

[For the Scientific American.]

## LATENT HEAT OF DISSOCIATION.

BY P. H. VANDER WEYDE.

It was reserved for quite recent investigation to discover another kind of latent heat, besides that to which bodies owe their fluid or gaseous condition; it is the same heat which becomes latent when, at a very high temperature, all chemical affinities are destroyed, and every elementary substance exists in its separate uncombined condition, notwithstanding its being intermingled, in its gaseous or fluid condition, with any other substance also in the same gaseous or fluid state. It is the condition of all the material which makes up the mass of our sun; this has been proved chiefly by the latest spectroscopic observations of this mighty luminary, and the deductions to which these observations have driven the investigators. We know now, therefore, three kinds of latent heat; first, that of fluidity; second, that of the gaseous condition; third, that of dissociation; and as the second surpasses the first considerably, so the third surpasses the second, in amount.

As this new subject is of the most intense interest, explaining, as it does, many points thus far quite obscure or totally inexplicable in physical science, the reader is requested not only to read carefully what is to follow, but to study it, to ponder over it, till the facts have become so familiar to his mind that he may call them his own. I will only state, as an illustration of this importance, that the origin of the heat of combustion, thus far a profound mystery even to the most advanced philosopher, is now perfectly explained by the theory of the heat of dissociation, in combination with the theory of the conservation of forces. The latter theory considers heat as a mode of motion, as most readers well know; and the present series of articles, weekly prepared for the SCIENTIFIC AMERICAN, is intended to lead the student gradually into the knowledge of the laws governing matter in motion, which is the only true and intelligible definition of that mysterious agency which we call force, and of which heat, light, electricity, magnetism, and gravitation are only different phases.

It is scarcely necessary to remark that this subject is not only interesting in a theoretical and abstract point of view, but has a direct practical bearing in all cases where heat is transformed into motion, as is the case in the steam, the calorific, and the solar engines, etc., the theory of which will be the culminating point of the present series.

The term "dissociation" meaning thus a condition of matter of so high a temperature as to be, not only gaseous and incandescent, but beyond the power of chemical affinity, it is clear that when the temperature descends, a point must be reached where the chemical affinities will manifest themselves; in the same way, as by an ascent of temperature, from a very low degree of heat, the other extreme point of this range of chemical affinity may be reached. It has been found that these affinities manifest themselves in a comparatively limited range of temperature, below and above which they do not exist. As at an extreme cold, no chemical combination can be made, so at an extreme heat, say of 8,000° Fah., not only no combination can be made, but all compound bodies are separated into their elements, or dissociated. On cooling them and reaching, say 4,000° or 3,000°, the substances will again combine, the chemical affinities will come into activity at once, combustion will ensue, a comparatively enormous amount of heat will be developed or set free; it is the heat which before was latent in the dissociated elements, and is driven out by the play of the chemical affinities, even as the latent heat of gases is driven out during their condensation into a liquid, and the latent heat of liquids is driven out during solidification.

It is as yet impossible to give a table of the latent heat of dissociation for different substances, as no reliable data have yet been published; there is only one substance of which the latent heat of dissociation has been definitely determined (by St. Claire Deville); this substance is steam. This investigator has found that when steam is heated to 5,072° Fah., it is changed into a mixture of its component gases, oxygen and hydrogen. In the same way, when water is evaporated, or, in other words, when changing water of 212° into steam of 212°, 962 units of heat are consumed or made latent, so by dissociating steam, or changing steam of 5,072° into a mixture of oxygen and hydrogen of 5,072°, not less than 8,000 units of heat are made latent. Further, in the same way as steam of 212°, when condensed into water of 212°, gives off its 1,000 units of latent heat, so, when dissociated oxygen and hydrogen of 5,072°, combining into steam of 5,072°, giving off its 8,000 units of latent heat, of course combustion ensues; and this heat produced by combustion is nothing but the latent heat of dissociation.

If this dissociation has taken place by heat, it is of course impossible to obtain the gases afterward in a separate condition, and therefore impossible to cool the mixture without passing this point of combustion; but fortunately there are other ways to communicate, to the elements of water, this heat of dissociation, without which they cannot exist in the separate gaseous condition. One of these means is that other form of matter in motion, which we call electricity; if we discharge a voltaic current through water, we decompose it, as is well known, into its elements, which we may then collect as separate gases or as a gaseous mixture. This will then possess about the temperature of the surrounding air and the water from which it originated; the thermometer will not indicate the 8,000 units of latent heat, which the electric current has stored up in the gaseous mixture, as the same instrument does not indicate the 962 units of latent heat in steam of 212°. But let us raise the temperature of the minutest portion of this gaseous mixture to the point required for the play of affinity between oxygen and hydrogen, that

is, to about 1,000°; and, in this minutest portion, the combination which takes place will expel its latent heat of dissociation, and this, in its turn, is enough to produce more than 1,000° of heat, and ignite the whole of the mixture, which then, by suddenly giving off all of its 8,000 units of latent heat, changing this into sensible heat, produces that enormous expansion or detonation of the gaseous mixture, of which the powerful effect is so well known among experienced chemists that none of them can ever believe that a bursting steam boiler ever contained any such explosive mixture. If such indeed were the case, the worst explosions would not be so comparatively mild, as was that of the *West-field*, for instance. Such a boiler, when it bursts by the ignition of oxygen and hydrogen, would have done infinitely more damage, and would surely have knocked the bottom out of the boat, and perhaps have shivered the whole into splinters. A mere soap bubble, filled with this mixture in the right proportion, two volumes of hydrogen to one of oxygen, gives, when ignited, a report like a pistol; and the ignition, of larger or confined portions of this mixture, which occasionally takes place in laboratories, has always been infinitely more destructive, in comparison, than the explosions of steam boilers. The details of the explosions of the latter are perfectly identical with those accidental explosions or rather burstings, also sometimes occurring in laboratories, when non-combustible gases are pumped into cylinders, and at last a pressure is reached, surpassing the strength of cohesion of the weakest part of the cylinder, and an explosion or violent bursting also ensues, which, however, in its distinctive result, does not compare with that produced by the ignition of the dissociated elements of water.

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## SOCIETY OF ARTS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

MEETING, HELD IN THE INSTITUTE IN BOSTON, DEC. 14, 1871.

The President, J. D. Runkle, in the chair.

An interesting paper, by the Secretary, Dr. S. Kneeland, on the Upper Mississippi, was the first thing in order. The paper had special reference to certain changes in the bed of the river, between Dubuque and St. Paul.

In 1870, the water, though shallow, did not obstruct navigation, but this year it was a rare thing for a steamer, if a large one, to make the trip between Dubuque and St. Paul without getting aground more or less frequently.

The water was so low that the heavy freight was shipped on flat barges, which were attached to each side of the steamer, to lessen the draft. And yet the surface of the water was four feet higher than in the summer of 1863, when the river was remarkably low, but the actual difference between the depth of the water in the summer of 1863 and that of 1871 is only five inches. This seems to show that the bed of the river is three feet and seven inches higher than it was eight years ago.

Generally there is a June or summer rise in the tributaries of the Mississippi and Missouri, which scours out, to a certain extent, the beds of these streams; the general drought which prevailed throughout the northwest last summer, drying up vegetation and preparing the country for those terrible conflagrations which have laid waste large portions of Michigan, Wisconsin and Minnesota, prevented the rise in the river this year. An immense amount of sediment must be washed into these rivers annually from the thousands of acres of cultivated land in Iowa, Minnesota, Wisconsin and Illinois. This will be readily understood by any one who has seen the turbid Missouri, or any of the tributaries of the Mississippi after heavy rains. The bottom of the Mississippi is now six and a half feet higher than it was in 1846.

The final overflow of the country, by the river, from the rising of its bed, will be prevented by two causes; first, the valley on each side of the river is gradually filling up, by the deposition of sediment from a multitude of streams, large and small, draining immense tracts of cultivated land, making a broad, natural levee; second, it is obvious that the volume of water flowing in the channel is decreasing annually. This last phenomenon is accounted for by the extensive destruction of forests and the cultivation of the land, which increases its absorptivity, and the consequent comparative desiccation of the country by the sun's heat. This has always been the case with rivers flowing through highly cultivated districts. The Danube, in Europe, is gradually becoming unfit for commercial purposes; and even our own Connecticut can be forced nine months in the year, where formerly there was a large volume of water during the whole year, and it is hardly navigable for ordinary vessels, even as far as Hartford. The rivers of the country are gradually drying up, and steam is being substituted for the former ample water powers. There seems to be a conflict between agriculture and water transportation, the former rapidly gaining the victory. It is remarkable that within a single generation man should so modify the physical configuration of the country—drying up its rivers, changing the course of trade, destroying important manufacturing interests, and, as has been seen, threatening the existence of the very "Father of Waters" as a means of communication between the great North West and the Gulf, and modifying the physical features of the Mississippi valley to such an extent as would seem impossible, except by long continued geological agencies. At the falls of St. Anthony, nature herself is opposed to man's manufacturing industry, and all the means which human skill and capital can command are employed to arrest a process of natural destruction. These falls were twenty-seven feet high forty years ago, and now they are hardly twenty. The time was when the falls were at Fort Snelling, seven miles below. They have worn their

way back seven hundred feet within forty years, averaging seventeen feet a year in their backward march. The danger has become so imminent that a company with a large capital has been organized to preserve these falls by every contrivance known to engineering science.

Professor Watson said that the river Rhine had been made to flow in a regular channel with a sufficient depth, where formerly it was very unstable, by the use of fascines and other engineering devices.

Professor Cross then made a communication upon the methods employed in illustrating lectures on physics, by means of photographs projected upon a screen. The oxyhydrogen or lime light is used for the purpose. After giving a short sketch of the history of the oxyhydrogen blowpipe, the Professor exhibited a new and superior burner, used by Mr. Black; the inner tube of the jet is perforated with small holes, which issues a more perfect mixture of the gases, and consequently finer results than are ordinarily obtained. The theory of projecting images upon the screen was explained, and then the applications of the light to lecture purposes was taken up. The decomposition of water by electricity was illustrated in a most striking and vivid manner. The evaporation of ether, at the ordinary temperature, was shown, the heavy vapor slowly rolling over the edge of the vessel. Also the convection of currents of air was well illustrated. A cylinder of steatite, being substituted for that of lime in the oxyhydrogen flame and its image magnified and projected upon the screen, it could be plainly seen that the steatite was partially fused; it was a good illustration of the intense heat developed in the oxyhydrogen flame.

The Professor then exhibited the aphonoscope, an instrument intended for the projection upon the screen of opaque objects. Two lime lights are made, by means of condensing lenses, to illuminate the object to be shown, which may be a card photograph, coin, cast, or almost any opaque object; and a magnifying lens forms the image upon the screen. This instrument was brought from London by Mr. Waldo Ross.

Mr. Stimpson made a few remarks, drawing attention to the fact that the intensity of the calcium light permitted the presence of a considerable amount of common artificial or sunlight in the room, without impairing the clearness of the image; and therefore without the fatigue, to the eyes, experienced in a short time when bright pictures are represented in a very dark room. He explained that the greater comfort to the eyes, in using semi-transparent instead of opaque shades on ordinary lights, was due to the same principle.

R. O. C.

## Recipe for Curing Hams.

To one gallon of water, take one and a half lbs. of salt, one half lb. of sugar, one half oz. of saltpeter, one half oz. of potash.

In this ratio, the pickle can be increased to any quantity desired. Let these be boiled together until all the dirt from the sugar rises to the top and is skimmed off. Then throw it into a tub to cool, and when cold, pour it over your beef or pork, to remain the usual time, say four or five weeks. The meat must be well covered with pickle, and should not be put down for at least two days after killing, during which time it should be slightly sprinkled with powdered saltpeter, which removes all the surface blood, etc., leaving the meat fresh and clean. Some omit boiling the pickle, and find it to answer well, though the operation of boiling purifies the pickle by throwing off the dirt always to be found in salt and sugar. [Having tried this recipe, we know it to be excellent. Ed.]

## Death of Mr. Sidney E. Morse.

Sidney E. Morse, a well known inventor and journalist, widely known and respected for his benevolence and philanthropy, died on December 23rd, at his residence in New York city, in the 78th year of his age. He was a native of Charlestown, Mass., and was educated at Yale, afterwards studying law and theology. For many years he was the editor and proprietor of the New York *Observer*, having, at the early age of 16, connected himself with journalism by writing on various political subjects. His inventions were ingenious and useful, and comprised, among others, the flexible piston for pumps, patented in 1817, a process of printing maps on an ordinary press, patented in 1839, and a bathometer, an ingenious device for making deep water soundings. In the latter invention, he was aided by his son, and up to the day of his death, it engrossed his attention. He was three years younger than his distinguished brother, Samuel F. B. Morse, and, like him, has lived a long life of hard work for the benefit of his countrymen and humanity.

**GOLDEN INK.**—Gold ink is prepared as follows: Grind, upon a porphyry slab with a muller, gold leaf and fine white honey, till the former is reduced to an impalpable powder. The paste is then carefully collected and diffused through water, which dissolves the honey, causing the deposition of the precious metal. The water must now be decanted and the sediment edulcorated to free it from the saccharine matter; the powder exsiccated is very brilliant, and, when required for use, is suspended in mucilage of gum arabic. After the writing executed with this ink is dry, it should be burnished with ivory. Silver ink is made in the same manner by substituting this metal in leaf for gold.

WE hear from Germany of the invention of a new alloy for making imitation jewelry. It consists of copper, 58.86 parts, zinc, 39.24 parts, and lead 1.90 parts. We cannot vouch for its success, but it is so simple that any of our readers can try it for himself.