APPLICATION OF FIBROUS COMPLEXING SORBENTS FOR TRACE ELEMENTS PRECONCENTRATION AND SEPARATION

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One of possible ways to increase the sorption efficiency is to apply the sorbents with high kinetic properties. To obtain these sorbents different methods are used. Namely, the sorbents can be synthesised on porous matrices with high-developed surface and synthetic or cellulose fibres. Additionally, different composition materials with the fast kinetics can be obtained.

"Filled" fibrous sorbents appear to be highly promising among other types of conventional fibrous sorbents thanks to their good kinetic properties. These sorbents represent composition of two polymers: polyacrylonitrile fibres (neutral polymer basis) and fine-grained (5–10 μm) complexing sorbents (filler, active component). A powdered polymer is retained well into fibre and has good contact with solution. The "filled" fibrous sorbents demonstrate good filtering and kinetic properties due to their hydrophility, porous structure of fibres and the small size of filler particles. The high selectivity and the sorptive capacity of such materials are stipulated by fillers' properties. Different materials can be used as fillers: inorganic or organic ion-exchangers, complexing sorbents, etc.

Fibrous "filled" sorbents are convenient in practice. Metal ions can be concentrated from the solution either in static or in dynamic mode. The dynamic mode is the most attractive. In this case the sorbents can be utilised in column or in form of disks placed on perforated surface or in the special cell. Also cartridge devices can be used for the concentration from big volumes of solutions. "Filled" fibrous sorbents are convenient for determination of metals after preconcentration. Metals can be determined after desorption as well as after the sorbent decomposition or directly in the sorbent phase.

This article is to demonstrate the application of the "filled" fibrous sorbents for preconcentration and separation of platinum metals, as well as heavy metals and radionuclides (Table 1). The POLYORGS complexing sorbents and ion-exchangers were used as fillers.

Table 1. "Filled" fibrous sorbents for trace elements preconcentration.

Fillers	Functional groups	Metals and preconcentration conditions
POLYORGS 4	3(5)-methylpyrazole	Au, Pt, Pd, Rh (1M HCl) Pu (3,5 – 7M HNO_3)
POLYORGS 15	3(5)-methylpyrazole	Pd (0,1 – 1M HCl)
POLYORGS 17	1, 3(5)-dimethylpyrazole	Au, Ag (0,1M HCl) Pt, Pd, Rh (0,1 – 1M HCl) Pu (3 – 7M HNO_3) Tc (0,1M HNO_3 – 0,1M NaOH)
POLYORGS 33	Amydoxime and hydrazidine	Am, Pu, Th, Pa, U (pH = 6) Pd (0,1 – 1M HCl); Cu, Pb, Zn (pH = 6)
Anion-exchanger	$-N^+(CH_3)_3$	Tc (0,1M HNO_3 – 0,1M NaOH) Pu (3 – 7M HNO_3)

"Filled" fibrous sorbents are very effective for metals preconcentration from big volume solutions. In this case the sorption in dynamic conditions was applied. The preconcentration of Cu from neutral solutions and Pt and Pd from 1N HCl solutions by the "filled" fibrous sorbents was investigated with the complexing sorbents POLYORGS used as fillers (Table 2).

Table 2. Dynamic preconcentration of Cu and Pd from big volume solutions
Cu: C_0 = 1 μg/ml; 0,5M NaCl; pH = 6,0–6,5;
Pd: C_0 = 1 μg/ml; 1,0M HCl

Metal ion	Sorbent	Sorbent mass, g	Preconcentration conditions			Recovery, %
			Preconcentration method	Flow rate, ml/min	Solution volume, ml	
Cu	POLYORGS 33-n	0,2	Column 1,0×2,5 cm	10	1000	86
		0,9	Column 1,0×4,5 cm	14	4500	90
		0,26	Disks ∅ 2,0 cm	10	2000	95
		1,0	Cartridge 1,0×4,0 cm	15	4500	90
Pd	POLYORGS 15-n	0,4	Disks ∅ 2,5 cm	5,5	1000	80
		0,5	Column 1,4×2,0 cm	10	1000	87
	POLYORGS 33-n	0,3	Disks ∅ 2,5 cm	5,5	2000	95
		1,5	Disks ∅ 4,0 cm	5,5	2000	99
		0,4	Column 1,0×2,0 cm	20	1900	92

Dynamic preconcentration conditions should be set for complete sorption of the elements: diameter and mass of the sorbent disk or the column as well as flow rate of the solution. These conditions depend on specific features of materials to be analysed and the requirements of the experimental task or detection method.

Usually the preconcentration conditions are selected on the basis of preliminary experiments. We have examined the possibility of mathematical modelling for determination of conditions of dynamic extraction by "filled" fibrous sorbents. It was found out that the mathematical solution, obtained for sorption process by resins in form of granules, can be used for selecting of preconcentration conditions by these sorbents. We have determined the equilibrium and kinetic characteristics of the palladium and platinum sorption by "filled" fibrous sorbents: distribution and diffusion coefficients. It was found out that the dynamic sorption is limited by external diffusion. This allowed to calculate the preconcentration conditions for trace amounts of Pt and Pd from hydrochloric solutions for various tasks. Preconcentration experiments carried out under these conditions show coincidence of calculated and experimental recovery of platinum and palladium from 1M HCl.

Extensive alteration of features as well as perfect kinetic properties and high selectivity of the "filled" sorbents confirm their applicability for trace elements preconcentration and separation in technology and analytical chemistry.