IMPROVING THE PURIFICATION PROCESS FOR AQUEOUS-ALCOHOLIC SOLUTIONS BY SHUNGITE

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The production of alcoholic beverages has significant place in the Ukrainian economy. Alcohol is one of budget-forming products. Therefore the research related to the improvement of alcohol quality parameters, and thus of alcohol beverages, as well as to the decreasing costs of these products is of current concern.

Ethyl alcohol is a product consisting of ethanol, water and evaporating impurities, which are formed during the process of ethanol distillation and rectification and which significantly influence its physical and chemical as well as organoleptic parameters. Alcohol is known to have more than 200 types of impurities, but their content does not exceed 0.5 – 0.6% of total quantity of ethyl alcohol. Professor V.A.Piendl [1] classified the impurities into alcohols, aldehydes, ethers, substances containing nitrogen and sulfur.

Quantity and quality contents of impurities have different impact on taste and aroma of alcohol, and thus on organoleptical parameters of aqueous-alcoholic solutions used for vodka production. Ethers of acetic and methylacetic acids cause alcohol to have sweetish flavor and its aroma to have fresh and light fruity tones. Alcohol has high quality parameters, provided that the ethers content is up to 10 mg/dm^3.

Ethyl ether of acetic acid takes active part in creating alcohol's bouquet. In concentrations up to 10 mg/dm^3, together with other ethers, it improves alcohol's aroma.

Group of ethers such as ethyl formiate, methyl butyrate, ethyl butyrate, isobutyl propionate impair the quality of alcohol, causing it to have unpleasant scents.

Aldehydes, higher alcohols, and methanol negatively affect alcohol's organoleptic.

Measure on additional purification of aqueous-alcohol solutions from harmful impurities may include the usage of natural adsorbent – shungite.

Shungite is a mineral, consisted of amorphous carbon (60-60%) and other chemical compounds (30-40%) [2].

Shungite carbon has amorphous structure, resistant to graphitization, characterized by high adsorptive capacities which could be explained by unique structure of adsorbent. In natural state shungite carbon forms a matrix, in which dispersive silicates with average size of particles around 1 micron are distributed evenly. Shungite's capacity to adsorb various substances is determined by structure of its surface, by nature and concentration of surface reactive groups. Shungite is the only known mineral containing fullerenes. The important factor is that shungite has fullerene carbon nanotubes with diameter of their alveoles constituting 1...6 nm, and length – up to several microns. Cylindrical surface of tubes are formed by active carbon circles and has free porous space.

The purpose of the research was to establish optimal parameters for purifying aqueous-alcoholic solutions with ethanol concentration of 40 % (called sortivkas), which are used for vodka production.

The quantity of impurities in sortivkas was determined through physical and chemical as well as gas-chromatographysical methods.

Shungite (with size of particles – 2.5 mm) was put into adsorption device and sortivka flew through it with speed of 23, 30, 40 dal/hour. After 10, 20, 30 minutes at temperature of 20C the contents of aldehydes and higher alcohols were determined. The results are shown at fig.1.

When analyzing data from fig.1 one can see that in 13 minutes the initial content of aldehydes decreased from 2.8 to 1.9 mg/dm^3.

Shungite effectively purifies sortivka from higher alcohols, decreasing their initial content from 2.2 to 1.50 mg/dm^3 in 12 minutes. When duration of contact between adsorbent and sortivka increases, the quality of aldehydes and higher alcohols also increases, and this evidences catalytic processes. Thus it is preferable to purify sortivka with shungite during 12-13 minutes.

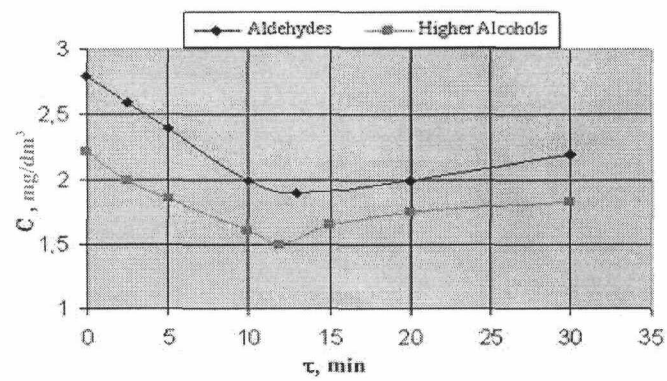
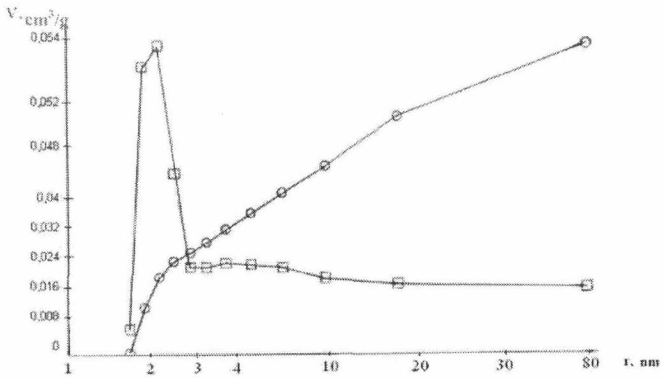


Fig.1 Dependence of mass concentration of aldehydes and higher alcohols on the duration of interaction between shungite and sortivka at 20°C

The research proved that when adsorbing aldehydes and higher alcohols from sortivkas, shungite simultaneously adsorbs methanol, decreasing the initial content of this impurity twofold.

For the purpose of scientific explanation for selectivity of shungite adsorption with regard to ethyl alcohol impurities a histogram for allocating radiuses and volumes of adsorbent pores was determined (fig.2).



It is shown that shungite has pores with radius of 1.8 ... 80 nm, large quantity of which is represented by micropores – within 1.8 ...2 nm, but there are also mesopores and macropores. Volume of micropores constitutes 0.004 ... 0.016 cm^3/g, of mesopores – 0.016 ... 0.052 cm^3/g, and of macropores – 0.052 ...0.054 cm^3/g.

The mechanism of adsorbing aldehydes, higher alcohols and methanol is likely to take place because fullerenes nanotubes take part in adsorption processes and there are pores between them, because reactive centers of fullers appear with non-compensated charges and because shungite pores adsorb impurities.

Conclusions

Shungite with the size of particle constituting 2.5 mm effectively adsorbs aldehydes, higher alcohols and methanol. The quantity of aldehydes in the purified sortivka decreases by 32%, of higher alcohols – by 30%, of methanol – by 50%. The optimal duration of interaction between shungite and sortivka is 12-13 minutes.

References.

[1] Piendl V.A. Die Bedeutung der alkoholischen Begleistoffe // Brauwelt.1978;118 (38):1388-1393.

[2] Kovalevskyi V.V. Shungite rocks – crystallogenesis and nanotechnologies // Mineralogy, petrology and mineragenia of Precambrian complexes in Karelia. Materials of the anniversary scientific session.-Petrozavodsk, 2007:35-36,335-339.