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Walther Hermann Nernst

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There have only been two electrochemists honoured as Nobel Laureates and Walther Hermann Nernst was the first in 1920 when he was awarded the prize for chemistry. Nernst was a Prussian physical chemist who devoted his life to electrochemical thermodynamics. In practical terms his work in electrochemistry was undoubtedly the most important but the prize was actually awarded for the third law of thermodynamics. His professional rivalries with Haber and particularly Ostwald were bitter and he tended to be dismissive of ‘lesser mortals’, ie. most others.

Nernst was born in Breslau, West Prussia (now part of Poland) on 25th June 1864. Initially he studied physics and mathematics at the Universities of Zurich, Berlin and Graz but then took a research post at the University of Leipzig with Wilhelm Ostwald, the leading physical chemist, having taken his Ph.D at Wurzburg under Friedrich Kohlrausch in 1887. After only 3 years at Leipzig he left in 1890 and founded the Institute of Physical Chemistry and Electrochemistry at Gottingen, heading it as a young full Professor. In 1904 he moved to Berlin where he stayed until his retirement in 1933. His retirement was occupied by his hobby of music and acoustics and in the 1930s he invented an electric piano for a Bechstein-Siemens consortium. He died in Gottingen on 18th November 1941.

Nernst’s contribution to physical chemistry was substantial but can be summarised in three equations and five fields spread over a period of 40 years. This disregards the dispute with fellow electrochemists in Germany during the 1890s and 1900s regarding the adoption of a definition of the zero of potential. Briefly, the argument was between using a practical scale based on the Calomel Electrode which had become established as the laboratory standard; this was supported by Ostwald. Nernst, however, contended that this was merely a present-day convenience and something more basic was required and therefore proposed that the standard hydrogen electrode be adopted. (Curiously the use of the most noble metal – gold or platinum – was never promoted). After many conference discussions (i.e. vituperative arguments) Nernst’s case was accepted both nationally and internationally and holds to this present day.

1. In the 1880s Nernst concerned himself with the thermodynamics of chemical equilibria and developed an electrochemical form of the Van’t Hoff equation. The application was to battery theory but also to differential cells in corrosion and electrorefining processes. The equation is referred to as the Van’t Hoff – Nernst equation.

\[ E = E^\circ + \frac{RT}{nF} \ln \left( \frac{C_2}{C_1} \right) \]

2. In the 1890s Nernst studied the properties of vapours at high temperatures and in 1897 he proposed the Nernst lamp now known as the incandescent lamp.

3. In 1904 his study of galvanic cells led to an understanding of concentration polarisation through the Nernst limiting current equation which showed how ion diffusion was the limiting process for electrode reactions.

\[ I_L = \frac{nFDCm}{\delta} \]

4. During the early 1900s (1900–1920) Nernst also concerned himself with the properties of solids at low temperatures and this led to the third law of thermodynamics which showed that at zero temperature the entropy tended to zero with the entropy at any given temperature expressed as an integral. It was this that gained him the Nobel prize.

\[ Cp \to 0 \text{ and } S \to 0 \text{ at } T = 0 \text{K} \]

\[ S_f = \int T \frac{Cp}{T} d\ln T \]

5. During the 1920s Nernst studied new methods of accelerating reactions using photolysis as the source of accelerating energy. This led to an improved understanding of the mechanism of photolysis.

For one man to make such contributions to physical chemistry is rare and puts Nernst almost on a par with Einstein. Not surprisingly Nernst was widely honoured and is almost unique in being honoured by having a postage stamp issued in his memory. It was one of a series from 1950 in the DDR featuring distinguished figures of the German Academy of Sciences, his peers in the series included A&W von Humboldt, Mommsen, von Helmholz, Planck, Grimm, Leibnitz and von Harnack.

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