

time, and then the mass bursts into flame. If the oily matter be placed in a warm position at first, spontaneous ignition may take place within a few hours, or even minutes. Galletly found that oily cotton at ordinary temperatures took some days to heat and ignite, while if placed in a chamber warmed to 130° to 170° F. (54° to 76° C.) the cotton greasy with boiled linseed ignited in 1 hour 15 minutes, and olive oil on cotton in 5 hours; and in a chamber heated from 80° to 200° F. (82° to 93° C.) olive oil on cotton ignited in two hours.

Cases of spontaneous combustion due to this cause have been more abundant than from any other, and cases are even on record where serious fires have resulted from sparrows using oily waste in the construction of their nests. In all well regulated workshops the orders against allowing any accumulation of oily waste are very stringent, and the most reasonable precaution to be taken is that all oily material when done with should be thrown into a metal vessel containing water, or which, at any rate, can be either emptied of waste or filled with water at night. If a sheet of cotton be hanging in a warm room and is splashed with oil, a hole will often be found charred in the fabric by the next morning, while if a few drops of a drying oil be allowed to fall on powdered charcoal or lampblack, ignition is almost certain to follow in a few hours.

Another common case of spontaneous ignition is that of haystacks which have been made up before the grass has been thoroughly dried, this being due to the sap left in the vegetable fiber undergoing fermentation, which, being a process of oxidation, gives rise to heat. This heat is kept in by the surrounding hay, which is an admirable non-conductor of heat, and gradually increases until the ignition point of the mass is reached, when the stack bursts into flame. In some cases the action does not go as far as this, and we often see the inside of a haystack charred to an almost black color, showing that the action has stopped but little short of the point required to give active combustion, this being probably due to the stack having been very closely built, and the access of air to the center being small, and in some cases when such a risk is cut, the air coming in contact with the central portion causes active ignition. If hay has once been properly dried and then becomes wet with rain, spontaneous ignition hardly ever takes place, although the hay becomes mouldy, and it is evident that the action which leads to ignition of the hay is fermentation of the sap.

Having now discussed the more common cases of spontaneous ignition, and seen that in every case it is due to rise of temperature, brought about by chemical action until the igniting point of the substance is reached, we are in a position to understand the impossibility of spontaneous combustion taking place in the human body.

The process of respiration by which the tissues of the body used up in every action, voluntary or involuntary, are got rid of by a process of slow combustion, gives a normal temperature to the living body, and it might seem at first sight possible, by preventing the escape of such temperature, to increase it to a point at which ignition might be possible; but we know by experience that the effect of swathing the body in non-conducting materials, so as to prevent the escape of heat from it, results in profuse perspiration, and before the living flesh could undergo combustion it would be necessary to drive from it the whole of the moisture which it contains.

The human body contains from 75 to 80 per cent. of its weight of water, and in order to evaporate this amount an enormous amount of heat would be required and life would have been impossible long before the necessary dryness of the mass had been arrived at. In fact, the moisture present in the body may be looked upon as its great safeguard against the effect of heat, and it is perfectly possible for a living man to remain in an oven which would roast a steak or cook an egg; the evaporation of water from the skin taking up so much heat that the temperature of the living flesh would never rise above a certain point until the moisture was exhausted. It used to be supposed that the cases of spontaneous combustion took place in people whose intemperate habits had caused the body to become saturated with alcohol, and that it was this substance which caused its ready ignition; but as Liebig pointed out some forty years ago, the presence of the alcohol could have no effect, as if we take a sponge and soak it in spirits of wine and ignite it, the alcohol burns away and leaves the sponge untouched, and the same thing would undoubtedly happen in the case of the living flesh.

In this lecture I have tried to bring before you the important fact that spontaneous combustion merely means that the heat due to chemical actions taking place in any substance, heat which has been unable to escape, has raised the temperature to the point of ignition, a point at which slow combustion passes into rapid combustion with manifestation of incandescence; and in speaking of spontaneous combustion we must clearly remember that it represents merely the acceleration of an action which has been going on slowly and surely, although our senses may have been too deadened to detect it, and that if we wished to be hypercritical, "Unaided Ignition," or "Natural Ignition," would be a far more correct term to apply to it than "Spontaneous Combustion."

#### COLOR REACTIONS OF CERTAIN AROMATIC TRIOXIDE COMPOUNDS.

By J. STAHL.

THE reactions mentioned occur in the cases of pyrogallol, gallic acid, pyrogallolcarbonic acid, and tannin. In all these substances alkalies, with the simultaneous action of the oxygen of the air, produce brown or brownish red colors, even if the trioxo-compounds are present only in very minute quantities.

One one-thousandth mgrm. of pyrogallol gives the reaction with ammonia, and soda lye with  $\frac{1}{10000}$  mgrm.;  $\frac{1}{10000}$  mgrm. gallic acid and tannin and  $\frac{1}{1000}$  mgrm. pyrogallolcarbonic acid yield the reactions.

In a series of other reactions given for the trioxo-compounds, e. g., potassium cyanide, sodium nitroprusside, arseniates, etc., the author ascribes the result to the alkalinity of the reagents, the other components merely producing slight modifications in the color.

Baryta and lime water give the above named trioxide compounds the same color reactions as the true

alkalies. Other phenols give with the alkaline earths yellow or reddish tones (resorcin, hydroquinone, phloroglucine) or no colorations ( $\alpha$ -naphthol, thymol, paracresol).  $\beta$ -naphthol turns bluish; pyrocatechine, first violet, afterward greenish black.

As regards the reactions—none of them characteristic—produced by osmic acid, molybdic acid, and solutions of chloride of lime, as also by the oxides of nitrogen and the compounds of chromic acid, we must refer to the original.

The behavior of the trioxo compounds with the compounds of iron is characteristic. Pyrogallolcarbonic acid yields with concentrated solution of ferric chloride a greenish brown coloration or, if much diluted, a violet.

The most sensitive reaction for pyrogallol ( $\frac{1}{10000}$  mgrm.) is a mixture of ferric chloride and potassium ferriyanide, which, in consequence of the reduction of the ferric chloride to the ferrous state, gives a precipitate of Turnbull's blue. Gallic acid, in the absence of air, is not affected by ferrous sulphate.—*Zeit. Anal. Chemie and Pharm. Central Halle; Chem. News.*

#### THE ELECTROLYSIS OF COMMON SALT.

FORMS of apparatus devised for effecting the electrolysis of common salt solution, and collecting the products set free about the electrodes, may be divided into two classes: Those having porous partitions between electrodes and those without, but having some other device, chemical or mechanical, for collecting or by which the products may be collected.

Of porous partitions, of course, there are a great many forms, but no practical data based upon their continued use appear to exist, and it will probably be some time before they are shown to be of much practical use for separating two such products as chlorine and sodium hydrate in solution, which is always above normal temperatures.

Of the method of employing mercury as the cathode, as a carrier of sodium from the electrolyte to another chamber containing water, in which the sodium is supposed to be given up and caustic soda formed, all that can at present be said with regard to it in the absence of working data is that sodium requires a higher electromotive force than hydrogen to liberate, and, therefore, represents greater expenditure of fuel; that it is almost impossible, for the same reason, to avoid the liberation of hydrogen, which, of course, forms an explosive mixture with chlorine; that the circulation of the mercury and appliances incidental thereto means complication, and that impurities or foreign matter settling upon the surface of the mercury will be detrimental to its action. But it is a question whether mercury is practicable for employment in alkali manufacture.

The only form of apparatus of which at present there appears to be any hopes in practical circles is that which has already gone through the ordeal of practical work at Snodland, Kent; and from which only an electrolytic caustic soda in a solid form and in bulk has been produced and sold. It is simple, automatic, compact, all parts are easily and cheaply renewable and no product is employed the loss of which can seriously affect the results.

The life of gas retort carbon as an anode in common salt solutions has been proved in this apparatus after night and day work for over a twelvemonth. Happily, it is much longer than was anticipated by the most sanguine, there being no difficulty whatever in constructing a cheap anode to last six months or longer.

The average efficiency of the apparatus on the basis of 210 ampere hours to the pound of salt is considerably over 80 per cent., maintainable until the solution attains 15 per cent. alkali, Na<sub>2</sub>O, from which 70 per cent. is now being produced of excellent color and purity in the well-known commercial form, in drums; manufacturers and others who have had it reporting upon it very favorably, as well as the bleaching powder produced.

The difference of potential at the terminals of the tanks, each having a capacity of 60 cubic feet, has been brought down by degrees to 4 volts, with a current of 500 amperes; so that the energy consumption can be calculated therefrom and compared with other methods of manufacture. In round figures one-half of the voltage may be said to be employed in overcoming the counter electromotive force from which the resistance proper of the tank is easily calculated.

A good margin of profit can be shown after deducting all costs and expenses incidental to a practical works, and nothing appears to stand in the way of the growth of this important new industry, which, we hope, may be the forerunner of others in the electrical world of a like progressive character.—*The Electrical Review.*

#### THE ALUMINUM COMPANY, LIMITED.

The sixth annual meeting of the shareholders of this company was held recently at the Cannon Street Hotel, London, under the presidency of Mr. G. W. Balfour, M.P. After referring to the actual financial position of the company, the chairman stated that hardly one of the processes with which they started was now in use at Oldbury, and this would indicate to them the difficulties against which the board and the management had had to contend. The title of the company had, in fact, become a misnomer, since they no longer produced aluminum. They had developed the trade in sodium, partly by finding new uses for it and partly by reducing the cost of production; and one material they manufactured—peroxide of sodium—was a completely new commercial product, in which they already did a very large business. Their new electro-chemical process, which was invented by their colleague, Mr. Castner, was for the manufacture of caustic soda and chlorine direct from common salt, by electrolysis. The process turned out the material in a state of chemical purity, and, they believed, at a very much lower price than at present, and it reached in efficiency very close to the margin of what was theoretically possible. Sir Henry Roscoe, M.P., seconded the motion, remarking that he could not endorse the chairman's statement, that in future the mode of making sodium would be by a process similar to that which the company now had in hand. The motion was unanimously adopted. A resolution was afterward passed for reducing the capital from £400,000 to £80,000 by canceling capital which had been called up, but was unrepresented by available assets to the extent of £4 a share and reducing the nominal value of the shares to £1 each.

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