Comparison of adsorption affinity of the plant derived activated carbons toward ionic polymers and heavy metal ions

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Introduction

Activated biocarbons have considerably developed porous structure and surface easy to modification. They are environmently friendly and can be succesfully regerated. Main aim of presented studies was to use activated biocarbons derived from the nettle (NE_AC), sage (SA_AC), mint (MT_AC) and lemon balm (LB_AC) herbs to adsorption of poly(acrylic acid) (PAA), polyethylenimine (PEI) and Cd(II) ions from their single and binary aqueous solutions.

Methods

Adsorption studies were carried out at pH 3, at 25°C for 24h. The substances adsorbed amounts were determined using the static method based on the change of the adsorbate concentration in the solution before and after the process, using 10ml of suspension containing 0.001mol/dm^3 NaCl (supporting electrolyte), 200ppm of appropriate adsorbate and 0.1g of the solid. The PAA and PEI concentrations were measured using UV–Vis spectrophotometer Carry 100 (Varian). Polyethylenimine concentration was determined based on its reaction with $CuCl_2$, resulting in formation of blue-coloured complex absorbing light at wavelength 285 nm [1]. In turn, the poly(acrylic acid) concentration was determined based on its reaction with hyamine 1622, which gives white-coloured complex absorbing light at wavelength 500nm [2]. Cd(II) concentration was determined using Inductively Coupled Plasma-Optical Emission Spectrometry (iCAP™ 7200 ICP-OES analyzer, Thermo Scientific).

Results

Table. 1. Textural parameters of examined activated biocarbons.

Adsorbent	Surface area [m^2/g]		Pore volume [cm^3/g]		Mean pore size [nm]	Micropore contribution
	total	micropore	total	micropore		
NE_ AC	801	157	0.847	0.074	4.231	0.087
SA_ AC	842	155	0.826	0.074	3.926	0.090
MT_AC	1145	184	1.465	0.073	5.115	0.050
LB_AC	950	149	1.100	0.069	4.630	0.063

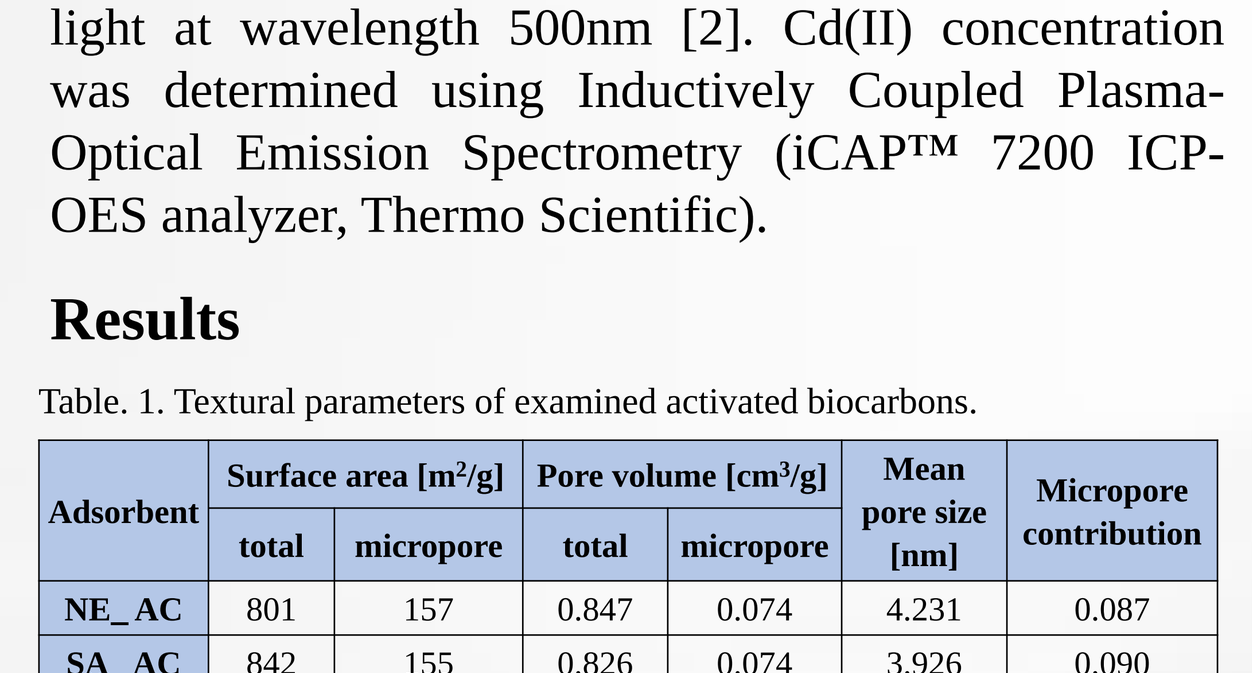

Fig. 1. Polyethylenimine adsorbed amount from single and binary solutions on the surface of activated biocarbons (pH 3, C_0=200ppm).

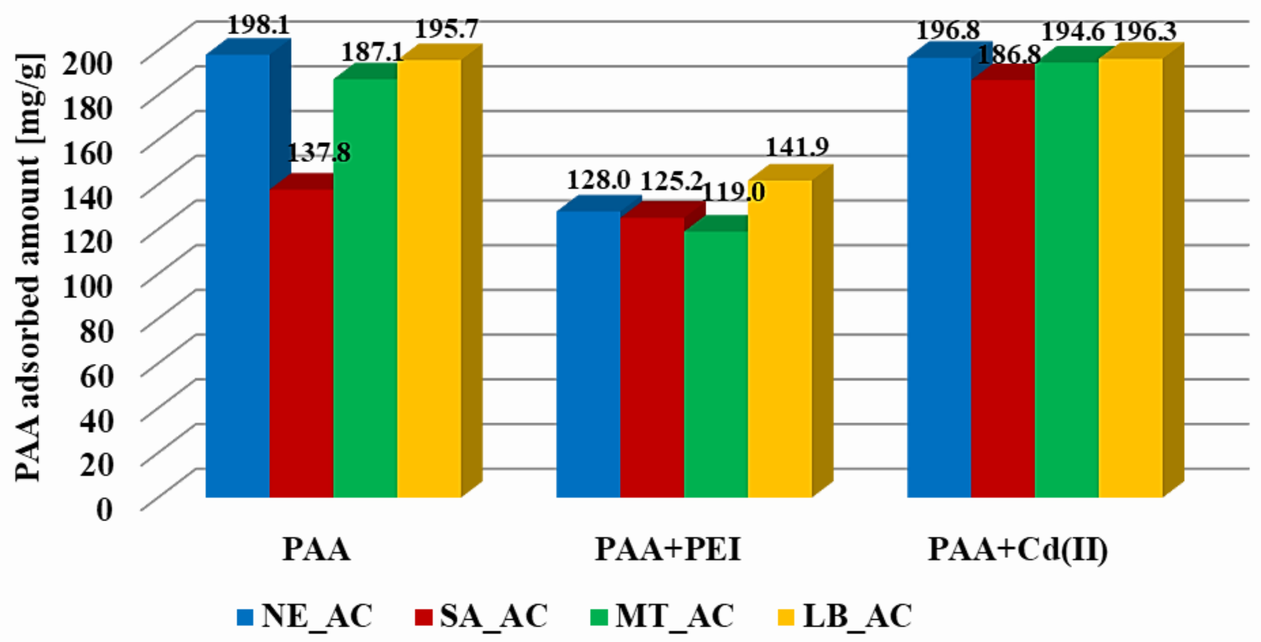

Fig. 2. Poly(acrylic acid) adsorbed amount from single and binary solutions on the surface of activated biocarbons (pH 3, C_0=200ppm).

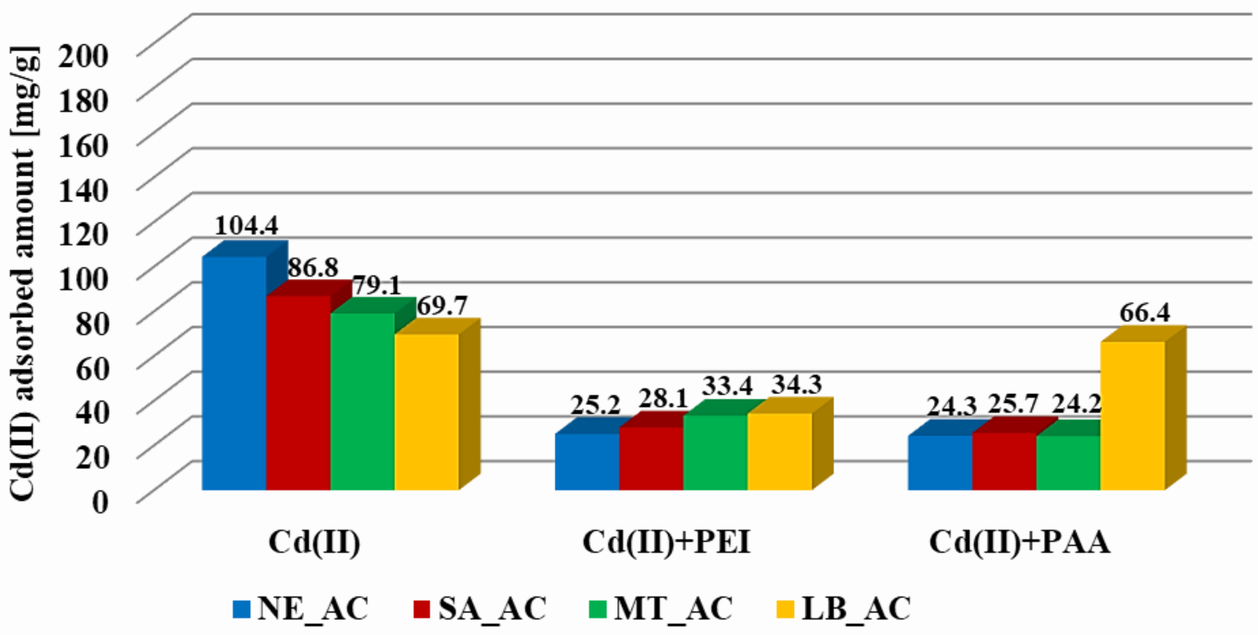

Fig. 3. Cadmium adsorbed amount from single and binary solutions on the surface of activated biocarbons (pH 3, C_0=200ppm).

Conclusions

- All examined activated biocarbons can be effectively used as adsorbents.
- Poly(acrylic acid) is the best adsorbed substance on the surface of all examined activated biocarbons.
- PAA and PEI show the worst affinity towards Surface of the activated carbon obtained from sage herb.
- Presence of another substances have no significiant impact on polyethyleneimine adsorption.
- PAA adsorbed amount decrease in the presence of PEI and increase in the solution containing cadmium ions.
- Both polymers cause decrease in Cd(II) adsorbed amount.
- All substances are adsorbed well from binary solutions with the usage of LB_AC activated carbon.
- The maximum adsorbed amounts are 84.3 mg/g for PEI, 198.1 mg/g for PAA and 104.4 mg/g for Cd(II).

References

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