NOTES

The Formal Identity of Langmuir's Adsorption Equation with the Law of Mass Action.—In his work on the adsorption of gases on the surfaces of solids, Langmuir[1] deduced, on the basis of his theory, a number of equations relating the amount of gas adsorbed to the pressure at equilibrium. The simplest of these equations is

$$q = abp/(1 + ap) \qquad (1)$$

where q is the amount adsorbed, p the pressure at equilibrium and a and b are constants. In connection with certain experiments[2] that were found to be fitted by such an equation, the writer noticed that an equation of exactly similar form could be derived from the law of mass action. Consider a reversible reaction between two substances A and B to form a compound AB. From the mass law,

$$\frac{(A)\,(B)}{(AB)} = k;\ \frac{(A)}{(AB)} = \frac{k}{(B)};\ \frac{(A) + (AB)}{(AB)} = \frac{k + (B)}{(B)};\ (AB) = \frac{\dfrac{(A) + (AB)}{k}\,(B)}{1 + \dfrac{(B)}{k}}. \qquad (2)$$

For an experiment in which the total A (that is, the sum of the concentrations of A and AB) is kept constant, Equation 2 is of the same form as Equation 1. The variables AB and B correspond to q and p, while the constant $1/k$ corresponds to a and the constant A + AB to b. Hence it must be concluded that the agreement of experimental data with an equation of this type is not decisive in determining whether the reaction in question is one of adsorption or chemical combination.

This fact seems to have been overlooked by H. Rinde,[3] who found that certain data of Jacques Loeb[4] on the equilibrium between gelatin solutions and hydrochloric acid could be fitted by such an equation. Rinde concluded that "it is therefore very likely that the 'reaction' between gelatin and HCl is not a chemical reaction in the sense assumed by Loeb, but an adsorption process.." Obviously Rinde's calculation adds nothing to the decision of this question. Other data bearing on the case of gelatin and hydrochloric acid have been presented by Jacques Loeb[5] and by the writer.[6]

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[1] Langmuir, THIS JOURNAL, **40**, 1384 (1918).
[2] Hitchcock, *J. Gen. Physiol.*, **8**, 61 (1925–1926).
[3] Rinde, *Phil. Mag.*, [7] **1**, 46 (1926).
[4] Loeb, "Proteins and the Theory of Colloidal Behavior," McGraw-Hill Book Co., New York and London, 2nd ed., **1924**, p. 183.
[5] Ref. 4, Chapters 2 and 4.
[6] Hitchcock, *J. Gen. Physiol.*, **6**, 95, 201 (1922–23).