the great masters and the pupils in the several modern schools, and mentioned, in a list of their additions to the store of the architect, the use of the niche, of pedestals, of balustrades, of sculpture (of all sorts), as mere decoration; of the araeostyle disposition of the basement and attic stories as features, of spires, and steeples, and bell towers, and of an extraordinary luxury of internal and external architecture.

The paper closed with the observation that, with Chambers, Mylne, Dance, Holland, and Soane expired the race of architects in one style only, but in a style of which they were masters; their successors being condemned to exposure to the caprice of patronage for a command, to summon up the resources of any style to clothe even an impracticable idea; and that the current of taste was undeniably tending toward an art altogether different from that of Greece in its construction, or else to that of Palladio and Chambers.

CHEMISTRY AS APPLIED TO CONSTRUCTION.*

BY PROFESSOR GRIFFITHS.

From the dawn of experimental chemistry to the year 1808, lime was regarded as a simple or elementary earth. Sir Humphry Davy then suspected that it might contain a *metal*, or be a *metallic oxide*, and the manner in which he proceeded to verify this suspicion by the test of experiment presents an admirable specimen of his philosophical skill. It was as follows:—

The metal *mercury*, is *fluid* at all ordinary ranges of atmospheric temperature, and in such state it is capable of exerting affinity for several metals that are *solid*,—silver, tin, and lead, for example,—in forming *compounds* with these, it loses its fluidity. The results are extremely soft, unctuous solids, technically called *amalgams*. Mercury can be boiled or distilled by heat, with nearly the same facility as water can be so treated; and when the metal is *pure*, like pure water, it leaves no residue in the vessels employed during the experiments; but the metals silver, tin, and lead cannot be boiled or distilled at the same heat as mercury, or in other words, whilst it is *volatile*, they remain *fixed*.

Accordingly, if an amalgam of mercury with silver be placed in a distillatory apparatus, a moderate heat will *volatilize* the mercury, whilst the silver will remain *fixed*, and thus an analysis, or a separation of the compound into its two elementary constituents, will be effected.

A *metallic oxide* will not form an amalgam with mercury; but the powerful agency of *electricity* is capable of *reducing* an oxide, or of eliciting its elementary *metal*, which then, in the generality of cases, *can* combine, or form an amalgam with mercury.

All these facts had been ascertained previous to the year 1808, and, therefore, Sir Humphry, in the true spirit of "inductive philosophy," proceeded from the *known* to the *unknown*, with the view of effecting the decomposition of lime.

He selected a piece of pure *lime*, and made in its centre a small cavity to hold a globule of pure *mercury*; he then placed the lime in connection with the positive pole of a voltaic battery, and the mercury in connection with the negative pole, to complete the electrical circuit. In this arrangement the mercury gradually lost its fluidity, as though it were amalgamated with a known metal, but no such element being present, the phenomenon of amalgamation could only result from the elimination of an *unknown* metal from the lime.

The new amalgam was then carefully removed into a small distillatory apparatus, constructed of a glass tube, filled with the vapour of pure *naphtha*, a substance containing no oxygen, and which experiments, with potassium and sodium,—the metals of the alkalies potassa and soda,—had taught Sir Humphry would protect or varnish such readily oxidizable elements from the action of the atmosphere, and some other sources of oxygen.

Upon the application of heat to the part of the apparatus containing the amalgam, the mercury volatilized or distilled, whilst a fixed substance, having a silvery lustre, remained; in fact, it was a *true metal*, evidently *educed* from the *lime*; for when heated in the air, it instantly kindled, and the *result* of the combustion was pure *lime*, *produced* by the union of such metal with the oxygen of the surrounding air.

The new metal was accordingly named *calcium*, in allusion to its source (*calx*), and *lime* was named *oxide of calcium*, as, during the formation of the amalgam, oxygen had evidently been expelled from the lime by the agency of the voltaic battery; and the newly-educed substance, when heated in contact with *oxygen*, produced *lime*, chemically the same as that in which for ages it had remained concealed.

It is probably correct to state that no experimenters excepting Sir Humphry Davy and his assistants, at the Royal Institution of Great Britain, ever saw *calcium*, and this on account of the great difficulty and expense attendant upon the process for its eduction, but all chemists agree in regarding *lime* as its *oxide*, because the above direct evidence of the existence of calcium was followed up and corroborated by indirect evidence of the most satisfactory nature: this fortunately admits of explanation in a very few words.

All pure metals have an affinity for the non-metallic element *chlorine*; the resulting compounds are termed *chlorides*, and it is found upon presenting the *generality of metallic oxides* of known composition to *chlorine* that they are decomposed, *oxygen* is expelled from them, and *chlorides* of their respective *metals* are *indirectly* produced, exactly similar in their chemical properties to those which are *directly* produced, by the presentation of the pure metals to pure chlorine.

Lime, or *oxide of calcium*, acts, with *chlorine*, in conformity with this general law, *oxygen* being expelled in true and definite weight, whilst the *chlorine* combines in its stead with the *metal*, producing *chloride of calcium*.

It would be pedantic, and also inconvenient not only for the chemist, but for the architect, the builder, and every practical man, to speak in strict accordance with chemical nomenclature, and say *oxide of calcium*; accordingly those who work in the laboratory, and those who design and construct its walls invariably call the extraordinary compound by its universally known name of *lime*. For the sake of euphony in chemical language, the term *calcia* might be adopted, the terminal letter *a*, as in the case of potassa, soda, alumina, silica, baryta, strontia, magnesia, and lithia, implying the fact of oxidation: but leaving opinions regarding names, and proceeding to experiments upon things, it is an established truth, that twenty parts by weight of *calcium* and eight parts by weight of *oxygen*, are found in twenty-eight parts by weight of *lime*, and it is a substance of inestimable value to the chemist, architect, engineer, operative, and artist.

Lime, quicklime, or *live lime*, is seldom if ever presented by nature, excepting in volcanic districts, and there only in very small quantity, apparently resulting from the action of volcanic heat upon limestone, or other calcareous compounds, or probably from the combustion of the metal calcium in subterranean recesses.

There are many kinds of limestone, and by submitting these to a strong artificial heat, as in the common process of "lime burning,"—the theory of which will be examined in the sequel—abundance of lime, sufficiently pure for all practical purposes, may be obtained: therefore an examination of its leading chemical characters may now be entered upon.

For all practical purposes, the weight of a cubic foot of pure water at the temperature of 62 degrees may be taken at 1,000 ounces avoirdupois. This is the standard to which the weight of a similar bulk of any other liquid or solid substance can be referred; and in the case of *lime*, a cubic foot of it will generally weigh 2,300 ounces, so that it is nearly twice as heavy as water, or the fact may be expressed thus, the inherent particular weight or *specific gravity of water* being = 1,000, that of *lime* is = 2,300.

There is no mystery whatever regarding the subject of *specific gravity*; on the contrary, it simply consists in ascertaining the weights of equal bulks of different liquid and solid substances, in reference to water as a standard of *unity*. This is extremely important in most branches of practical science, and in many instances, when accurate tables of specific gravities are once constructed, the deviation of a substance from the exact specific gravity that it should possess, immediately points out to the experimenter, that it is not absolutely or chemically pure.

Lime is excessively infusible, it shews no tendency to pass from the solid to the fluid state in the most intense heat of a furnace fire; if it be subjected to the far superior heat of the voltaic flame, it then slowly and imperfectly melts, so that for all practical purposes, lime may be regarded as infusible when heated *per se*. If lime be mixed with other substances that are popularly called *earths*, then upon exposure to the heat of a furnace, it facilitates their fusion in a very remarkable manner, it combines with them forming vitrifiable compounds, hence the extreme utility of lime as a cheap and powerful *flux* in many operations of practical chemistry, but particularly in the operation which relates to the reduction of iron from the clay iron-stone.

This ore contains clay, and other earthy matters, in combination with carbonate of oxide of iron; it is therefore first of all heated to redness, or "roasted," to expel the carbonic acid, and leave an oxide of iron; this is mingled in due proportions with coke and limestone, and then subjected to the intense heat of a "blast furnace." The carbon of the coke exerts affinity for the oxygen of the oxide, and the iron is liberated or educed; but this iron would immediately burn, or return into the state of oxide, by combining with a portion of the oxygen of the blast of air, so that the operation would be futile, did not the lime of the limestone at the same time combine with the clay and other earthy matters, to form an extremely fusible glass, which envelopes and protects the globules of newly reduced iron from the oxygen of the blast, and permits them to sink down and accumulate in the lower part or hearth of the furnace, from whence at due intervals the molten iron is run off into moulds.

The scoria, or "slag," produced by the lime when withdrawn from the furnace and cooled, is of very little value, excepting for the construction of rude fences, and for repairing roads; but as it has an exceedingly sharp vitreous fracture, it is scarcely admissible for the latter purpose.

When a fragment of lime is held in the pale flame of a spirit lamp, or, better still, in the pale flame resulting from the rapid combustion of oxygen and hydrogen gases; as the lime becomes highly heated, an intense white light is evolved: but the lime undergoes no chemical change in this experiment, it merely volatilizes or *sublimes* to a slight extent, and its vapour, when condensed upon a cold surface, forms a white solid *sublimate*, which is identical in composition with the fragment of lime from whence it ascended. The experiment presents an example of the phenomenon called *ignition*, which, chemically defined, implies the evolution of light from a solid substance when its temperature is raised, and its chemical nature unchanged.

The light evolved by the *ignition* of lime rivals that of the sun in its intensity and purity; it admits of refraction by a glass prism into the seven primary, or prismatic colours of solar light, and in the "lime light," as it is now popularly called, there is no excess of the yellow ray, consequently, it is admirably adapted for artificial illumination, whilst the artificial light, derived from the more ordinary sources of oil, wax, tallow, spermaceti, and gas, contains a considerable excess of the yellow ray. Thus an apartment exquisitely finished in the beautiful colours of decorative art displays them all during the day time as they were intended to be displayed by the artist, but upon artificially illuminating the apartment, an effect that he never contemplated is very frequently produced by the yellow ray changing, or modifying, all the colours, and especially some of the blue colours to various shades of green.

Water is a compound of oxygen and hydrogen gases, and in a small quantity it admits of ready decomposition by voltaic electricity, so that both these gases may be collected and burned to reproduce water. Now, if it were possible to decompose a large quantity of water at a cheaper rate than by electricity, the *combustion* of its gaseous elements, conjoined with the *ignition* of lime, would probably supersede most methods of artificial illumination; for

* See p. 69, ante.