FIBERS AND MATERIALS OF MEDICAL APPLICATION

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1. CARBON FIBROUS ADSORBENTS

It was Hippocrates's idea that medicine is plus and minus: we take away everything that is extra and add what is missing, and the person who is doing that in the best possible way is the best doctor. Efferent sorption methods of organism detoxication (by medical trend) are presented today.

The application of carbon in medicine goes back to the time when ancient Egyptians and the doctors of Hippocrates's school recommended it for powdering of wounds. In 1830 French pharmacist Turey demonstrated an effective experiment at the meeting of the Academy of Sciences; he had taken a lethal dose of strychnine and successfully neutralized the toxic effect with charcoal. The American Hort was evidently the first doctor who used active carbon with the therapeutic aim of saving the patient poisoned by a corrosive sublimate.

Recently, specialists have shown their keen interest in the problem of treating exogenous and endogenous intoxications. This has been stipulated by the growing production and accumulation of chemical products for industrial, agricultural and domestic needs. We should take into account the growing production of various drugs and peoples' contact with them; consequently, it is imperative to improve the method of accelerated clearance of the organism from toxic products.

To solve this problem the industrial production of carbon fibrous adsorbents was developed and implemented at NII *Chimvolokno* in St. Petersburg. As a source of raw material we used cellulose fibers which were heat treated from 500 up to 9000°C and subsequently activated by steam, carbon dioxide or their mixture at the temperature of 900–1000°C to burn out (degree of activation) 30–60% of the mass. Application of carbon fibers as the source of raw material on a base of pitch and polyacrylonitrile resulted in obtaining sorbents with stimulating and carcinogenic properties. Carbon fibrous adsorbents on a cellulose base are not toxic and carcinogenic and do not possess irritant and allergic effects.

By changing the heat treatment temperature of cellulose fibers and by also using a type of activating agent (as well as conditions of activation/time and temperature), it is possible within a wide range to vary the porous structure and chemical state of the resulting adsorbents.

Table 1. Dependence of Physical Parameters of Carbon Fibrous Adsorbent Structure on the Type of Activating Agent and Degree of Activation

	Decree of activation	Volume of pores, sm^3 micro	meso	macro	Characteristic break of micropores X, nm	Specific surface of mesopores m^2/gr	density gr/cm^3
Activating Agent	17	0.28	0.04	0.00	0.58	41	1.78
	20	0.31	0.07	0.00	0.62	48	1.79
	25	0.34	0.09	0.01	0.71	43	1.81
	30	0.39	0.19	0.02	0.73	83	1.84
	39	0.44	0.16	0.04	0.76	109	1.92
	46	0.62	0.06	0.06	0.95	189	1.98
	22	0.13	0.09	0.02	0.57	34	1.96
	38	0.25	0.15	0.04	0.62	73	2.01
	56	0.37	0.23	0.07	0.64	90	2.06
	64	0.51	0.25	0.09	0.69	105	2.09

Application of small size materials (the diameter of a single fiber is 6–15 mkm) and shape promote easier gas extraction. Fibrous shapes: threads, tow, fabrics, nonwoven materials) provide uniform (in section) development of destructive processes: thermal decomposition of cellulose and subsequent burning out of charcoal during the activation. This in its turn results in the formation of a uniform microporous structure of adsorbents displaying high velocities and specific sorbtion processes. We have conducted sorbtion research by marking substances to determine the spectrum of those substances which are absorbed by carbon-fibrous sorbents with the aim of applying them. For comparison we investigated the absorption of the same substances by grained active carbon SKH-4M and Adsorba-3000C.

Table 2. Absorbing Ability of Adsorbents /mg/1/ with Respect to Low Molecular Substances

Sorbent	Original concentration mg, 5%	ADSORBA 300C SKN-4M						Carbonfibrous adsorbent, degree of activation-50%		
		Time of activation, min								
		5	30	60	5	30	60	5	30	60
Medinol	20	1.50	9.45	18.30	14.42	25.45	25.65	29.60	29.80	29.92
Creazinin	15	5.40	11.25	14.73	13.51	18.30	19.55	21.50	22.42	22.45
Uric acid	50	9.75	20.85	40.95	41.85	69.32	73.25	74.72	44.93	74.95

The results of laboratory tests on animals and comprehensive laboratory investigations enabled us to implement carbon fibrous adsorbents into clinical practice (in a wide range) as hemosorbents/lymphoplasmosorption/mecvosorbents, enterosorbents, and sorbents in application therapy.

Table 3. Absorbing Ability of Adsorbents /mg/gr/ with Respect to Medium Molecular Substances

Sorbate	Initial concentration	ADSORBA-3000 SKN-$N						Carbonfibrous adsorbent		
		Duration of Contact, min								
		5	10	60	5	30	60	5	30	60
Vitamin B-12	33 mkg/ml	0.12	0.70	0.79	1.37	3.95	4.53	4.54	4.88	4.95
Insulin	7.5 mg/ml	0.04	0.05	0.05	0.90	3.50	5.35	7.50	7.50	7.50
Ribonucleasa "Sigmo"	30mkg/ml	-	-	-	-	-	-	4.49	4.50	4.50

Effectiveness of Carbonfibrous enterosorbents is shown in Table 4.

Table 4. Variation of LD_{50} When Grained Charcoal "Carbolen" and Fibrous Carbon are Used as Enterosorbent

LD_{50} is a lethal dose of exogenous poison causing the death of 50% of the experimental animals in our experiment with rats (quantity of poison in mg on 1 kg of animal weight).

Toxic substances	LD_{50}, mg/kg		
	Control without sorbent	Carbolen	Carbonfibrous sorbent
Carbontetrachloride	22215	2901	3425
1,2 dichlorethane	640*	829	1042
barbamyl	276	388	519
carbophos	0.875	1.132	1.500
strychnine	7	21.6	30.2

Experimental data demonstrate promising results of entorhinal application of fibrous sorbent in cases of poisoning danger. A striking clinical effect using derivatives of phenothiazine in the application of fibrous enterosorbents was obtained with patients suffering from alcohol poisoning. It was successfuly used in the treatment of hepatitis A and B; in the case of leptospirosis the death rate was reduced from 25% to 7–8%; in the case of acute gastro-intestinal disturbance a prescription of fibrous sorbent resulted in quick cupping of intoxication and diarrhea syndrome; in the case of resorptive fever enterosorption provides cupping of gastroenteropathy and decreases the general level of endogenous intoxication. With the same aim enterosorption was successfully applied to patients having complications from drug-and-radiotherapy cancer treatments. Positive effects were also obtained with patients suffering from food and drug allergy, and also from diabetes mellitus.

The application of carbon-fibrous sorbents in the case of hemosorption demonstrated that their effect on the contoured blood elements does not exceed analogical indexes of spherical carbon hemosorbents. Hemosorption on a carbonfibrous sorbent base was employed in the case of leptospirosis, rheumatoid arthritis, critical forms of myasthenia, psoriasis, asthma, and exotoxicoses. On the basis of such studies it was assumed that fibrous sorbents are highly effective hemosorbents in therapeutic endo-4 exogenno intoxications. The high rate of sorption determines the advantages of their application at the departments of intensive therapy/revivification.

The problem of effective removal of toxic products from wound surfaces is one of the vital problems of purulent surgery. Sorbing dressing consisted of a carbon-fibrous adsorbent layer between two layers of gauze. Dressings with fibrous carbon are comfortable; they are easily adapted to the wound surface for any relief not causing traumatosis of the wound. It was noted as decreasing intoxication, diminishing edema, preventing secondary necroses development, limiting fibrinous films, strengthening of epithelization of the wound surface, stimulating granulation growth, and shortening the period of preparation of wounds for epidermatoplasty. The subjective state of patients was improved; temperature dropped within 1–3 days of starting the application of dressings and drains with carbonfibrous sorbent.

Patients with a lightning form of anaerobic infection were under supervision also. In the process of cytologic examination of wounds it was found that after the first dressing the total number of freely lying microbic bodies decreased by an order of 1–3, and a considerable number of connective elements appeared. Positive dynamics of perpheric blood indexes and decreasing toxemia within the stages of leukocyte destruction were noted. During the treatment of burned patients a trauma from the dressings was noted. Dressings were successfully applied in the case of patients with post injection abscesses of soft tissues, in the complex therapy of nonformed intestinal fistula, in the course of complex

*Not able to verify with the author.

treatment of first and second degree peritonitus. Tampons with carboniferous sorbents were tested for treatment of postnatal ruptures of the perineum of a woman in labor. Due to the application of sorbing dressings it was possible to escape dangerous septic consequences in patients suffering from puerperal endometriosis.

The obtained results enable us to consider the application of sorption with carbonfibrous sorbents to be very promising, especially in cases of mass arrivals of wounded people, when the application of dressings with fibrous carbon allows extension of the prehospital period.

Sorbent application can be used not only for wound and burn treatments, but also for protection of surfaces injured by chemical and biochemical toxic substances.

Finalizing the research results of applying carbon sorbents in medicine, we can conclude that in cases of acute poisoning it is desirable to apply, simultaneously, hemo and enterosorption. When treating wounds and burns accompanied by exogenous intoxication, it is possible to apply a complex sorption method of treatment, including hemo, enterosorption and application therapy.

COMPRESSION-DISTRACTION APPARATUS OF ACADEMICIAN B. KALNBERZ

The apparatus is designed for setting fractured bones. The construction base of Kalnberz's apparatus consists of hexahedral rings and clamps to provide a special rigid truss structure.

Application of modern composite materials (CFM) for manufacturing apparatus elements enabled us to improve its parameters considerably. In particular, we decreased the apparatus weight, preserved its strength, and improved the deformative characteristics and operational-hygienic properties.

CFM were used in the construction of rings and rods with a directed arrangement of reinforced fibers of different types. The necessary level of elasto-strength properties of directed-reinforced material was obtained by reinforcement hybridization. The surface modification of the apparatus elements was carried out by applying a special protective polymer layer to provide the apparatus elements with the necessary surface medical-biological properties, namely: nontoxicity, possibility of sterilization by any known methods without surface damage, prevention of injury to the doctor's hands and the patient's body. Medical-biological tests and the clinical ones of the Kalnberz apparatus were conducted using modern CFM. The results of the tests are given below.

Reinforcing filler	Mass gr	Inner diameter, mm	Breaking load	Destruction deformation, mm	Mass of serial elements, gr
	62	150	3200	16	72
Glass roving	71	170	3050	19	-
Glass roving + 5% SVM	78	200	2550	29	172
Glass roving = 10% SVM	91	240	2100	36	217
Glass roving + carbofiller	78	240	2400	- -	- -