

THE MAGNETIC PROPERTIES OF NITROSYL PENTAMMINE COBALT CHLORIDE*

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Widely divergent values have been reported by different workers for the magnetic moment of cobalt in nitrosyl pentammine cobalt chloride. The values range from 1.5 Bohr magnetons (B.M.) (Ghosh and Ray 1943) to 2.8 B.M. (Ray and Bhar 1928); values lying between these extremes have been reported by Milward, Wardlaw, and Way (1938), and Mellor and Craig (1944). The variations appear to be associated with the manner in which the compound is prepared. Specimens of the complex prepared in this laboratory without paying special attention to the exclusion of air appeared to have a moment of 2.0 B.M. If, however, air is rigorously excluded during the preparation as described by Moeller and King (1953), specimens may be obtained with a molar susceptibility

TABLE 1
MAGNETIC MEASUREMENTS

Temp. (°K)	$10^6\chi_g$ (g)	$\mu=2.839$ $\times \sqrt{(\chi_M T)}$	Temp. (°K)	$10^6\chi_g$ (g)	$\mu=2.839$ $\times \sqrt{(\chi_M T)}$
95.5	7.82	1.26	202.3	4.30	1.39
106.1	7.32	1.28	249.8	3.63	1.43
120.1	6.63	1.30	295.5	3.12	1.46
149.5	5.70	1.36			

as low as $+765 \times 10^{-6}$ c.g.s. units at 23.2 °C. The moment calculated by allowing a correction of -132×10^{-6} for diamagnetism is 1.46 B.M.‡ The specimen for which this value was observed appeared under the microscope to be crystalline and homogeneous and was presumed to be pure.§ Its susceptibility increased on standing in moist air. Further measurements on the pure substance showed that its susceptibility was independent of field strength and that down to 95 °K it followed the Curie-Weiss law. The data are summarized in Table 1. Since the compound obeys the Curie-Weiss law it may be inferred that the abnormally low moment does not arise, as it does in cupric acetate, for example, from the

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‡ A similar low value has been reported by Mr. A. A. Taggart (Auckland University College, N.Z.), who has investigated a wide variety of salts of this type. He obtained a value $\mu=1.39$ B.M. (susceptibility 808×10^{-6} , $T=24.8$ °C) for the black chloride. This value is calculated from the formula $\mu=2.839\sqrt{(\chi_M T)}$ with a diamagnetic correction of 132×10^{-6} .

§ The identity of the compound was checked by means of an analysis for cobalt (Found: Co, 24.1%. Calc. for $[\text{Co}(\text{NH}_3)_5\text{NO}] \text{Cl}_2$: Co, 24.1%).

interaction of two metal atoms. The absorption of the compound is most marked; under the microscope even thin crystals appear almost black. This suggests that the cobalt atoms may exist in two oxidation states (Co(II) and Co(III)). The moment calculated on the assumption that the compound is a dimer ($\mu=2.06$ B.M.) is consistent with this view of its constitution though it is difficult to see how an inner orbital d^2sp^3 bonded Co(II) complex could be formed with the ligands available (NH_3 and NO). It would seem that nothing short of a complete crystal structure analysis will clear up the constitution of this puzzling compound.

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