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Anisotropy of Effective Gas Diffusion Coefficients in Extruded Carbon Rods

It is well known that, in extruded cylindrical samples composed of either particles of amorphous carbon or graphitized carbon, the properties of thermal expansion, thermal conductivity and electrical conductivity are highly anisotropic[1]. The anisotropy in these properties is caused by the orientation of the irregular particles with their long side parallel to the direction of extrusion and by the inherent anisotropic behaviour of the crystallites composing the particles.

The orientation of irregular particles would also be expected to produce anisotropy of effective gas diffusion coefficients in extruded carbon rods. To investigate this phenomenon, effective diffusion coefficients, D_{eff} (H_2–N_2), were determined on three commercial samples, all using coal-tar pitch as a binder: a lampblack gas baked at about 1,000° C. (*A*), a petroleum coke graphitized at about 2,500° C. (*B*), and a petroleum coke graphitized at about 3,000° C. (*C*). The apparatus and procedure described by Weisz and Prater[2] and us[3] were used. Samples $\frac{1}{8}$ in. long by $\frac{1}{8}$ in. in diameter were used; they were previously cut either parallel or perpendicular to the direction of extrusion from rods 2 in. long by $\frac{1}{2}$ in. in diameter. The results on each sample, shown in Table 1, represent at least three different specimens, with the individual values duplicated within ± 5 per cent.

D_{eff} (H_2–N_2) was calculated on the basis of the external geometrical length of the cylinder. If the pores in the solid are completely random in direction, the average length of travel of gas is shown by Wheeler[4] to be 1·41 times the external length of sample (tortuosity factor). However, if the particles composing the sample are oriented by extrusion, it is seen that the assumption of randomness of pore direction is no longer valid. Parallel to the extrusion

Table 1. Effective Diffusion Coefficients of Hydrogen–Nitrogen in Carbon Rods parallel and perpendicular to Direction of Rod Extrusion

Sample	D_{eff} (cm.²/sec., S.T.P.)		Ratio of D_{eff}
A	0·049	0·038	1·29
B	0·044	0·039	1·13
C	0·088	0·053	1·66

direction the tortuosity factor would be expected to approach more closely to 1 (perfect channelling) the higher the degree of orientation. Conversely, the tortuosity factor perpendicular to the direction of extrusion would be expected to become progressively greater than 1·41 with increased orientation of the particles. Therefore, it is felt that the anisotropy of effective gas diffusion coefficients in the extruded carbon rods is primarily a result of differences in the tortuosity factor produced by particle orientation.

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