



INTRODUCTION TO THE ENGLISH TRANSLATION OF “THE THEORY OF DISSOCIATION” A Forgotten Classic of Chemical Thermodynamics

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It was originally intended that the *Bulletin for the History of Chemistry* should function as a vehicle not only for the publication of scholarly papers dealing with the history of chemistry and alchemy, but also for the publication of translations of key historical documents—a function which has so far been exercised in only a few cases (1, 2). Though the problem of the gradual disappearance of history of chemistry courses and its potential impact on history of chemistry as an academic discipline has been commented on several times in the past (3, 4), the increasing inability of modern-day American chemistry majors to access directly primary documents in the history of chemistry, due either to a lack of modern language skills or the absence of suitable English translations, has so far escaped notice. For most of the 20th century, doctoral programs in chemistry required at least a minimal reading proficiency in either German, French, or Russian. However, beginning in the early 1990s, this requirement was dropped from most of these programs and, as far as most current chemistry majors are concerned, the vast majority of 18th-, 19th-, and early 20th-century European chemical literature might as well be written in ancient Greek or Latin when it comes to their ability to read it in the original.

Ironically, there was a conscious effort to provide suitable English translations of many classic chemical papers during the period when most American chemists still had some reading knowledge of either French or German, though at present, when the need is far more pressing, the majority of publishers are no longer interested in such projects. Thus, beginning in the late 19th century, both Harper Brothers of New York and the British-based Alembic Club, under the leadership of Leonard Dobbin, issued English translations and/or reprints of classic scientific papers of chemical interest (5, 6), and a similar program was initiated by Dover Books in the 1960s (7). In addition, several collections containing translations of selected passages from key papers were also published—most notably the volumes by Leicester (8, 9), Farber (10), and Crosland (11) —as well as several collections of key papers in such specialized fields as colloid chemistry (12) and chemical kinetics (13).

Nevertheless there are still many notable exceptions. Thus it is only recently that an English-language collection of Mendeleev’s key papers on the periodic law has been published - nearly 136 years after its ini-

tial proposal (14). The classic 1904 and 1916 papers by Abegg (15) and Kossel (16) on the electronic theory of chemical bonding still await translation, as does the famous 1867 paper by Pfaundler on the application of the kinetic theory to chemical reactions (17) and, until now, the foundational 1873 paper by Horstmann on the first application of the second law of thermodynamics to the theory of chemical equilibrium (18).

These latter two examples also illustrate a curious asymmetry in the translation record. More than four decades ago Stephen G. Brush published a three-volume collection of many of the basic papers dealing with the origins of the kinetic theory of gases (19); and several collections of classic papers relating to the establishment of both the first (20) and second laws (21-23) of thermodynamics have also been published, some of which date back to the 19th century. What is missing, however, in all of these collections are translations of the key papers in which these fundamental models and principles were first explicitly applied to chemical processes.

The foundational status of Horstmann's publication of 1873 for the discipline of chemical thermodynamics is justified in the paper which appears in this issue and which also serves as a commentary on the following translation (24). Consequently, all that is required here are a few comments on the basic mechanics of the translation process itself. In 1987 I commissioned Heike Ulmer, who was at that time a German exchange student in the Chemistry Department at the University of Cincinnati, to produce a preliminary translation of Horstmann's paper. This I have since extensively revised. In so doing, I have exercised my preference for a free, rather than a literal, translation in order to avoid what are, from the standpoint of the English reader, awkward sentence structures and word choices. In keeping with this, I have sometimes inverted the order of the various sentence clauses and have modernized some of the chemical nomenclature when I felt this did not introduce a serious historical anachronism. Perhaps more controversial is my decision to substitute the term "mole" for Horstmann's more awkward phrase *eines Molekulargewichtes* of substance. Though he actually used the abbreviation "Mol" in several places for this concept, this is not quite the linguistic equivalent of the Latin term *mole*, which was first introduced into chemistry by Ostwald sometime around 1900 (25). Likewise, I have taken the liberty of occasionally rendering the term *Zufälligkeiten* or "random accidents," which Horstmann uses when discussing Pfaundler's kinetic approach, as "fluctuations," as this term is more congenial to the modern reader and is certainly in keeping

with Horstmann's intended meaning. The reduction of Horstmann's original equations to a single-line format has also required the introduction of various parentheses and brackets in order to maintain mathematical consistency. Likewise, in keeping with the style of the *Bulletin*, Horstmann's original references have been removed from the bottom of the various pages and have instead been collected together at the end of the translation.

In reprinting Horstmann's paper in 1903 for Ostwald's series, *Klassiker der exakten Wissenschaften*, van't Hoff noted a number of corrections which have been incorporated without comment in the present translation (26). Otherwise any additional editorial clarifications within the body of the translation have been enclosed in square brackets. Interestingly, a more serious problem, which passed unnoticed by van 't Hoff, was Horstmann's inconsistent use of the symbol x . In his first four equations he correctly uses it to represent the number of moles of reactant that have decomposed and thus to represent the degree of reaction or dissociation. However, he then immediately turns around and redefines it in his fifth equation as the moles of reactant which have not yet decomposed, thus negating his third equation for total entropy production as a function of x . Luckily, this inconsistency does not seriously mar the remainder of his paper and the modern reader is able to make the necessary adjustments.

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2. W. B. Jensen, "Erasmus on Alchemy," *Bull. Hist. Chem.*, **2006**, 31, 58-65.
3. W. B. Jensen, "History of Chemistry and the Chemical Community: Bridging the Gap?" in S. H. Mauskopf, Ed., *Chemical Sciences and the Modern World*, University of Pennsylvania Press: Philadelphia, PA, 1993, 262-276.
4. W. B. Jensen, "Textbooks and the Future of History of Chemistry as an Academic Discipline," *Bull. Hist. Chem.*, **2006**, 31, 1-8.
5. The hardcover series *Harper's Scientific Memoirs* was edited by J. S. Ames and published by Harper & Brothers of New York City. Most of the volumes dealt with collections of classic papers related to the history of physics. Those few of interest to chemistry included: (a) H. C. Jones, Ed., *The Modern Theory of Solutions*, 1899; (b) C. Barus, Ed., *The Laws of Gases*, 1899; and (c) G. M. Richardson, Ed., *The Foundations of Stereochemistry*, 1901.

6. A set of 22 volumes of *Alembic Club Reprints* was published by E. and S. Livingstone of Edinburgh between 1898 and 1958, largely in the form of small, paper-bound booklets, each containing selected reprints and/or translations of either complete papers or excerpts relating to specific areas of chemistry. They were reissued once again in the 1960s.
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