ISSN:2249-5347
IJSID
International Journal of Science Innovations and Discoveries
An International peer Review Journal for Science

Nobel Prize in Chemistry 1909

Wilhelm Ostwald

The Nobel Prize in Chemistry 1909 was awarded to Wilhelm Ostwald *"in recognition of his work on catalysis and for his investigations into the fundamental principles governing chemical equilibria and rates of reaction"*.

RESEARCH INFORMATION:

The Royal Academy of Sciences has resolved to award the former professor at Leipzig University and Geheimrat, Wilhelm Ostwald, the Nobel Prize for Chemistry 1909 in recognition of his work on catalysis and associated fundamental studies on chemical equilibria and rates of reaction.

As early as the first half of last century it had in certain cases been observed that chemical reactions could be induced by substances which did not appear to participate in the reaction themselves and which at all events were not altered in any way. This led Berzelius in his famous annual reports on the progress of chemistry for 1835 to make one of his not infrequent brilliant conclusions whereby scattered observations were collated in accordance with a common criterion and new concepts were introduced in science. He termed the phenomenon *catalysis*. However, the catalysis concept soon came up against

opposition from another eminent quarter as allegedly unfruitful and gradually fell utterly into discredit.

Some 50 years later Wilhelm Ostwald carried out a number of studies to determine the relative strength of acids and bases. He sought to solve this extraordinarily important matter for chemistry in a variety of ways which all yielded consistent results. Amongst other things he found that the rate at which different processes take place under the action of acids and bases can be used to determine the relative strengths of the latter. He performed extensive measurements along these lines, and in so doing laid the foundations for the entire procedure for studying rates of reaction, all the more essential typical cases of which he examined. From that time onwards the theory of the rate of reaction has become increasingly important for theoretical chemistry; these tests, however, were also able to throw new light on the nature of catalytic processes.

After Arrhenius had formulated his well-known theory that acids and bases in aqueous solution are separated into ions and that their strength depends on their electrical conductivity, or more accurately, on their degree of dissociation, Ostwald tested the correctness of this view by measuring the conductivity and hence the concentration of the hydrogen and hydroxyl ions with the acids and bases which he had used in his previous experiments. He found Arrhenius' theory corroborated in all of the many cases which he himself investigated. His explanation why he consistently found the same values for the relative strength of the acids and bases whichever method he used was that in all these cases the hydrogen ions of the acids and the hydroxyl ions of the bases acted catalytically and that the relative strength of the acids and bases was determined solely by their ion concentration.

Ostwald was hence led to undertake a more thorough study of catalytic phenomena and he extended its scope to other catalysts, as they were called, as well. After consistent, continuous research he successfully formulated a principle to describe the nature of catalysis which is satisfactory for the present state of knowledge, namely that *catalytic action consists in the modification, by the acting substance, the catalyst, of the rate at which a*

chemical reaction occurs, without that substance itself being part of the end-products formed. The modification can be an increase, but also a decrease of the reaction rate. A reaction which otherwise proceeds at a slow rate, taking perhaps years before equilibrium is attained, can be accelerated by catalysts to such an extent that it is complete in a comparatively short time, in certain cases within one or a few minutes, or even in fractions of a minute, and conversely.

The rate of a reaction is a measurable parameter and hence all parameters affecting it are measurable as well. Catalysis, which formerly appeared to be a hidden secret, has thus become what is known as a kinetic problem and accessible to exact scientific study.

Ostwald's discovery has been profusely exploited. Besides Ostwald himself a large number of eminent workers have recently taken up his field of study and the work is advancing with increasing enthusiasm. The results have been truly admirable.

The significance of this new idea is best revealed by the immensely important role - first pointed out by Ostwald - of catalytic processes in all sectors of chemistry. Catalytic processes are a commonplace occurrence, especially in organic synthesis. Key sections of industry such as e.g. sulphuric acid manufacture, the basis of practically the whole chemical industry, and the manufacture of indigo which has flourished so during the last ten years, are based on the action of catalysts. A factor of perhaps even greater weight, however, is the growing realization that the *enzymes*, so-called, which are extremely important for the chemical processes within living organisms, act as catalysts and hence the theory of plant and animal metabolism falls essentially in the field of catalyst chemistry. As an illustration, the chemical processes involved in digestion are catalytic and can be simulated step by step using purely inorganic catalysts. Furthermore the ability of various organs to transform nutrients from the blood in such a way that they are suitable for the specific tasks of each organ can indubitably be explained by the occurrence of various kinds of enzymes within the organ capable of catalytic actions adapted to their particular purpose. That apart, it is strange that such substances as hydrocyanic acid, mercuric chloride, hydrogen sulphide and others which act as extremely potent poisons on the organism have also been observed

to neutralize or "poison"even pure inorganic catalysts such as e.g. finely dispersed platinum. Even from these brief references it should be clear that a new approach to the difficult problems of physiological processes has been possible with the aid of Ostwald's theory of catalysis. Because they are related to the actions of enzymes in the living organism, the new field of research is of an importance for mankind that cannot as yet be fully gauged.

Although the Nobel Prize for Chemistry is now being awarded to Professor Ostwald in recognition of his work on catalysis, he is a man to whom the chemical world is indebted also in other ways. By the spoken and the written word he, perhaps more than any other, has carried modern theories to a rapid victory and for several decennia he played a leading part in the field of general chemistry. In other ways too he has furthered chemistry by his versatile activity with numerous discoveries and refinements in both the experimental and the theoretical spheres.

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