

With this there is a careful compilation of pertinent matter from the works of others on the subject, in every instance duly accredited, and the whole is thoroughly well indexed.

The manner in which the earlier editions of this work were appreciated by practical men is a strong endorsement by the most competent critics upon the subject; the present edition contains much additional information and is compiled with the same conscientious care that has secured the confidence of the engineering public in all of this author's works. The book is simply invaluable as the best on the subject.

S. L. W.

SCIENTIFIC NOTES AND COMMENTS.

TECHNOLOGY.

A NEW PROCESS OF PROTECTING IRON EFFECTUALLY AGAINST CORROSION.
—For a period of more than ten years experiments have been made under the auspices of the Hydrogen Company of the United States to discover a simple, economical and practical method of protecting iron and steel from all ordinary corrosive influences. A large number of patents were secured and about \$100,000 expended in the erection of plants at Washington, D.C., Newburg-on-the-Hudson and New York, and some of the results were of the most satisfactory character. Iron that had been treated by the processes referred to effectually resisted the action of nitro-muriatic acid and other severe tests to which it was subjected, while untreated iron was immediately attacked by the acids and quickly destroyed.

But although many of the specimens thus treated gave very satisfactory results, others proved defective, and it became apparent to the contributors to the funds that the exact conditions as regards temperature, quality and quantity of material employed, and duration of treatment had not been so accurately determined that results could be duplicated with unerring certainty; an essential condition without which no process could ever be made a commercial success.

This explanation has been considered necessary to account for the fact that an industry which promised results of such extraordinary value to the public and to the parties financially interested should have been allowed to linger until the greater portion of the life of the original patents had expired.

But persistency has at last been rewarded with success. The company succeeded in securing the services of a thoroughly practical and scientific engineer, chemist and metallurgist, Dr. Geo. W. Gesner, who was enabled to discern the defects of former treatments and to remedy them successfully by new apparatus and processes, which have recently been patented, so that while the old patents are still held by the company, they have to a great extent been superseded by more recent issues under which operations now are and will hereafter be conducted.

The former treatment consisted in placing the articles to be operated upon in a close chamber, similar to a gas retort, and when heated to a temperature

of about 1,200° F., steam superheated in a separate furnace was introduced, followed by naphtha or other hydrocarbon vapor.

The results, as previously stated, were not always uniform, and when satisfactory, could not be duplicated under former management with certainty as to the result.

All this is now changed, and the results are so uniform and certain, that with a few hours of instruction in the manipulation of the apparatus an ordinary laborer, with no technical education and with average intelligence, can secure results with entire uniformity.

Dr. Gesner soon discerned that one of the chief defects in the former treatment arose from the fact that the steam superheated in a separate furnace and conducted by pipes into the retort was invariably cooled to the extent of several hundred degrees before admission and came in contact with the heated iron at a much lower temperature.

To remedy this defect and insure absolute uniformity of temperature between the iron and the superheated steam at the instant of contact, a peculiar but very simple form of superheater was devised and inserted in the retort itself. The result was entirely satisfactory, and after a number of experiments by him to determine the conditions necessary to insure the best treatment, the works were turned over to an employé who has since operated them with uniform results.

The plant now in operation is located at East Port Chester, near the extensive foundry of Abendroth Brothers, and consists of twelve vertical retorts with a capacity for the treatment of about twenty tons per day of the Gesner sanitary soil pipe. The time required for each charge is about two hours.

THE PROCESS.

After the pipes have been lowered into the retorts by means of a traveller, the retorts are closed for about fifteen minutes until the contents are heated to the proper temperature. Steam from a boiler at sixty pounds pressure is then introduced into the superheater, which it traverses and from which it escapes at the temperature of the iron upon which it acts for about one hour. A measured quantity of some hydrocarbon is then admitted with a jet of steam, followed again by a fixing bath of superheated steam, which completes the process.

The most extraordinary feature of the operation is that, as Prof. Gesner positively asserts, there is no pressure in the retort and no free explosive gases. The water seals attached to the retorts show only slight oscillations, but not an inch of pressure, and when the covers are removed and air admitted, there is no explosion, as there always is when free hydrogen or carbonic oxide are present, and as there always was before Prof. Gesner took charge.

The absence of pressure and of explosive gases is a proof that all the operations have been so nicely regulated as regards material used, quantity and time of application, that a perfect absorption and union of the carbon, oxygen and hydrogen with the iron has been effected.

The protection thus afforded to the iron is not a mere coating, like paint,

but an actual conversion, to a greater or less depth, into a new material, just as in the process of case-hardening, iron is converted into steel. When properly treated, this material does not seem to be detachable by pounding, bending, hammering, rolling or heating. The pipes treated at Port Chester have been immersed in baths of dilute sulphuric acid and exposed to the salt air for weeks without change, while untreated pipes were quickly covered with red oxide or with sulphate of iron.

The exact chemical composition of the material produced by this treatment has not been reported upon by Prof. Gesner, but it is probably a carbide, hydride and superoxide of iron. This would seem to be a necessary result, if, as is stated, the retorts when opened contain no free gases, neither hydrogen, oxygen nor carbonic oxide. As these gases are necessarily formed, their disappearance can only be explained on the theory that they have combined with the iron forming the three compounds of superoxide, plumbago and the alloy of hydrogen and iron, for which Prof. Gesner has proposed the name of Hydron.

The plant now in operation at Port Chester has been designed simply for cast-iron soil pipe, but Prof. Gesner is preparing plans for a more extensive plant for the treatment of wrought iron and steel, to be erected at South Brooklyn.

In the application of this process each specialty will require a plant adapted to it, and a series of experiments to determine the exact conditions as to temperature, quantity, kind, duration, etc., to secure the best results, after which they can be duplicated indefinitely with any ordinary intelligence.

The question is often asked: What is the effect of this treatment upon the tensile strength of the material? This can only be answered by direct tests, but if the new material should not possess the tensile strength of the untreated iron, as in wires or rods, compensation can be secured by a slight increase in diameter. It is certain that in some specimens the treatment has increased the toughness and strength by the annealing process to which the material is subjected. Sheet iron of poor quality, that would break by bending, has been rendered tough and pliable.

The cost of the process is said to be about one-fourth of that of galvanizing, while the durability under similar conditions promises to be greatly extended.

H. HAUPT.

ON THE LABORATORY APPLICATION OF RAOULT'S METHOD FOR THE DETERMINATION OF MOLECULAR WEIGHTS.—K. Auwers (*Berliner Berichte*, **21**, 701). Raoult has shown that the lowering of the freezing point of a liquid occasioned by the solution of any substance is a function of the molecular weight of that substance, and has deduced formulæ by which molecular weights may be calculated from observed lowering of the freezing points. The method has been experimentally verified with several solvents by Blagden (*Phil. Trans.*, **58**, 277), Coppet (*Pogg. Ann.*, **114**, 63; **116**, 55; **145**, 599), and again by Raoult (*Ann. Chim. Phys.*, **4**, **23**, 366; **25**, 502; **26**, 98; **5**, **20**, 217; **28**, 133; **6**, **2**, 66, 93, 99, 115; **4**, 401; **8**, 289, 317).

If C be the lowering of the freezing point occasioned by the solution of P

grammes of substance in L grammes of the selected liquid, and A the depression occasioned by one gramme of the substance in 100 grammes of the liquid,

$$A = \frac{C \cdot L}{P \cdot 100}$$

The value A is named by Raoult the coefficient of depression for the substance and liquid, and its product when multiplied by the molecular weight M of the dissolved substance, yields a value $M \cdot A = T$, which he calls the "molecular depression" of the substance. The value of A varies with the nature of the substance, and like that of T , with the nature of the solvent, but when the same solvent is employed, T remains sensibly constant for large classes of substances of analogous chemical constitution. In other words, substances of similar chemical constitution exert the same molecular depression.

The law has been still further investigated by Raoult, who shows that if the calculation be made for the depression T_1 , caused by the solution of one molecule of the substance in 100 molecules M_1 of the solvent, the value

$$T_1 = \frac{M}{M_1} A = \frac{T}{M_1}$$

is not only constant so long as T remains constant, but that it remains sensibly the same no matter what solvents be employed. Thus, if t_1, t_2, t_3 be the molecular depressions of liquids whose molecular weights are m_1, m_2, m_3 ,

$$\frac{t_1}{m_1} = \frac{t_2}{m_2} = \frac{t_3}{m_3} = T_1 = \text{constant.}$$

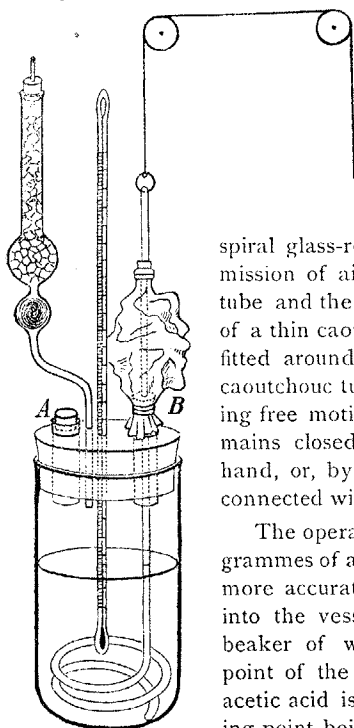
The value of this constant, according to the experiments of Raoult, varies between $0^{\circ}59$ and $0^{\circ}65$, and the mean is $0^{\circ}63$, and the law may be expressed as follows: If one molecule of any substance be dissolved in 100 molecules of any chosen solvent, the freezing point of the latter will be lowered $0^{\circ}63$. Raoult names this the general law of congelation.

The law holds good for temperatures between 0° and 80° , the freezing points of the solvents used by Raoult lying within these limits. It does not appear to apply in the case of water, with which the value of T_1 varies between $0^{\circ}92$ and $1^{\circ}27$ for carbon compounds, and is different for each class of salts, a fact probably depending on a not fully understood chemical action.

The liquid best adapted for the determinations is crystallizable acetic acid, and even when the substance under experiment is hygroscopic it is not necessary that the acid shall be perfectly dry, for while the result of the first experiment may be erroneous, the substance already introduced will have taken any small quantity of water present, and the introduction of a second and a third quantity will produce constant results. The molecular depression of acetic acid is about 39 .

It must be well understood that the method does not yield absolute results; it cannot be used as a substitute for the determination of vapor densities, but it will prove of immense service in cases where the determination of vapor densities is impracticable or impossible.

The apparatus required for the experiments is quite simple. A beaker, 4.5 or 5 cm. in diameter and 13–16 cm. high, is fitted with a caoutchouc stopper pierced with four holes. Through the central hole passes a good thermometer, graduated, say, from 0° to 50° in one-tenth degrees, and the bulb of the thermometer should be in the middle of the liquid. Behind the thermometer a calcium chloride tube is adapted to one of the openings for



the drying of the air, which enters as the vessel is cooled. Through the third opening passes a short, wide tube, which is closed by a cork that is only removed to drop in a crystal of acetic acid, in order to start the congelation. The other opening is also fitted with a short tube through which

passes, without friction, the stem of a spiral glass-rod agitator, and that there may be no admission of air in the space between the walls of the tube and the rod, the latter is passed through the wall of a thin caoutchouc balloon, the opening of which is fitted around the extremity of the tube; a very thin caoutchouc tube will answer the same purpose, allowing free motion up and down, while the opening remains closed. The agitator may be moved by the hand, or, by means of a cord and pulleys, may be connected with a small water motor.

The operation is conducted as follows: About 100 grammes of acetic acid—the weight need not be known more accurately than to decigrammes—are introduced into the vessel, and the latter is placed in a large beaker of water, cooled 1° or 2° below the melting point of the acetic acid; that is, to about 14° . The acetic acid is then cooled to $\frac{1}{2}^{\circ}$ or $\frac{1}{4}^{\circ}$ below its freezing point, being constantly stirred by aid of the agitator,

and a crystal of acetic acid is then dropped into the liquid. The mercury then falls two- or three-tenths of a degree, but soon begins to rise, at first rapidly, then slowly; in a short time a maximum is attained, after which the temperature slowly falls. The maximum temperature is read to the $\frac{1}{100}$ ths of a degree by the aid of a magnifying glass, and this temperature is accepted by Raoult as the true freezing point. The apparatus is then removed from the beaker of water, and placed on a water bath, care being taken that the steam does not touch it. As soon as the acetic acid is perfectly liquified, a second determination of its freezing point is made in the same manner as the first; the result of the second experiment is $0^{\circ}.01$, $0^{\circ}.02$ or even $0^{\circ}.03$ below that of the first, and a third determination will sometimes show a still further depression of $0^{\circ}.005$. The differences are probably to be explained by the moisture on the walls of

the vessel and in the balloon at the beginning of the experiment, and the substance, whose molecular depression is to be determined, should not be introduced until the freezing point of the acid is constant in two determinations; sometimes two are sufficient—four may be required. As soon as a constant freezing point is indicated, the substance under experiment, accurately weighed to milligrammes, is dropped into the apparatus through the wide tube, and after it has been dissolved by stirring, three determinations of the freezing point are made; the greatest difference between the first and third will be about $0^{\circ}.01$. A second weighed quantity of the substance is then introduced, and three more determinations made, the differences observed in this series being similar to those in the first.

The required time is about ten minutes for each determination; three or four hours will suffice for a series of, say, eleven consecutive determinations with all the manipulations and weighings.

W. H. G.

GEOLOGY.

GEOLOGICAL MAP OF EUROPE.—Those readers of the JOURNAL who are interested in geography or geology, are notified that the subscription list to the Geological Map of Europe, which the International Geological Congress is to issue shortly, is nearly complete, but twelve more copies remaining to make the century assigned to the United States. As almost all, if not all, the leading institutions of learning and of research in the country are subscribers to this map, it is time for those who desire to avail themselves of the opportunities of securing it, at twenty per cent. less than its market price, and before it is sold to the general public, to send their names in to Dr. Persifor Frazer, Secretary American Committee, 201 South Fifth Street, Philadelphia. The cost of the map to institutions will be \$21, and to individuals \$26, the difference being the duty, which to the former class is not chargeable. No money contribution is required until the map is issued, which will probably not be before next fall or winter.

Franklin Institute.

[Proceedings of the Stated Meeting, held Wednesday, April 18, 1888.]

HALL OF THE INSTITUTE, PHILADELPHIA, April 18, 1888.

Mr. JOS. M. WILSON, President in the Chair.

Present, 132 members and fourteen visitors.

Additions to membership since last meeting, sixteen.

The Actuary reported the election, by the Board of Managers, at its meeting held Wednesday, April 11, 1888, of the following persons, to serve as Trustees in accordance with Article I, Section 2, of the By-Laws:

CHAS. HARE HUTCHINSON,

JOHN T. MORRIS,

EDWARD LONGSTRETH,

SAMUEL SARTAIN,

J. VAUGHAN MERRICK,

WM. SELLERS,

JOSEPH M. WILSON.