DOI:10.31081/1681-309X-2023-0-2-21-30 Specialty: 102; 161. U.D.C. 552.576.1:661.183.03:544.723.2

ADSORPTION OF CHLOROPHENOL BY ACTIVATED CARBON FROM MIXTURES OF LONG FLAME COAL AND SECONDARY COKING PRODUCTS

© **V.A. Кucherenko**, Doctor of Chemical Sciences, **Ju.V. Tamarkina,** PhD in Chemical Sciences, **V.A. Sabierova**, PhD in Chemical Sciences, **I.B. Frolova,** PhD in Chemical Sciences (L.M. Litvinenko Institute of Physical-Organic and Coal Chemistry of the National Academy of Sciences of Ukraine, 02160, Kyiv, Kharkiv Highway St., 50, Ukraine)

The purpose of this work is to evaluate the effect of secondary coking products (SCPs) on the adsorption properties of activated carbons (ACs) from mixtures of SCP and long-flame coal D.
AC samples with specific surface area SBET = 885–1173 m2/g were prepared from coal D and mixtures of coal (85 %) and SCP (15 %). Fuses (F), acid tar (AT) of the sulfate department, polymers (P) of the benzene department, cube residue (CR) and coal tar (T) were used, and the corresponding samples are designated as AC(D), AC(F), AC(AT), AC(P), AC(CR), AC(T). The adsorption capacity for 4-chlorophenol (CP) (ACP) was determined at the AC content of 1 g/L (25°C) and the CP initial concentration CCP(0) ≤ 600 mg/L. The CP concentration was determined from the solution optical density at 280 nm (Perkin-Elmer Lambda 20 spectrophotometer). The specific adsorption capacity ACP(S) (mg/m2) was determined by the ratio ACP(S) = ACP/SBET, which is proportional to the concentration of adsorption centers on the AC surface. The degree of CP extraction and the degree of surface coverage were calculated. The CP adsorption kinetics were approximated by pseudo-first order, pseudo-second order and intraparticle diffusion models. The adsorption isotherms were approximated by the Langmuir and Freundlich models.
The SCP type was established to have a significant effect on the AC adsorption activity which is expressed by significant differences in the values of adsorption capacity, kinetic characteristics, and isotherm parameters. The CP adsorption kinetics was found to obey the pseudo-second order model (determination coefficient R2 ≥ 0.996) with constants varying from 2,78·10-4 g/mg·min to 6,29·10-4 g/mg·min depending on the SCP type. By comparing the calculations of the kinetics by the pseudo-first order and intraparticle diffusion models, the rate-determining stage was found to be the physical sorption and chemisorption of CP. In the range of equilibrium concentrations of CCP(e) ≤ 350 mg/l, the adsorption isotherms were approximated by the Langmuir model (R2 ≥ 0,994) better than by the Freundlich model (R2 ≥ 0,887). The calculated capacitances of the monolayer for the obtained ACs differ by a factor of ~2 and are in the interval of ACP(L) =214,3 – 414,3 mg/g, Langmuir constants are from 1,89·10-2 l/mg to 5,29·10-2 l/mg. The CP adsorption capacity was found to increase almost linearly with increasing SBET (R2 = 0.931), but the AC(AT) sample sharply drops out of this dependence and shows a 2-fold lower capacity value, which is due to the AT composition. It is determined that the CP capacity and degree of extraction increase in the series of AC(AT) < AC(D) < AC(F) < AC(T) < AC(P) < AC(CR). Judging by the effect on the AC properties, the most effective SCP is the cube residue, which maximally contributes to the formation of adsorption centers being active in relation to CP. The AC(CR) sample exhibits the highest adsorption capacity (414 mg/g), specific capacity (0.353 mg/m2), surface coverage (80.6 %), and initial CP uptake rate. During the first 5 min, AC(CR) absorbs 35.8 % of the CP total amount at CCP(0) = 600 mg/l. The values of this parameter for other samples are lower and range from 11.5 % (AC(AT)) to 29.2 % (AC(P)). Namely SPS composition is concluded to determine the set of chemical reactions forming the AC spatial framework. All SPCs (except acid tar) promote the formation of AC with a higher capacity and an increased adsorption rate, which makes their use promising for improving the ACs adsorption characteristics.

Key words: long flame coal, secondary coking product, activated carbon, adsorption, 4-chlorophenol

Corresponding author: Tamarkina Ju.V., e-mail: Tamarkina@nas.gov.ua