lengths of the *c* axes and the volumes per molybdenum atom of the three phases indicates that the carbon content can scarcely be less than that corresponding to the formula MoC. The fact that the transformation $\gamma' \rightarrow \gamma$ takes place without any other changes in the powder photographs suggests the formula MoC.

A metal lattice similar to that of the γ' -phase has been found by Kiessling¹ for the tungsten boride, W₂B₅. In this case the parameter *z* is slightly different from $\frac{1}{3}$, namely, 0.139.

A detailed report will be published elsewhere.

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¹Kiessling, R., *Acta Chem. Scand.*, **1**, 893 (1947).

Preparation and Magnetic Susceptibility of an Oxygen Clathrate Compound

DURING attempts to prepare samples of β -quinol by the method of Powell and Riesz¹, we observed that the crystals obtained, which gave X-ray powder photographs characteristic of β -quinol, effervesced when dissolved in water. When 1 gm. of a sample of this substance which had been dried *in vacuo* was dissolved in water, 7.9 c.c. (at N.T.P.) of a gas were evolved. This gas contained 28 per cent oxygen, and the rest appeared to be nitrogen. It therefore seems probable that this is an 'air' clathrate² compound of β -quinol in which about 12 per cent of the available spaces are filled.

This suggested that an oxygen clathrate compound might be prepared if oxidation of the quinol could be prevented. A warm saturated solution of quinol in air-free alcohol was placed in a monel metal bomb and allowed to cool slowly over a period of about 24 hr., under a pressure of 25–40 atmospheres of oxygen. Faintly yellow crystals were obtained which, when dissolved in water, evolved a gas. The volume of gas obtained corresponded in different samples to clathrate compounds in which 40–50 per cent of the available spaces had been filled. The densities of the samples were consistent with this interpretation. In one case, the gas was analysed and found to contain 97.6 per cent of oxygen.

The magnetic susceptibility of a finely powdered sample was measured, and it was found to be paramagnetic ($\chi = +3.31 \times 10^{-6}$ at 17° C.). Analysis of the same sample gave 39.0 per cent of the available spaces filled. Assuming the specific susceptibility³ of quinol to be -0.604×10^{-6} , this leads to a value of $\chi = +109.5 \times 10^{-6}$ at 17° C. for the oxygen molecules trapped in the spaces. The experimental values for χ for gaseous oxygen range from 104.5 to 110.0×10^{-6} at 17° C., the theoretical value⁴ being 107.7×10^{-6} . This shows that there is very little magnetic interaction between the oxygen molecules in the crystals. The magnetic behaviour of the oxygen molecules at low temperatures might well prove interesting, since they will not have the opportunity of forming loose complexes O₄ as occurs in liquid and solid oxygen. Since the concentration of oxygen molecules in these samples corresponds to gaseous oxygen at a pressure of about 40 atmospheres, the magnetic properties are easy to observe.

A method of preparing pure β -quinol containing no enclosed gases has now been devised in which

a warm strong solution of quinol in air-free alcohol is seeded with a crystal of argon clathrate compound and allowed to cool in a refrigerator. Unless it is kept in a very dry atmosphere, pure β -quinol tends to revert to α -quinol.

A more detailed account of these and other measurements on clathrate compounds will appear elsewhere.

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¹Powell, H. M., and Riesz, P., *Nature*, **161**, 52 (1948), and private communication from Mr. Powell.

²Palin, D. E., and Powell, H. M., *J. Chem. Soc.*, 815 (1948).

³French, C. M., *Trans. Farad. Soc.*, **41**, 676 (1945).

⁴Selwood, P. W., "Magnetochemistry", 117 (Interscience).

Stabilization of Free Radicals: its Importance in Reaction Kinetics

A PREVIOUS paper¹ reported on a reaction of the radical chlorine oxide:

enabling the transfer of chlorine oxide by means of addition of oxygen into the more stable chlorine trioxide and eventually, at a low temperature, into the stable chlorine hexoxide (Cl₂O₆). Similarly, the discussion² of the mechanism of the decomposition of ozone sensitized or catalysed by chlorine points to the fact that chlorine dioxide can also be considered as a chlorine atom stabilized by an oxygen molecule. The process $\text{Cl} + \text{O}_2 = \text{ClO}_2$ is exothermic to an extent of 1.5 kcal., and runs down practically without activation energy³. On examining the other cases in which the oxygen atom or molecule behaves in a similar manner, the cases of HO₂, NO and NO₂ radicals are striking. HO₂ and NO₂ are hydrogen and nitrogen atoms stabilized by an oxygen molecule, whereas NO is a stabilized complex from N· and O· and can also be transformed by addition of O₂ into NO₂.

In the mechanisms of organic pyrolyses and oxidation reactions, R· and R·C· radicals are also frequently encountered, forming in the presence of oxygen RO₂· or RCO₂·, or, in other cases, only with atomic oxygen RO· or RCO· respectively. In the reaction schemes they are considered to be rate-determining, fairly stable, intermediate products⁴. In their halogenated forms, these radicals behave in a similar fashion. They are characterized by all having unpaired electrons and being paramagnetic. On the other hand, radicals having even numbers of electrons do not exhibit analogous behaviour in any instance. Taking numerous other examples into account, the following rule can be established.

The paramagnetic radicals containing unpaired electrons combine with the similarly paramagnetic oxygen atoms as well as with oxygen molecules, or more generally with other paramagnetic molecules, such as nitric oxide, into more or less strongly bonded