

coal rank. This will form the subject of a further communication. It may be mentioned here, however, that at room temperature the degree of extraction of low-rank coals rapidly approaches a limit (about 10 per cent) as the solvent/coal ratio is increased; if the sol is then removed by filtration and fresh solvent is added, a further substantial amount of extract (about 5 per cent) is obtained. This can be repeated many times before the amount of extract becomes negligible.

It is now well recognized that coal has a colloidal structure<sup>3</sup>. The type of extraction phenomenon outlined in the last paragraph is characteristic of colloidal systems, although the present case appears to have some unusual features. Swelling in solvents is a normal property of colloidal substances, including polymers. In the case of coal, a thermodynamic treatment must take into account the distribution of colloidal material in appreciable concentration between both phases.

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<sup>1</sup> Frémy, E., *C.R. Acad. Sci., Paris*, **52**, 114 (1861). Friswell, A. J., *J. Soc. Chem. Ind.*, **11**, 9 (1892). Bedson, P. P., *J. Soc. Chem. Ind.*, **18**, 738 (1899).

<sup>2</sup> Bone, W. A., and Sarjant, R. J., *Proc. Roy. Soc., A*, **96**, 119 (1920).

<sup>3</sup> "The Ultrafine Structure of Coals and Cokes", B.C.U.R.A., 1944; *Chem. Soc. Ann. Rep.*, 29 (1943).

### Properties of Ethylene Diamine

THE properties of ethylene diamine have been summarized by Wilson<sup>1</sup> and by Putnam and Kobe<sup>2</sup>. In the course of recent work with this substance, additional and in part contradictory information has been obtained.

Samples of commercial anhydrous ethylene diamine were refluxed with metallic potassium until the liquid became permanently dark-coloured; it was then distilled, and redistilled to check the boiling point. At 20° C. the viscosity was found to be 1.52 cp., the density 0.893 gm./c.c. These values are rather lower than previous determinations. The kinematic viscosity is very sensitive to small quantities of water and of carbon dioxide, and its measurement has been found convenient as a rapid test for purity. A striking maximum (~12.7 cp.) occurs in the curve relating dynamic viscosity to water content, at a molecular proportion of approximately 1 diamine : 2 water. The refractive index is not sensibly altered by addition of up to 3 per cent by weight of water. It has also been found that the point of half-neutralization in the potentiometric titration curve can readily be detected, but is not sharp enough to be used for the accurate analysis of ethylene diamine-ammonia mixtures.

The anhydrous diamine is miscible in all proportions not only with water, but also with lower alcohols, ethers and ketones, chloro-methanes and lower benzene homologues. Addition of 2-4 per cent of water by volume has been found to effect sensibly complete separation of ethylene diamine from solution in such liquids as xylene and ether; it is probable that earlier reports of its limited solubility in some of the above solvents have arisen from the use of insufficiently dried diamine.

Diamine is immiscible with paraffins unless a third component, such as alcohol or chloroform, is added.

So far as we are aware, the unpleasant temporary physiological discomforts which can be

caused by ethylene diamine are not well known. The liquid if not washed from the skin causes blistering. One of the authors appears to be allergic to the fumes even in low concentration. The symptoms (acute fits of coughing some hours after exposure) did not in the first instance develop for some weeks.

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<sup>1</sup> Wilson, A. L., *Ind. Eng. Chem.*, **27**, 867 (1935).

<sup>2</sup> Putnam, G. L., and Kobe, K. A., *Trans. Electrochem. Soc.*, **74**, 609 (1938).

### Solubility of Bituminous Coal in Alcoholic Potash

IN the course of some exploratory experiments carried out eighteen months ago when I was a member of the staff of the British Coal Utilisation Research Association, it was observed that appreciable quantities of some bituminous coals were soluble (or dispersible) in alcoholic potash. A Northumberland coal containing 82.6 per cent of carbon and 5.1 per cent of hydrogen (on ash-free basis) was soluble to the extent of 20 per cent. Since its solubility in aqueous potash was quite inappreciable, this coal contained no significant quantity of ulmic material ('humic acids'), such as is formed when coal is oxidized by air exposure. Moreover, the proportion of coal extracted by alcoholic potash at the boiling temperature was unchanged when the experiment was carried out in the complete absence of air.

The extracted material remained dissolved (or dispersed) on diluting the alcoholic solution with water, but—like the so-called 'humic acids' obtained by the slow oxidation of coal—was immediately flocculated to a brown powder on addition of dilute acid. The elementary composition of this material was close to that of the parent coal (both being reduced to the pure coal basis), but it contained a somewhat higher proportion of oxygen (determined 'by difference').

The presence of small quantities of water in the alcohol (or the coal) slowed down the rate of extraction somewhat, but appeared to have but little influence on the proportion of extract finally obtained.

In further experiments the same parent coal was first separated into  $\alpha$ -(pyridine-insoluble),  $\beta$ -(pyridine-soluble, chloroform-insoluble) and  $\gamma$ -(chloroform-soluble) fractions. The  $\gamma$ -fraction was found to be almost completely soluble in hot alcoholic potash, the  $\beta$ -fraction soluble to the extent of c. 50 per cent and a small portion of the  $\alpha$ -fraction was also soluble. The extracts from all three fractions were similar in their behaviour.

A South Wales 'coking' coal (containing 89.7 per cent carbon and 5.0 per cent hydrogen on the ash-free basis) was soluble only to the extent of about 5 per cent in alcoholic potash. The extract showed similar behaviour to that from the Northumberland coal. While these experiments with only two coals afford insufficient data for generalization, a decreasing degree of solubility with increase of rank is for several reasons to be expected.

One possible interpretation of the behaviour described is that the alcoholic potash effects an ester