COMPARATIVE STUDY OF PHENOL AND NONYLPHENOL ADSORPTIONS ON ACTIVATED CARBONS

D. M. Nevskaia and A. Guerrero-Ruíz
Dpt. Química Inorgánica y Química Técnica. Facultad de Ciencias. Universidad Nacional de Educación a Distancia (U.N.E.D.). c/Senda del Rey s/n. Madrid 28040. Spain.

Introduction

Activated carbons are frequently used for wastewater decontamination [1]. Many researchers have applied activated carbons to extract phenols and other organic contaminants from potable water [2]. Besides the adsorption capacity and mainly for economic reasons, the regeneration of activated carbons for further uses, is also an aspect of interest [3]. In many cases, trying to improve the adsorption capacity and the regeneration of the spent carbons chemical nature of the surface is modified [4].

Experimental

An activated carbon prepared from olive stones (ICASA, Spain) was used (S). The carbon was also oxidized with HNO_3 (SN). The specific surface areas were determined by N_2 adsorption at 77 K (Micromeritics ASAP 2010) and using the B.E.T. method. In order to obtain the adsorption isotherms, the activated carbon was put in contact with the organic pollutant aqueous solutions and stirred until equilibrium was reached. The adsorbed amount was calculated on basis of the concentration change, determined by UV spectroscopy before and after pollutant adsorption on activated carbon. TG-TPD experiments were performed in a thermobalance (Seiko SSC/320) under N_2 atmosphere and a gas flow of 50 cm^3 min^{-1}. A mass spectrometer (Baltzers, QMG 421), directly attached to the TG system, allowed to measure, in the gas phase, the desorbed species from the activated carbons during the temperature programmed desorption.

Results and Discussion

The adsorbed amounts of phenol and nonylphenol on fresh activated carbon are closed (Figures 1 and 2). However the isotherms shape are different: L shape for phenol and stepped for nonylphenol. When carbons are oxidized, a different adsorption behavior for phenol and nonylphenol is observed. In the case of phenol a decrease of adsorbed amount and a stepped isotherm is found. This fact can be interpreted as a specific interaction of the water molecules with the oxygen surface groups, which acts by inhibiting the adsorption of phenol at lower equilibrium concentrations [5]. By contrary, the surface oxidation improves the nonylphenol adsorption. This implies that adsorption mechanism is different.

Desorption of phenol from S carbon under N_2 atmosphere gave a single peak at 200° C (Figure 3). The

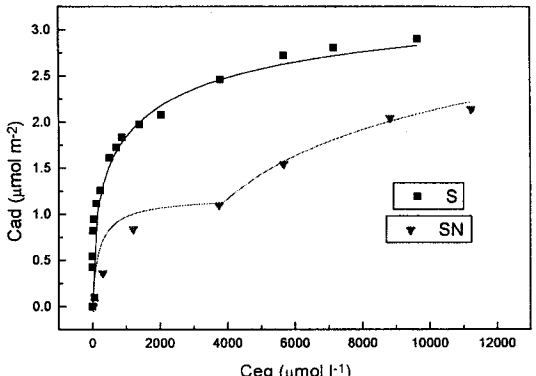

Figure 1. Adsorption isotherms of phenol

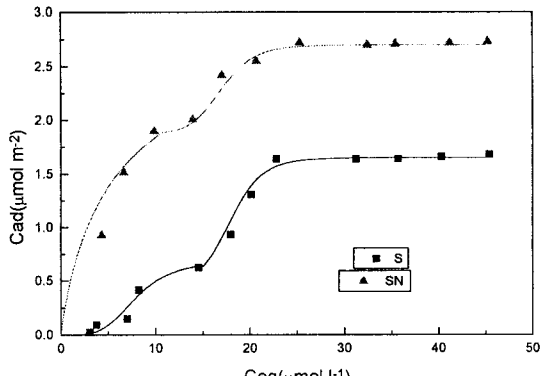

Figure 2. Adsorption isotherms of nonylphenol

same desorption behavior is observed on the oxidized carbon (SN). The phenol desorption is followed by m/z=94 and the nonylphenol desorption is followed by m/z=41 that corresponds to CH_2=CH_2-CH because is better detected than m/z=220 signal (nonylphenol molecular weight) (Figure 4). The maximum of

nonylphenol desorption appears at around 380°C. However, when SN carbon is used, the maximum of nonylphenol desorption shifts to 240°C. These facts indicate that there is no interaction between oxygen surface groups and phenol molecules but on the contrary, it seems that a some kind of hydrogen bonds are produced between the OH groups of the nonylphenol micelles and oxygen surface groups of the carbon. This interaction is weaker than that which is produced with fresh carbon, and the activated carbon can be regenerates at lower temperatures.

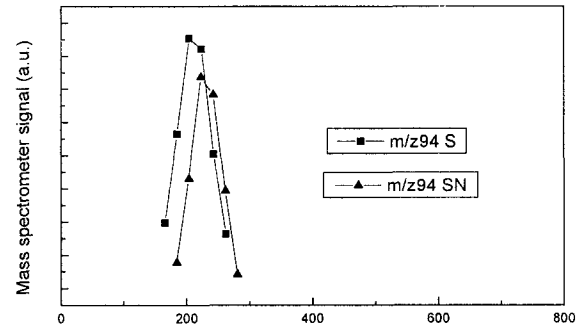

Figure 3. TPD profiles of phenol

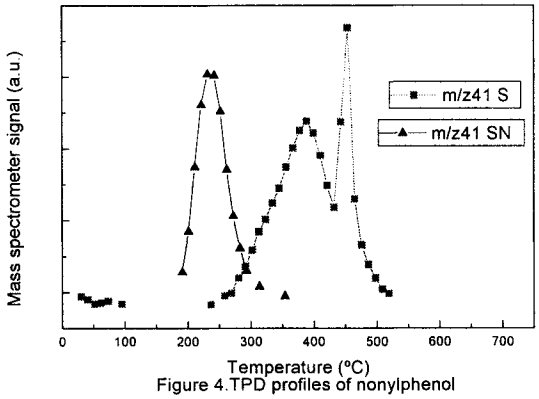

Figure 4.TPD profiles of nonylphenol

Conclusions

The presence of oxygen surface groups decreases the adsorbed amount of phenol on activated carbon due to a stronger interaction of these groups with the solvent. The phenol thermal desorption begins at 125°C and finishes at 325°C. Influence of surface oxidation on thermal regeneration has not been observed.

The oxidizing treatment improves the nonylphenol adsorption. This fact seems to indicate an interaction between oxygen surface groups and nonylphenol micelles. The shifting of the desorption profile towards lower temperatures implies a weaker interaction of nonylphenol with oxygen surface groups.

References

1. Bansal RC, Donnet JB, Stoeckli F. Active Carbon. Marcel Dekker, N.Y. 1988: 335.
2. Akubuiro EC, Wagner NJ. Assessment of activated carbon stability toward adsorbed organics. Ind Eng Chem Res 1992; 31: 339-346.
3. Salvador F, Merchan MD. Study of the desorption of phenol and phenolic compounds from activated carbon by liquid-phase temperature-programmed desorption. Carbon 1996;34(12): 1543-1551.
4. Metatov-Meytal Yu I, Sheintuch M, Shter GE, Grader GS. Optimal temperatures for catalytic regeneration of activated carbon. Carbon 1997;35(10-11):1527-1531.
5. Nevskaia DM, Santianes A, Muñoz,A, Guerrero-Ruíz A. 1999, Interaction of aqueous solutions of phenol with commercial activated carbons: An adsorption and kinetic study. Carbon 1999 (in press).

Acknowledgments

This work has been supported by the Comunidad de Madrid under project 08/008/96.