption affinities depending on type of MPs following this order: PET>PEg≈PP>PLA

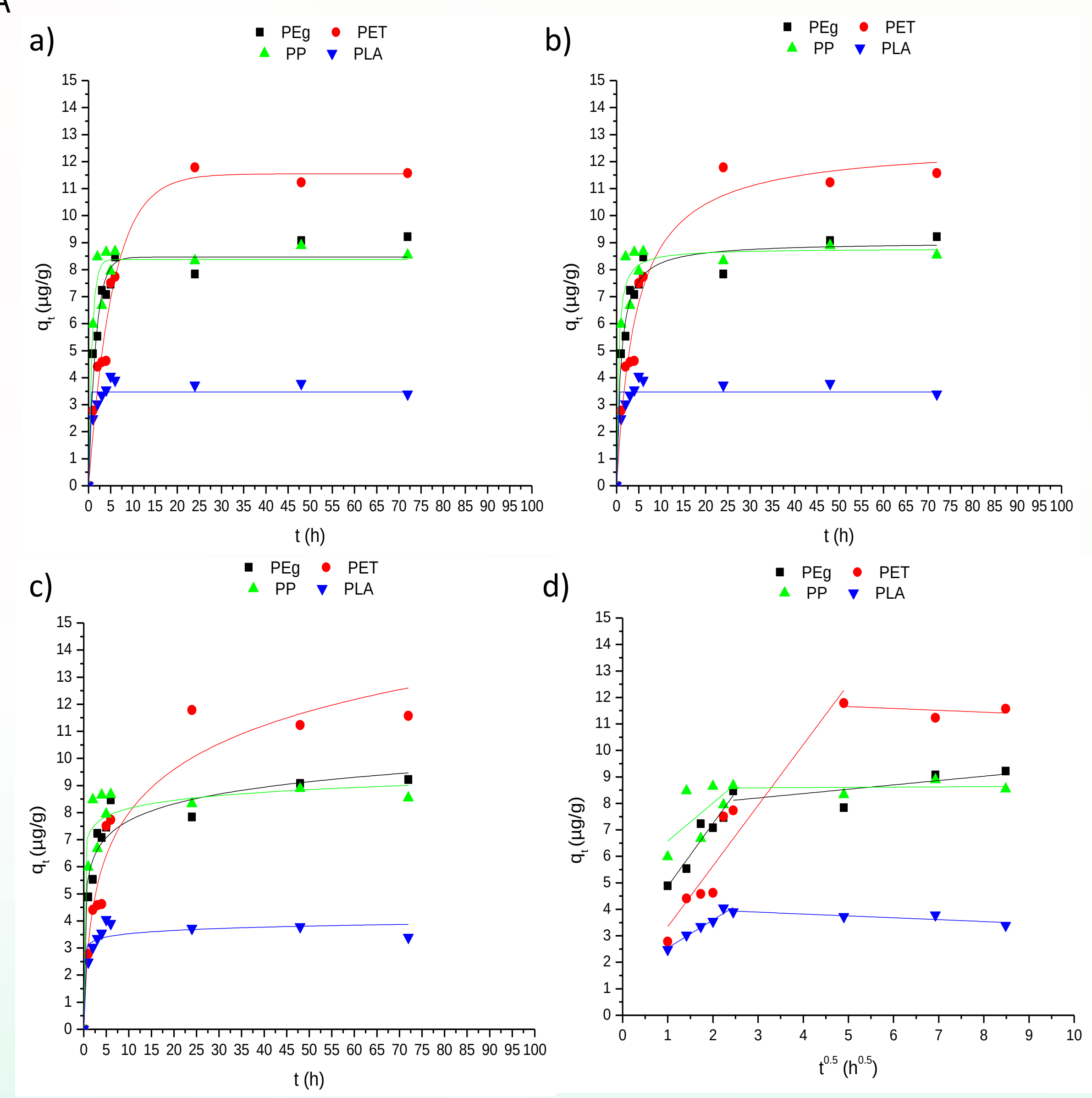

Figure 2. Plots for the adsorption kinetics, based on the (a) pseudo-first-order model, (b) pseudo-second order model, (c) Elovich and (d) Weber-Morris model, of 4-MBC on PEg, PET, PP and PLA particles in the synthetic water matrix

Table 1. Values calculated by kinetic models for adsorption of 4-MBC on MPs

Sorbent	Pseudo-first order			Pseudo-second order					Elovich		
	k_1 (h^{-1})	q_e (μg/g)	R^2	k_2 (g/μg h)	h (μg/g h)	q_e (theoretical) (μg/g)	q_e (experimental) (μg/g)	R^2	α μg/g h	β μg/g	R^2
PEg	0.61	8.46	0.943	0.12	9.76	9.02	9.08	0.968	492.0	1.12	0.939
PET	0.18	11.5	0.960	0.02	3.20	12.7	11.7	0.962	6.602	0.42	0.932
PP	1.29	8.37	0.940	0.31	23.9	8.78	8.47	0.943	7.11E6	2.32	0.916
PLA	99.8	3.47	0.833	8.52E4	10.6E^5	3.52	3.85	0.831	9.33E6	5.69	0.879

[a]k_1 - rate constant of first-order sorption; [b]q_e - adsorption capacity; [c]R^2 - correlation coefficient; [d]k_2 – rate constant of second-order sorption; [e]q_e - equilibrium adsorption capacity

- R^2 values attained by applying all selected kinetic models (Figure 2a-c, table 1) are high (R^2 = 0.831-0.968)
- Slightly higher R^2 values obtained with PSO model for adsorption of 4-MBC on PEg, PET and PP - chemisorption as possible adsorption mechanism
- Elovich model fitted data better for adsorption of 4-MBC on PLA.
- W-M model obtained results - first and fastest adsorption step occurred in the first few hours, after which the second, slower step occurs during the equilibrium stage

Aleksandra Tubić
University of Novi Sad,
Faculty of Sciences, Department of Chemistry,
Biochemistry and Environmental Protection
Trg Dositeja Obradovica 3, 21000 Novi Sad, R. Serbia
tel: +381 (0)21 485 2798
e-mail: aleksandra.tubic@dh.uns.ac.rs

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