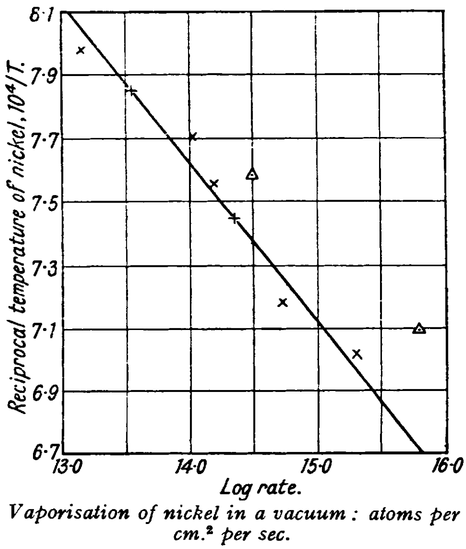
331. *The Evaporation of Nickel in a Vacuum.*

By GEORGE BRYCE.

THE rate of evaporation of nickel in a vacuum has been measured (Jones, Langmuir, and Mackay, *Physical Rev.*, 1927, **30**, 201) by determining the loss in weight undergone by filaments heated to temperatures in the range 1318—1602° Abs. It is more accurate to analyse the metal evaporated. On account of its great sensitivity, this method has the advantages of avoiding the difficulty of keeping the temperature constant whilst the filament becomes much thinner, and also of being useful for determining the quantities of metal evaporated during short experiments in the presence of gases.



Vaporisation of nickel in a vacuum: atoms per cm.² per sec.

The present results were obtained with the apparatus described in the preceding paper. The filament was glowed for a suitable time, the resistance being kept constant in a vacuum of 10^{-5} mm. Hg or less. During an experiment 2—3 × 10^{-5} g. of nickel was evaporated, and the condensate was invisible. With constant resistance, the temperature and rate of evaporation of the filament fell steadily, but calculation and experiment showed that removal of this amount of nickel changed the resistance at constant temperature by 0·2—0·3%, and hence reduced the rate of evaporation at constant resistance only by 20—30%. The greatest errors arose in the absolute determination of the temperature.

The nickel deposited on the bulb was dissolved with 10 c.c. of hot dilute nitric acid, and the solution evaporated almost to dryness (repetition of the process showed that all the nickel had been removed); the solution was neutralised with ammonia, and the nickel then estimated colorimetrically by Jones's method (*Analyst*, 1929, **54**, 582), which is so sensitive that 1×10^{-5} g. of nickel in 100 c.c. of solution could be estimated with an accuracy of 10%. All reagents used were shown to be free from nickel.

The results are plotted in the figure. The slope of the line gives an energy of about 85 kg.-cals. for the vaporisation of nickel atoms. The two values in this range due to Jones, Langmuir, and Mackay (*loc. cit.*) are indicated by triangles. A plot of all their five points gives a mean latent heat in agreement with the above.

If c is the condensation coefficient of nickel atoms on a nickel surface at temperature $T°$ Abs., and p is the vapour pressure of nickel (in mm. Hg), the following expression for p can be deduced from the above results: $\log_{10}(cp) = 9{\cdot}148 - 2{\cdot}00 \times 10^4/T$. Since c cannot be greater than unity, the expression on the right-hand side of this equation gives a *lower limit* to the value of p at temperature T.

A uniform unilayer of nickel on a smooth surface would correspond to about 10^{15} atoms per sq. cm., and hence on the geometrical surface opposite the filament to about 2×10^{-5} g. The consistent results obtained whether one-third layer or two layers of nickel were evaporated on to the bulb suggested that the atoms stuck on first striking the glass, and the sharp shadows of the leads produced when more metal was evaporated supported this view. Moreoyer, the same rates of evaporation were found whether the bulb was at 15° or at − 190°. On glass, 18 layers of nickel could readily be seen, the minimum quantity visible being about 10 layers, but this does not necessarily give information concerning the absorption of light by 10 uniform layers, since the metal may have formed aggregates on condensing. The thicker deposits were tenacious, showed dull black by transmitted light, but had a metallic lustre in reflected light.

Department of Colloid Science, Cambridge. [*Received, August 27th*, 1936.]