

Activated Carbons Prepared from Natural and Synthetic Raw Materials with Potential Applications in Gas Separations

Isabel P.P. Cansado^a, Paulo A.M. Mourão^b, Manuela L. Ribeiro Carrott^c and
Peter J.M. Carrott^d

Centro de Química de Évora and Departamento de Química, Universidade de Évora,
Colégio Luís António Verney, 7000-671 Évora, PORTUGAL
^aippc@uevora.pt, ^bpamm@uevora.pt, ^cmanrc@uevora.pt, ^dpeter@uevora.pt

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Abstract. A carbon molecular sieve for the purification of a gas mixtures containing O₂, N₂ and CO₂, CH₄ was produced from a waste granulated PET by means of a single carbonisation step at 973 K. Activated carbon materials presenting good adsorption capacity and some selectivity for O₂/N₂ and CO₂/CH₄ were prepared from granulated PET and cork oak with pore mouth narrowing using CVD from benzene. The diffusion coefficients of O₂, N₂, CO₂ and CH₄ in these materials were calculated and are comparable to published values determined on Takeda 3A and on a carbon molecular sieve prepared from PET textile fibres by means of carbonisation and subsequent CVD with benzene. However, the selectivities were not quite as good as those given by Takeda 3A. However, taking into account that this is a first attempt at producing CMS from PET, the results are encouraging, and it is to be expected that further development of the experimental procedure will result in new materials with improved performance.

Introduction

Activated carbons (AC) are commonly used as adsorbents for decontamination processes such as purification of drinking water, wastewater and sewage treatment, but also play a crucial role in many applications within the fields of emission control and gas separation and purification. Activated carbons can be prepared from a variety of raw materials, but the most referred precursors are hard coal, brown coal, wood, coconut shells, polymers and some agricultural by-products [1-14]. The use of a particular AC, designated as carbon molecular sieve (CMS), in the chemical process industry, to separate various gases has been known for several decades [4, 7, 15]. The development of suitable porosity which will favour the adsorption/separation of gases and vapours depends upon the carbonaceous precursors as well as the preparation methods and on the post treatment. Kinetic separation based, for example, on differences in the molecular sizes, may be obtained by controlled reduction of the pore size of the adsorbent. To generate an effective separation, the CMS must present a pore opening of about one molecular diameter of the larger gas in the mixture [5-7]. Three factors, applied singly or in combination, may allow the desired selectivity to be achieved: steric factors (such as the difference in shape and size of the adsorptive molecules), equilibrium effects (when the adsorption isotherms of the components of the mixture differ considerably) and kinetic effects (when the components have substantially different diffusion or adsorption rates) [5-8].

The narrowing of the pore size may lead to an increase in the diffusion speed for smaller molecules when compared with those which are larger. A post treatment by chemical vapour deposition (CVD) involves the deposition of pyrolytic carbon on a microporous carbon material which had a homogeneous micropore structure with mean pore entrance dimension slightly larger than that required for effective molecular sieving action. A post treatment by CVD from different hydrocarbons [4-9] or a post thermal treatment with a microwave furnace, on activated carbon fibres were also reported as achieving optimum separation for CO₂/CH₄ and N₂/O₂ [2].