HUMIC COMPOUNDS UPTAKE FROM TAP WATER BY GRANULAR ACTIVATED CARBONS OF VARIOUS NATURE.

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Introduction

Humic compounds - primary contributors to natural organic matter (NOM), presented in potable water, are polymeric, polyfunctional low acidic compounds of variable structure (humic, fulvic acids, etc). Their molecular weight varies in the range of 500 and 25000, effective size – 10 and 100 Angstrom[1]. NOM is the major source of precursors of disinfection by-products (DBP), which are formed during water treatment operations and are worldwide recognized as the public health risk water contaminants. Several methods are currently used for NOM removal from potable water, but NOM adsorption with granular activated carbons (GAC) seems to be preferred. [2, 3]

The main objective of current research was to investigate the uptake of NOM with several GACs of various nature, pore size distribution, grain size, surface characteristics in dynamic system and to determine the major characteristic to choose the optimal sorbent for the process.

Experimental

Methods

NOM concentration was estimated with Oxidizable Compounds Content index (OCC) (mgO_2/l). Dynamic tests were carried out for 13 months in glass columns: diameter 20-23 mm, bed height 300-450 mm, flow rate – 250 ml/h, analysis checkpoint every 12 hours. Structure characteristics of GAC samples were calculated using N_2 adsorption data measured with Digisorb "Micromeretics" and ASAP-200M "Micromeretics".

Objects

- Kiev tapwater: OCC up to 7.8 mgO_2/l
- 6 GAC samples, major characteristics determined with standard procedures shown in table 1.

Calculations

Adsorption efficiency was estimated using two main values:

Capacity by NOM (OCC):

$$E^* = \int_0^V (C_0 - C)dV$$

(mgO_2/ml of sorbent), V- specific volume (ml of water/ml of sorbent).

Results and Discussion

Adsorption data analysis shows that NOM capacity of the samples at the recovery (α) of 0.6 increase as follows: **charcoal < coconut < coal < bituminous.** (fig.1,2). Comparing the last with GAC characteristics (table. 1) one can notice, that ratio of 20-200 Angstrom diameter pores volume/total pore volume (β) increases in the same manner. We can suggest thus, that pores of 20-200 Angstrom diameter form the primary adsorption space for humic compounds molecules and correlates well with average humic and fulvic acids molecules effective sizes, mentioned above. Thus, the larger is β, the higher is NOM capacity of GAC. Sample #6 with the highest β, (bituminous GAC, which porous structure was created especially for the purposes of NOM uptake from water) showed the best results.

Further investigations showed that NOM capacity depends on GAC effective grain size and surface characteristics (fig. 1, 3). The larger is grain size the lower is NOM capacity. This can be easily explained basing upon adsorption kinetics. Silver impregnated coconut GAC has lower NOM capacity than non-impregnated sample. This can occur due to the more hydrophilic surface of impregnated GAC, and confirms assumed van der Vaals mechanism of interaction. It's important to note, that surface polarity is much less important for NOM capacity than grain size.

Coconut and charcoal based GACs reached the highest α values at the initial adsorption stage (fig. 3) due to their high alkalinity and, therefore, possible electrostatic interaction with humic and fulvic acids..

Conclusions

GACs adsorb humic compounds primarily in pores of 20-200 Angstrom diameter. Thus, the higher is β ratio, the higher is NOM capacity. The lower is surface acidity of GAC sample, the higher is recovery of NOM.

NOM capacity of GAC grows with grain size and surface polarity decreasing.

Table 1. Investigated GAC samples major characteristics.

Sample No.	Description	Grain size distribution mm	Effective grain size, mm	Total pore volume, cc/g	20-200 Angstrom diameter pores volume/total pore volume (β)	Iodine number, mg/g	Water extract pH
1	Coconut based GAC (Sutcliffe 207C)	2-3	2,1	0,442	0,079	1107	10,5
2	Coconut based GAC (Sutcliffe207C)	0,6-1,7	0,7	0,442	0,079	1081	10,5
3	Coconut based GAC silver impregnated (Sutcliffe AGC)	0,6-1,7	0,7	0,442	0,079	1091	10,5
4	Coal based GAC (Sutcliffe 207EA)	0,6-1,7	0,7	0,505	0,3	891	8
5	Coal based GAC (Carbon CWZ)	0,6-2,36	1,2	0,505	0,3	969	8,1
6	Bituminous coal based GAC (Calgon F300)	0,6-2,36	0,8	0,67	0,42	1002	8,1
7	Charcoal based GAC (Carbon CWZ)	2-3	2,1	1,623	0,044	649	9,6

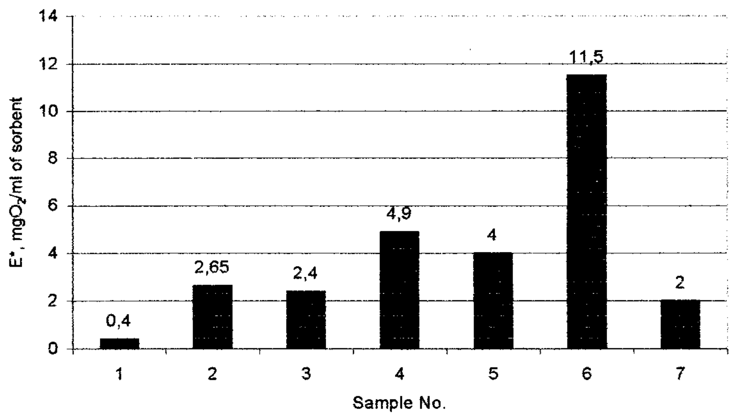

Figure 1. NOM capacity of the investigated GAC samples (recovery a=0.6)

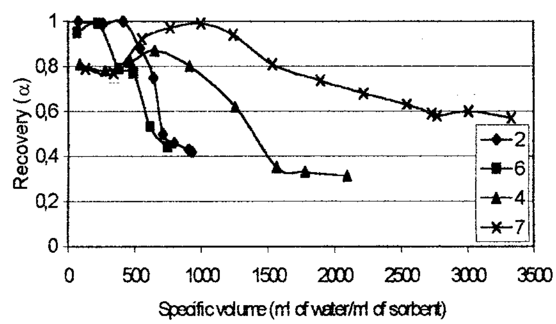

Figure 2. Humic compounds uptake from water by GAC of various nature

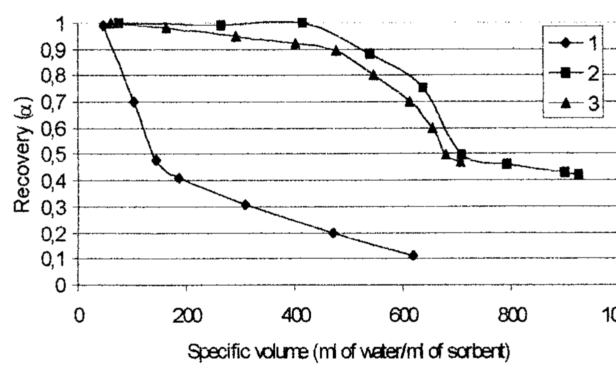

Figure 3. NOM recovery by coconut based GACs

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