PHYSICAL PROPERTIES OF CDE CHARCOAL CLOTH

By F.A.P. Maggs, G.A. Robins, and M.E. Smith

Chemical Defence Establishment, Porton Down, Salisbury, Wiltshire, UK

Introduction

In another paper to this Conference (1) the adsorptive properties of CDE charcoal cloth have been described. In the present paper the ranges of tensile strength, flexibility, electrical resistivity and other physical properties measured on samples taken from an experimental plant producing charcoal cloth in 60 cm wide, 50 m long rolls are given. The variation of some of these properties with extent of activation is also recorded.

Cloth Structure

The cloth is a woven material composed entirely of charcoal, and although several weave forms have been made, the major production has been in square form linen weave having 13 double threads per cm; the properties recorded in this paper refer to this form only. The diameter of the filaments forming the thread is ca. 20 μm (scanning electron micrographs).

The surface density, w (weight per unit area) lies in the range 9 to 16 mg/cm^2. The bulk density, measured by compressing a pile of discs until further compression has little effect is 0.25 - 0.3 g/ml. The cloth thickness is in the range 0.04 to 0.05 cm.

Cross-Sectional Area

This may be estimated as $\frac{2wk}{d}$, assuming weave isotropy, and a thread crimping factor k; d is the envelope density of the filaments and has been estimated as 1.8 g/ml for unactivated material. It has also been observed (2) from electron micrographs that activation proceeds internally, the filament diameters showing only small changes during the process. From these observations the cross-sectional area of the linen weave cloth has been estimated as 4×10^{-3}cm^2 per cm.

Breaking and Tensile Strength

The breaking strength of samples of cloth taken from experimental production falls in the range 2.5 to 3.5 kg/cm width. The tensile strength thus falls in the range 6.3 to 8.8 $\times 10^5$g/cm^2 (60 to 80 MN/m^2) (a quarter of the tensile strength of a single carbon fibre derived from rayon).

Flexural Rigidity

This was measured by the method of BSS 3356: 1961. Values range from 100 to 400 mg cm. ⌐ Such values are found for dress linens; a light canvas gives ca. 4500 mg cm⌋. The material thus has a cloth-like, flexible "handle", and may be utilised as a conventional fabric.

Air Flow Resistance

From measurements of the pressure drop (ΔP) across a number of multi-layer pads of charcoal cloth at a series of air velocities (6 to 60 cm/s) it was calculated that in the equation $\Delta P = KnL$, K varied from 11 10^{-3} to 18 10^{-3} cm water gauge (11 to 18 N/m^2) where n is the number of layers in the pad and L the linear air velocity (cm/s).

Electrical Resistance

For a material having two-dimensional isotropy, the resistance may be expressed as Ohms per square of material (independent of the size of the square). The resistance is a function of production parameters such as temperature and extent of activation: values ranging from 10 to 300 ohms per square have been recorded. By use of the cross-sectional area derived earlier, specific resistances in the range 0.04 to 1.2 ohm/cm^3 are calculated.

Variation of Properties with Activation

Strips of unactivated material were activated in CO_2 for different periods, the weight loss being recorded. Surface density is found to decrease linearly with increasing activation, and thus may be used to assess the extent of activation. Strength, electrical resistance and flexural rigidity were measured with the results shown in Figure 1 where fractional changes (in terms of unactivated material) are plotted against the activation yield. Flexibility is improved by activation; loss of breaking strength through loss of material is unimportant until activation beyond 60% yield is reached. It is noted that loss of electrical conductivity is greater than that calculated merely from loss of conducting carbon from the cross-sectional area.

References

(1) Adsorptive Properties of CDE Charcoal Cloth, Maggs F.A.P., Robins G.A., and Smith M.E. This Conference.

(2) Robins G.A. M.Sc. Thesis, Bath University, U.K. September 1974.

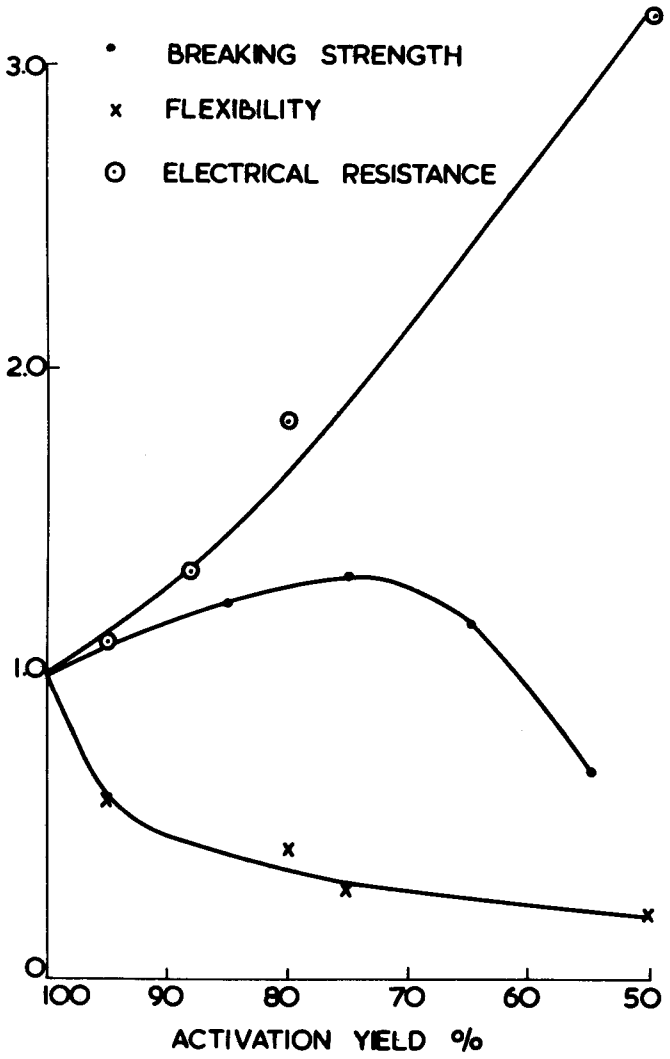

Figure 1. Variation of physical properties with activation