for not to exceed 20 cents per bushel in order that alcohol might replace this gasoline. The average farm value for potatoes from 1907 to 1915 inclusive was 61.4 cents per bu. It is hard to see how the farmer could be stimulated to produce more potatoes if a lower price were offered as must be if potatoes are to figure as alcohol producers. The popular mind has become so obsessed with the idea of cheap alcohol from potatoes that it is forgotten that the German idea of cheap alcohol is alcohol at about 40 cents per gallon 180 proof.

CONCLUSIONS

Water, fuel and cost of raw material represent about all the factors susceptible of approximate calculation. In addition labor, insurance and depreciation must be taken into account. If starchy substances are used, malt or acids must be used for conversion which is an additional cost. It cannot be too strongly impressed on the prospective manufacturer that sporadic sources of material such as fruit, cornstalks, canning wastes, must always be used under the disadvantage of long periods of idleness resulting in increased depreciation, and disorganization of the working force.

It must not be understood that the writer intends to depreciate the possibility of producing alcohol at a cost to enable it to be used as a motor fuel. Quite the contrary. But it has seemed to him that unless more care is used in experiments on the production of alcohol that capital will abandon the field as unpromising. The newspapers are full of stories about the possibilities of production of cheap alcohol and even our own JOURNAL has not been entirely free from them. As a matter of fact, the production of cheap alcohol presents as many difficulties as the manufacture of cheap gasoline. The alcohol industry is one that requires experience as much as any other chemical industry and in spite of opinions to the contrary, uses at present about as scientific methods as any.

AUTHOR'S NOTE (Received May 16, 1917): Owing to recent increases in grain costs, it is probable that grain alcohol costs will be over fifty cents per proof gallon for the year 1917.

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WILLARD GIBBS MEDAL AWARD

The Willard Gibbs Medal for the year 1917 was conferred upon Dr. Edward Williams Morley, former Professor Emeritus in Chemistry, Western Reserve University, Cleveland, Ohio, at the meeting of the Chicago Section of the American Chemical Society, held May 18, 1917, in the Louis XVI Room of the Hotel Sherman. One hundred and forty-six members and friends of the Chicago Section were present.

Mr. A. V. H. Mory, Chairman of the Chicago Section, opened the meeting and introduced Dr. W. A. Noyes, Professor of Chemistry, University of Illinois, and Editor of the *Journal of the American Chemical Society*, who made the presentation address. The medal address, entitled "Early Researches in Hydrogen and Oxygen," will appear in full in the *Journal of the American Chemical Society*, and we are printing below an abstract prepared by Dr. Morley at our request.

Dr. Morley spoke in his usual happy vein. He showed the distinguishing quality of his mind—that keen sense of proportion that made possible his great work, by fully appreciating the sort of treatment of his subject that would be most acceptable to a mixed audience, including many who had no knowledge of chemistry. There was a personal touch to Dr. Morley's talk that was much enjoyed and he skilfully employed an occasional narrative to drive the points home.

Letters of regret were received from a number of invited guests, including the presidents of the Middle West universities, and a number of the prominent chemists of the country, among them Secretary Charles L. Parsons.

At the speakers' table, besides the chairman, Professor Morley, and Professor Noyes, were President Stieglitz; Harry Pratt Judson, President of the University of Chicago; F. I. Moulton, President of the City Club of Chicago; John H. Long, Professor in Chemistry at the Northwestern University Medical College; William H. Burton, Vice-President of the Standard Oil Company of Indiana; and Edward Bartow, Director of the Illinois Water Survey, each of whom spoke briefly and entertainingly. President Stieglitz was able to give some interesting information concerning the work of our society in these stirring times.

The occasion was a memorable one and established even more completely, if it were possible, the high character of the Willard Gibbs Award.

Edward Williams Morley was born in Newark, N. J., in 1838. He received the degrees of A.B. (1860) and A.M. (1863) from Williams College, and an honorary Ph.D. from University of Wooster (1878). He has also received the honorary LL.D. degree from Adelbert College (1891), Williams College (1901), Lafayette College (1907), University of Pittsburgh (1915), and the Sc.D. degree from Yale (1909). Dr. Morley was professor of chemistry from 1869 to 1906 at Western Reserve College, formerly at Hudson, Ohio, and afterwards removed to Cleveland. He also held the chair of professor of chemistry in the Cleveland Medical College from 1873 to 1888. Dr. Morley is an honorary member of the Royal Institute of London; corresponding member of the British Association for the Advancement of Science; associate fellow of the American Academy of Arts and Sciences; fellow of the American Association for the Advancement of Science, of which he was president, 1895–1896; a member of the National Academy of Sciences, American Philosophical Society, Astronomical and Astrophysical Society of America, the Chemical Society of London, and the American Chemical Society, of which he was president, 1899–1900.

Dr. Morley was honorary president of the Eighth International Congress of Applied Chemistry which met in New York City in September, 1912. The photograph of which a copy is shown here was made at about that time.

The *Chicago Chemical Bulletin* furnished us with the following brief account of Dr. Morley's most important work:

"The attention of chemists was first attracted by his work on a very accurate series of analyses of air which demonstrated that the per cent of oxygen in the air varies between narrow limits and is probably smaller in the higher strata of the atmosphere.

"In 1842 Dumas had made a series of determinations of the composition of water, on the basis of which the value 15.96 was accepted as the atomic weight of oxygen for nearly fifty years. Toward the end of this period a number of different chemists worked upon the problem and it gradually became clear that the value found by Dumas was in serious error, but it was not until Dr. Morley's paper appeared in 1895 that the chemists of the world accepted a quite different value as fully demonstrated. In an elaborate series of investigations, to which he gave more than ten of the best years of his life, the densities of hydrogen and of oxygen gases were determined with an accuracy that has not been excelled or even reached by any other observer. Dr. Morley also effected for the first time a complete quantitative synthesis of water, weighing both the oxygen and hydrogen and also the water formed by their union. The results of all of his studies gave the value 15.879 as the atomic weight of oxygen, or 1.00762 as the atomic weight of hydrogen, and it seems quite certain that these values will never be essentially changed.

"In the domain of physics the Michelson-Morley experiments, upon the transmission of light in the direction of the motion of the earth in space and at right angles to that motion, have been the basis of the modern theory of relativity and have gone far to undermine the confidence of physicists in the existence of the ether.

"Dr. Morley is not only one of the greatest of American chemists, but he is a man whose rare personal qualities have won for him a wide circle of friends."

INTRODUCTORY ADDRESS

By A. V. H. Mory

When William A. Converse, on retiring from the chairmanship and active work in the local section of the American Chemical Society, donated a sum to be used in founding a medal in the name of the Chicago Section for the encouragement of local talent, he builded better than he knew. Certain it is, his native modesty would have deterred him from presuming to found a medal of such dignity and importance as the Willard Gibbs Medal has come to be.

The committee appointed to draw up rules governing the award saw so many difficulties in the way of a local award by a local jury that it broadened the scope of the award. When the now honored president of our national society, Dr. Stieglitz, then chairman of the Medal Committee, proposed that the award bear the name of that most illustrious of American chemists, J. Willard Gibbs, the modest proposal of Mr. Converse then and there took on national importance.

A number of the most prominent chemists of the country were later invited to sit on the jury of award and the distinguished Swedish chemist, Arrhenius, was the first of those recognized in the bestowal of the Willard Gibbs Medal.

That there has been no lowering of the high standard thus set up is attested by the list of illustrious medalists that have followed—Theodore William Richards, Leo H. Baekeland, Ira Remsen, Arthur Amos Noyes, Willis Rodney Whitney, and last of all, our honored guest of the evening—Edward Williams Morley.

It goes without saying that the Chicago Section stands committed to a policy that insures the continued high character and dignity of the Willard Gibbs Medal. And it may be added that we, of the Chicago Section, including the founder of the medal, shall ever remain content to render such humble service as may be our privilege in simply providing, as it were, the machinery for bestowing the honors that the eminent jury shall elect to award.

EDWARD WILLIAMS MORLEY
WILLARD GIBBS MEDALIST, 1917

PRESENTATION ADDRESS

By William A. Noyes

There are a considerable number of fundamental physical constants which lie at the very foundation of all accurate scientific work. Among these the density of the common gases and the relative weights of the atoms of the elements have occupied a very prominent place in the attention of chemists. The earlier determinations of these constants were made by crude and inaccurate methods and the values obtained were displaced by other, better values within a few years. Literally thousands of such determinations have been made, but the large majority, although they usually represent the work of many months, have been displaced by others within a few years or, at most, within a generation. Regnault in Paris in 1845 determined the densities of hydrogen and oxygen with such care that his work stood for a generation without serious question. About the same time Dumas, also working in Paris, determined the ratio of the atomic weights of hydrogen and oxygen and his result also stood for a generation, although we now know that it did not deserve the confidence which it received. Dumas himself considered that the value he obtained was in error, possibly as far as one part in 200. The fact that Regnault did not think of the compressing effect of the pressure of a ton or more on the outside of his empty globe, introduced an error in his value for the density of hydrogen which was almost identical with the error of Dumas's determination of the oxygen-hydrogen ratio. This accidental agreement of two results, each of which was affected by a serious but different source of error gave chemists a very undue confidence and they allowed them to stand without serious question for forty years. After that a number of chemists and physicists gave to the world much better values for both constants. But Professor Morley was not content to give to the world values of the ordinary sort which might stand for a few years and then be displaced by others. He was willing to study, one after the other, and with almost an infinite patience, the sources of error in the determinations, and then he carried out his work with such an ingenuity in the execution of details, and with such accuracy, that at present there is no indication that the work will need to be repeated for a century.

I am glad to express in this way the estimate which the world places on the work of Professor Morley, but there is also a keen personal pleasure in being permitted to make this presentation. I have known Professor Morley for twenty-five years, and with the years there has grown an intimate personal friendship which has become one of the most inspiring influences in my life. Professor Morley is a merciless critic—of himself. He has very little to say about the shortcomings of others, though few see more clearly what some of those shortcomings are. And so I take the greatest pleasure in presenting this medal to a personal friend, to a man who has done work of the very highest quality and to one who has given to the world values for two of our most fundamental constants which will always stand as very close indeed to the truth.

EARLY RESEARCHES IN HYDROGEN AND OXYGEN MEDAL ADDRESS[1]

By Edward Williams Morley

The chemical principles involved in the synthesis of weighed quantities of water from weighed quantities of hydrogen and oxygen require no description; it is only the details of the manipulation by which errors were minimized which are interesting.

Pure hydrogen cannot easily be prepared by solution of a metal

[1] Author s abstract

in acid. Carbon and carbon compounds derived from metallurgical operations introduce impurities which cannot be removed. If we remove carbon and carbon compounds, as by distillation of zinc in a vacuum, it is difficult to utilize the hydrogen produced in a given generating vessel to sweep out the nitrogen previously included and still have sufficient gas for the destined use. Electrolysis is accordingly a more convenient source. Electrolysis of caustic alkali would be convenient except that the presence of carbonate introduces impurity which cannot be removed. Dilute sulfuric acid is therefore to be preferred; it gives a gas which, of course, contains nitrogen; it contains vapor of water, and sulfur trioxide; it contains oxygen, ozone and vapor of hydrogen dioxide, diffused through the liquid from the other pole; it also contains sulfur dioxide and hydrogen sulfide. Prolonged evolution finally sweeps out nitrogen. Red-hot copper removes oxygen, ozone and hydrogen dioxide and converts all sulfur compounds into copper sulfide or hydrogen sulfide, which is easily removed by absorption in caustic alkali. Lastly, water is removed by phosphorus pentoxide.

Absence of nitrogen was proved by the absorption of a liter of the gas by means of hot copper, with eudiometric analysis of the one per cent of residue. It was proved that at last less than one part of nitrogen remained in two hundred thousand parts of hydrogen. But in the syntheses, the gas was next absorbed in palladium, the palladium tube was freed from accompanying nitrogen by a prolonged current after absorption had ceased, and this doubly purified hydrogen was utilized.

The amount of moisture remaining in a gas after drying with phosphorus pentoxide was measured; it was given by the loss of weight of a special absorption tube, and was about one milligram in 40,000 liters. The amount of pentoxide taken up by the gas was also determined and found also to be some such quantity as a milligram in 40,000 liters. It is probable that the milligram lost by the absorption tube and at first regarded as moisture was actually pentoxide, and that the amount of moisture remaining after drying with pentoxide is far less than a milligram in 40,000 liters.

The hydrogen used in syntheses was free from carbon compounds and compounds of sulfur. This was proved by burning a slow current of the hydrogen in an atmosphere of the oxygen produced in the same electrolysis. The combustion took place in a closed vessel, so that solution and absorption of possible products of combustion must have been complete. When some 600 cc. of water had accumulated, the liquid was examined; it contained no carbon dioxide and no oxide of sulfur; it contained 0.02 milligram of phosphorus pentoxide.

It was interesting to notice that in this experiment, when the platinum jet had been heated to incandescence in an atmosphere of pure oxygen for some ten days, the inside of the flask was covered with a rust-colored oxide of platinum. When the combustion was stopped, the current of hydrogen was maintained, and the oxide was immediately converted into a deep black coating of metallic platinum.

AUTHOR'S NOTE—Many other details of manipulation are described in the complete address, but they are mostly already on record and need not be here repeated.

CURRENT INDUSTRIAL NEWS

EXTRACTIONS OF LOW-GRADE LEAD ORES

At the Salt Lake City, Utah, Experiment Station of the Bureau of Mines, Department of the Interior, Mr. A. E. Wells, metallurgist in charge, reported as follows to the Washington office of the bureau:

The most successful results of the metallurgical research branch during the month were with low-grade lead ores which have failed to yield to flotation or leaching processes described in previous reports. By mixing these ores with sodium chloride and heating to temperatures of about 800° C. high extractions can be obtained with the lead irrespective of the type of gangue in the ore. The lead volatilizes as a chloride and any silver or gold present is likewise volatilized. These chlorides are precipitated from the fume by the use of the Cottrell precipitator. The precipitated lead chloride after a mixture with lime and a small amount of reducing agent is heated to a red heat when a slag of calcium chloride and metallic lead is formed. The calcium chloride is an advantageous substitute for sodium chloride in the first operation, and from 50 to 75 per cent of the chlorine is recovered in this manner. This process will have the advantage of producing bullion from either oxides or sulfite ores in localities which do not contain sufficient water for milling purposes. Cost calculations indicate a considerable possibility of this process being cheaper than water concentration followed by smelting.

COAL IN CHINA

The *Board of Trade Journal* of December 21, states that a Hong-Kong contemporary had about that time published extracts from a report respecting the coal reserves of China, which had been drawn up recently by the Director of the Chinese Geological Survey. According to the report, coal seems to be very widely distributed in China. There is not a single province in which coal is not found. The northeastern provinces, Shansi, Chihli, Shantung and Honan are, undoubtedly, the most important, the first named being the richest of all. Both Inner Mongolia and Manchuria are fairly well supplied with coal. The northwestern and southeastern regions are, however, much poorer, the geological formation being unfavorable. Both bituminous and anthracite coal occur in China, the latter being more extensive, as the coal in Shansi and Honan is largely anthracite. In fact, the latter variety has been more used in China, as it can be burned in open stoves without chimneys. The bituminous coal industry has acquired increasing importance in recent years as the coal now worked on a large scale is mostly of this variety and, out of twenty mines worked by machinery, only three are producing anthracite. The production of coal of all kinds in China in 1913 was about 15,000,000 metric tons (1 metric ton = 2,204.6 lbs.).—A. McMillan.

FRENCH RESINOUS PRODUCTS

According to a report in the *Oil and Color Trade Journal*, **51** (1917), 975, the output in the resin market for the coming year is very satisfactory. The Landes depots and warehouses report stocks of spirit of turpentine amounting to 3,000,000 kgs., to which there must be added 1,041,391 kgs. in Bordeaux warehouses, making a grand total of 4,000 tons. Half of this total has already been sold so that only 2,000 tons are available to keep things going until the new season has opened. Hence prices are very firm at present and it is probable that a rise in price will take place and the present month may close with rates at $45 to $50 per 100 kilos. For dried sorts, there is a pressing demand but very scant stocks. Lots on hand do not, probably, exceed 20,000 barrels of pitch and colophonium. Prices are expected to advance from $15 to $16 delivered Landes stations. The market is greatly favored by the fact that sharp advances will probably occur in America due to higher freights and insurance rates and to shipping dangers. Arrivals are also getting scarcer in England, and London will probably be willing to replace American with French resins.—M.