

reduces substantially or even completely caking properties and the yield of tar. In case of permanganate treatment, the yield of tar is not reduced. The caking property, however, appears to be slightly affected. But the retention of caking property even after considerable degradation of the coal is itself surprising. Further, in contrast to other oxidizing agents, permanganate does not increase at all the solubility of the treated coal in alkali.

No interpretation of these results can be offered at the moment. However, it is of interest to note that the action of permanganate on synthetic polymers of the phenol-formaldehyde type shows similar results (Table 3).

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<sup>1</sup> Howard, H. C., in *Chemistry of Coal Utilization*, edit. by Lowry, H. H., I, 346 (Wiley, New York, 1947).

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### Fluorescence Spectrum of Anisole Vapour

THE fluorescence spectrum of anisole in the vapour state has been developed following the technique of Bass and Sponer<sup>1</sup>. The vapour was contained in a cell fitted with quartz windows and the fluorescence was excited by the radiation from condensed spark between manganese electrodes. The spark was produced by a high-voltage transformer rated 1/4 kW. at 15,000 V. with a condenser of capacity 0.05  $\mu$ F., placed in the circuit parallel to the spark gap. The spectrum of the fluorescent radiation was photographed on Hilger medium quartz spectrograph kept at right angles to the incident unfiltered beam. For a satisfactory record of the spectrum on II-0 plate, with slit width 35 $\mu$ , an exposure of 110 hr. was needed.

The spectrum extends from 2700 Å. to 3100 Å., and consists of about 60 bands degraded towards the red. A strong continuum covering the whole region mars the sharpness of the bands which have been measured on a Hilger comparator using low-power objective. The mean of three measurements are taken and the values of the bands are accurate to about 5 cm.<sup>-1</sup>.

The anisole molecule belongs to symmetry class  $C_{2v}$ , and the spectrum under discussion represents the electronic transition  ${}^1B_1 \rightarrow {}^1A_1$ , which is allowed with transition moment lying in the molecular plane and perpendicular to C—OCH<sub>3</sub> bond. We expect the 0,0 band and totally symmetric vibrations,  $a_1$ , to be strong and the latter forming a progression. The vibrations of symmetries  $b_1$  and  $a_2$  will give rise to weak bands. Transitions involving vibrational frequencies of symmetry  $b_2$  are forbidden, except ( $2v, 0$ ) and ( $v, v$ ) transitions.

The strong band at 36,386 cm.<sup>-1</sup>, which has appeared due to self-absorption, is taken as the 0,0 band. This is in good agreement with the value 36,389 cm.<sup>-1</sup> measured in ultra-violet absorption<sup>2</sup>. The vibrations which are excited in the ground state have the frequencies 265, 450, 522, 611, 788, 1,000, 1,029, 1,178, 1,250 and 1,310 cm.<sup>-1</sup>, which agree well with Raman data<sup>3</sup>. The 522 and 611 cm.<sup>-1</sup> frequencies arise from the 606 cm.<sup>-1</sup>  $e^+g$  carbon vibration in benzene, when the symmetry is reduced from  $D_{6h}$  to

$C_{2v}$ . The 522 cm.<sup>-1</sup> vibration belongs to symmetry  $a_1$ , while the vibration 611 cm.<sup>-1</sup> has the symmetry  $b_1$ . The frequencies 1,000 and 1,029 cm.<sup>-1</sup> are totally symmetric vibrations; of these, 1,000 cm.<sup>-1</sup> frequency is the strongest, which corresponds to the 992 cm.<sup>-1</sup> 'breathing vibration' of benzene. The vibrational frequency 788 cm.<sup>-1</sup> is probably due to C—OCH<sub>3</sub> stretching. The frequency 1,178 cm.<sup>-1</sup> appears to be a non-totally symmetric vibration involving the motion of hydrogen atoms predominantly. Bands due to combinations of the above frequencies have been observed. In addition the difference frequencies 30, 56 and 120 cm.<sup>-1</sup> resulting from  $v-v$  transition have also been recorded.

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<sup>1</sup> Bass, Arnold M., and Sponer, H., *Opt. Soc. Amer.*, 40, 389 (1950).

<sup>2</sup> Sreeramamurthy, K., *Indian J. Phys.*, 24, 421 (1950).

<sup>3</sup> Kohlrausch, K. W. F., and Pongratz, A., *Monat. Chem.*, 65, 6 (1934).

### Non-ideality of Cyclohexane-Benzene Mixtures

THE second virial coefficients of benzene-cyclohexane vapour mixtures have been measured using an apparatus of the differential type previously described<sup>1</sup> and the results used to calculate the interaction coefficient  $B_{12}$  from the expression:

$$B = x_1^2 B_{11} + 2x_1 x_2 B_{12} + x_2^2 B_{22}$$

where  $B_{11}$ ,  $B_{22}$  and  $x_1$ ,  $x_2$  are the virial coefficients and the mole fractions of the pure components cyclohexane and benzene respectively.

Measurements were made at 35° C., 50° C. and 70° C. on several mixtures and pure cyclohexane. Instead of the customary nitrogen, benzene was used as the reference gas with  $B$  values found from the previous work. The slight differences between the compressibility of one component, benzene, and the mixture were thereby measured more directly. Furthermore, with such similar vapours present simultaneously on both sides of the apparatus, adsorption effects were minimized. Since the apparatus was capable of measuring a pressure-volume product to 1 in 100,000, the composition of the mixtures was determined with more than sufficient accuracy by noting the pressure-volume product before and after adding the second component.

Table 1 summarizes the results.

Table 1  
 $B$  values, cm.<sup>3</sup>/mole [ $PV = RT(1 + B/V)$ ]

	35° C.	50° C.	70° C.
(Benzene) (ref. 1)	-1,388	-1,186	-1,028
$B_{12}$	-1,346	-1,215	-1,041
Cyclohexane	-1,457	-1,309	-1,121

These results, which we regard as accurate within 10 cm.<sup>3</sup>/mole at least at the two higher temperatures, definitely show that the  $B_{12}$  values are some 30 cm.<sup>3</sup>/mole less negative than the arithmetical mean of the values for the two components, but not as small as the value for benzene, the least compressible component. Waelbroeck's<sup>2</sup>  $B_{12}$  values lie midway