Fires Within

THE CHEMISTRY OF SPONTANEOUS COMBUSTION

Among the wonderful phenomena which chemistry presents to us, there are few more remarkable than those of spontaneous combustion, in which bodies both animate and inanimate emit flames, and are sometimes entirely consumed by internal fire. One of the commonest experiments in chemistry is that of producing inflammation by mixing two fluids perfectly cold. Becker, we believe, was the first person who discovered that this singular effect was produced by mixing oil of vitriol with oil of turpentine.

Borrichios showed that aqua-fortis produced the same effect as oil of vitriol. Tournefort proved that spirit of nitre and oil of sassafras took fire when mixed; and Homberg discovered that the same property was possessed by many volatile oils when mixed with spirit of nitre. Every person is familiar with the phenomena of heat and combustion produced by fermentation. Ricks of hay and stacks of corn have been frequently consumed by the heat generated during the fermentation produced from moisture; and gunpowder-magazines, barns, and paper-mills have been often burned by the fermentation of the materials which they contained. Galen informs us that the dung of a pigeon is sufficient to set fire to a house; and he assures us that he has often seen it take fire when it had become rotten. Casati likewise relates, on good authority, that the fire which consumed the great church of Pisa was occasioned by the dung of pigeons that had for centuries built their nests under its roof.

Among the substances subject to spontaneous combustion, pulverized or finelypowdered charcoal is one of the most remarkable. During the last thirty years no fewer than four cases of the spontaneous inflammation of powdered charcoal have taken place in France. When charcoal is triturated in tuns with bronze bruisers, it is reduced into the state of the finest powder. In this condition it has the appearance of an unctuous fluid, and it occupies a space three times less than it does in rods of about six inches long. In this state of extreme division it absorbs air much more readily than it does when in rods. This absorption, which is so slow as to require several days for its completion, is accompanied with a disengagement of heat which rises from nearly of Fahrenheit, and which is the true cause of the spontaneous inflammation. The inflammation commences near the centre of the mass, at the depth of five or six inches beneath its surface, and at this spot the temperature is always higher than at any other.

Black charcoal, strongly distilled, heats and inflames more easily than the orange, or that which is little distilled, or than the charcoal made in boilers. The most inflammable charcoal must have a mass of at least 66lbs. avoirdupois, in order that it may be susceptible of spontaneous inflammation. With the other less inflammable varieties, the inflammation takes place only in larger masses. The inflammation of powdered charcoal is more active in proportion to the shortness of the interval between its carbonization and trituration. The free admission of air to the surface of the charcoal is also indispensable to its spontaneous combustion. Colonel Aubert, to whom we owe these interesting results, likewise found that when sulphur and saltpetre are added to the charcoal, it loses its power of inflaming spontaneously.

But as there is still an absorption of air and a generation of heat, he is of opinion that it would not be prudent to leave these mixtures in too large masses after trituration. A species of spontaneous combustion, perfectly analogous to that now described, but produced almost instantaneously, was discovered by Professor Dobereiner of Jena in. He found that when a jet of hydrogen gas was thrown upon recently prepared spongy platinum, the metal became almost instantly red hot, and set fire to gas. In this case the minutely divided platinum acted upon the hydrogen gas in the same manner as the minutely divided charcoal acted upon common air. Heat and combustion were produced by the absorption of both gases, though in the one case the effect was instantaneous, and in the other was the result of a prolonged absorption.

This beautiful property of spongy platinum was happily applied to the construction of lamps for producing an instantaneous light. The form given to the lamp by Mr. Garden of London is shown in the annexed figure, where AB is a globe of glass, fitting tightly into another glass globe CD by a ground shoulder m n. The globe AB terminates in a hollow tapering neck m n o p, on the lower end of which is placed a small cylinder of zinc o p. A brass tube a b c, is fitted at a into the neck of the globe CD, and through this tube, which is furnished with a stop-cock d, the gas can escape at the small aperture c. A brass pin c f, carrying a brass box P, is made to slide through a hole h, so that the brass box P, in which the spongy platinum is placed, can be set at any required distance from the aperture c. If sulphuric acid, diluted with an equal quantity of water, is now poured into the vessel AB by its mouth at S, now closed with a stopper, the fluid will descend through the tube m n o p, and if the cock d is shut, it will compress the air contained in CD.

The dilute acid thus introduced into CD will act upon the ring of zinc o p, and generate hydrogen gas, which, after the atmospheric air in CD is let off, will gradually fill the vessel CD, the diluted acid being forced up the tube o p m n, into the glass globe AB. The ring of zinc o p floats on a piece of cork, so that when CD is full of hydrogen, the diluted acid does not touch the zinc, and consequently is prevented from producing any more gas. The instant, however, that any gas is let off at c, the pressure of the fluid in the globe AB, and tube m n o p, overcomes the elasticity of the remaining gas in CD, and forces the diluted acid up to the zinc o p, so as to enable it to produce more gas to supply what has been used.

The lamp being supplied with hydrogen in the manner now described, it is used in the following manner. The spongy platinum in P being brought near c, the cock d is turned, and the gas is thrown upon the platinum. An intense heat is immediately produced, the platinum becomes red-hot, and the hydrogen inflames. A taper is then lighted at the flame, and the cock d is shut. Professor Cumming, of Cambridge, found it necessary to cover up the platinum with a cap after every experiment. This ingenious chemist likewise found, that, with platinum foil the part of an inch thick kept in a close tube, the hydrogen was inflamed; but when the foil was only the of an inch thick, it was necessary to raise it previously to a red heat. Spontaneous combustion is a phenomenon which occurs very frequently and often to a great extent within the bowels of the earth.

The heat by which it is occasioned is produced by the decomposition of mineral bodies and other causes. This heat increases in intensity till it is capable of melting the solid materials which are exposed to it. Gases and aqueous vapours of powerful elasticity are generated, new fluids of expansive energy imprisoned in cavities under great pressure are set free, and these tremendous agents, acting under the repressing forces of the superincumbent strata, exhibit their power in desolating earthquakes; or, forcing their way through the superficial crust of the globe, they waste their fury in volcanic eruptions. When the phenomena of spontaneous combustion take place near the surface of the earth, its effects are of a less dangerous character, though they frequently give birth to permanent conflagrations, which no power can extinguish.

An example of this milder species of spontaneous combustion has been recently exhibited in the burning cliff at Weymouth; and a still more interesting one exists at this moment near the village of Bradley, in Staffordshire. The earth is here on fire, and this fire has continued for nearly sixty years, and has resisted every attempt that has been made to extinguish it. This fire, which has reduced many acres of land to a mere calx, arises from a burning stratum of coal about four feet thick and eight or ten yards deep, to which the air has free access, in consequence of the main coal having been dug from beneath it. The surface of the ground is sometimes covered for many yards with such quantities of sulphur that it can be easily gathered. The calx has been found to be an excellent material for the roads, and the workmen who collect it often find large beds of alum of an excellent quality.

A singular species of invisible combustion, or of combustion without flame, has been frequently noticed. I have observed this phenomenon in the small green wax tapers in common use. When the flame is blown out, the wick will continue red-hot for many hours; and if the taper were regularly and carefully uncoiled, and the room kept free from currents of air, the wick would burn on in this way till the whole of the taper is consumed. The same effects are not produced when the colour of the wax is red. In this experiment the wick, after the flame is blown out, has sufficient heat to convert the wax into vapour, and this vapour being consumed without flame, keeps the wick at its red heat.

A very disagreeable vapour is produced during this imperfect combustion of the wax. Prof. Dobereiner, of Jena, observed that, when the alcohol in a spirit of wine lamp was nearly exhausted, the wick became carbonized, and though the flame disappeared, the carbonized part of the wick became red-hot, and continued so while a drop of alcohol remained, provided the air in the room was undisturbed. On one occasion the wick continued red-hot for twenty-four hours, and a very disagreeable acid vapour was formed. On these principles depend the lamp without flame which was originally constructed by. It is shown in the annexed figure, where AB is the lamp, and h a cylindrical coil of platinum wire, the hundredth part of an inch in diameter. This spiral is so placed that four or five of the twelve coils of which the cylinder consists are upon the wick, and the other seven or eight above it.

If the lamp is lighted, and continues burning till the cylindrical coil is red-hot, then if the flame is blown out, the vapour which arises from the alcohol will by its combustion keep the coils above the wick red-hot, and this red heat will in its turn keep up the vaporization of the alcohol till the whole of the alcohol is consumed. The heat of the wire is always sufficient to kindle a piece of German fungus or saltpetre paper, so that a sulphur match may at any time be lighted. Mr. Gill found that a wick composed of twelve threads of the cotton yarn commonly used for lamps will require half an ounce of alcohol to keep the wire red-hot for eight hours.

This lamp has been kept burning for sixty hours; but it can scarcely be recommended for a bed-room, as an acid vapour is disengaged during the burning of the alcohol. When perfumes are dissolved in the alcohol, they are diffused through the apartment during the slow combustion of the vapour. A species of combustion without flame, and analogous to that which has been described, is exhibited in the extraordinary phenomenon of the spontaneous combustion of living bodies. That animal bodies are liable to internal combustion, is a fact which was well known to the ancients. Many cases which have been adduced as examples of spontaneous combustion are merely cases of individuals who were highly susceptible of strong electrical excitation. In one of these cases, however, Peter Bovisteau asserts, that the sparks of fire thus produced, reduced to ashes the hair of a young man; and John de Viana informs us, that the wife of physician to the Cardinal de Royas, Archbishop of Toledo, emitted by perspiration an inflammable matter of such a nature, that when the ribbon which she wore over her shift was taken from her, and exposed to the cold air, it instantly took fire, and shot forth like grains of gunpowder.

Peter Borelli has recorded a fact of the very same kind respecting a peasant whose linen took fire, whether it was laid up in a box when wet, or hung up in the open air. The same author speaks of a woman who, when at the point of death, vomited flames; and Thomas Bartholin mentions this phenomenon as having often happened to persons who were great drinkers of wine or brandy. Ezekiel de Castro mentions the singular case of Alexandrinus Megetius, a physician, from one of whose vertebræ there issued a fire which scorched the eyes of the beholders; and Krantzius relates, that during the wars of Godfrey of Bouillon, certain people of the territory of Nevers were burning with invisible fire, and that some of them cut off a foot or a hand where the burning began, in order to arrest the calamity. Nor have these effects been confined to man. In the time of the Roman consuls Gracchus and Juventius, a flame is said to have issued from the mouth of a bull without doing any injury to the animal.

The reader will judge of the degree of credit which may belong to these narrations when he examines the effects of a similar kind which have taken place in less fabulous ages, and nearer our own times. John Henry Cohausen informs us that a Polish gentleman in the time of the Queen Bona Sforza, having drunk two dishes of a liquor called brandy-wine, vomited flames, and was burned by them, and Thomas Bartholin thus describes a similar accident: “A poor woman at Paris used to drink spirit of wine plentifully for the space of three years, so as to take nothing else. Her body contracted such a combustible disposition, that one night, when she lay down on a straw couch, she was all burned to ashes except her skull and the extremities of her fingers.”

John Christ. Sturmius informs us, in the German Ephemerides, that in the northern countries of Europe flames often evaporate from the stomachs of those who are addicted to the drinking of strong liquors; and he adds, “that seventeen years before, three noblemen of Courland drank by emulation strong liquors, and two of them died scorched and suffocated by a flame which issued from their stomachs.” One of the most remarkable cases of spontaneous combustion is that of the Countess Cornelia Zangari and Bandi of Cesena, which has been minutely described by the Reverend Joseph Bianchini, a prebend in the city of Verona.

This lady, who is in the sixty-second year of her age, retired to bed in her usual health. Here she spent above three hours in familiar conversation with her maid, and in saying her prayers; and having at last fallen asleep, the door of her chamber was shut. As her maid was not summoned at the usual hour, she went into the bed-room to wake her mistress; but receiving no answer, she opened the window, and saw her corpse on the floor in the most dreadful condition. At the distance of four feet from the bed there was a heap of ashes. Her legs, with the stockings on, remained untouched, and the head, half burned, lay between them. Nearly all the rest of the body was reduced to ashes.

The air in the room was charged with floating soot. A small oil lamp on the floor was covered with ashes, but had no oil in it; and in two candlesticks, which stood upright upon a table, the cotton wick of both the candles was left, and the tallow of both had disappeared. The bed was not injured, and the blankets and sheets were raised on one side, as if a person had risen up from it. From an examination of all the circumstances of this case, it has been generally supposed that an internal combustion had taken place; that the lady had risen from her bed to cool herself, and that, in her way to open the window, the combustion had overpowered her, and consumed her body by a process in which no flame was produced which could set fire to the furniture or the floor.

The Marquis Scipio Maffei was informed by an Italian nobleman who passed through Cesena a few days after this event, that he heard it stated in that town, that the Countess Zangari was in the habit, when she felt indisposed, of washing all her body with camphorated spirit of wine. So recently as a similar example of spontaneous combustion occurred in our own country, at Ipswich. A fisherman's wife, of the name of Grace Pett, of the parish of St. Clement's, had been in the habit for several years of going down stairs every night, after she was half undressed, to smoke a pipe. She did this on the evening of the of April,. Her daughter, who lay in the same bed with her, had fallen asleep, and did not miss her mother till she awaked early in the morning. Upon dressing herself, and going down stairs, she found her mother's body lying on the right side, with her head against the grate, and extended over the hearth, with her legs on the deal floor, and appearing like a block of wood burning with a glowing fire without flame.

Upon quenching the fire with two bowls of water, the neighbours, whom the cries of the daughter had brought in, were almost stifled with the smell. The trunk of the unfortunate woman was almost burned to ashes, and appeared like a heap of charcoal covered with white ashes. The head, arms, legs, and thighs, were also much burned. There was no fire whatever in the grate, and the candle was burned out in the socket of the candlestick, which stood by her. The clothes of a child on one side of her, and a paper screen on the other, were untouched: and the deal floor was neither singed nor discoloured. It was said that the woman had drunk plentifully of gin overnight in welcoming a daughter who had recently returned from Gibraltar. Among the phenomena of the natural world which are related to those of spontaneous combustion, are what have been called the natural fire-temples of the Guebres, and the igneous phenomena which are seen in their vicinity.

The ancient sect of the Guebres or Parsees, distinguished from all other sects as the worshippers of fire, had their origin in Persia; but, being scattered by persecution, they sought an asylum on the shores of India. Those who refused to expatriate themselves continued to inhabit the shores of the Caspian Sea, and the cities of Ispahan, Yezd, and Kerman. Their great fire-temple, called Attush Kudda, stands in the vicinity of Badku, one of the largest and most commodious ports on the Caspian. In the neighbourhood of this town the earth is impregnated with naphtha, an inflammable mineral oil; and the inhabitants have no other fuel, and no other light, but what is derived from this substance. The remains of the ancient fire-temples of the Guebres are still visible about ten miles to the north-east of the town.

The temple in which the deity is worshipped under the form of fire, is a space about thirty yards square, surrounded with a low wall, and containing many apartments. In each of these a small volcano of sulphureous fire issues from the ground through a furnace or funnel in the shape of a Hindoo altar. On closing the funnel, the fire is instantly extinguished; and by placing the ear at the aperture, a hollow sound is heard, accompanied with a strong current of cold air, which may be lighted at pleasure by holding to it any burning substance. The flame is of a pale, clear colour, without any perceptible smoke, and emits a highly sulphureous vapour, which impedes respiration, unless when the mouth is kept beneath the level of the furnace.

This action on the lungs gives the Guebres a wan and emaciated appearance, and oppresses them with a hectic cough, which strangers also feel while breathing this insalubrious atmosphere. For about two miles in circumference, round the principal fire, the whole ground, when scraped to the depth of two or three inches, has the singular property of being inflamed by a burning coal. In this case, however, it does not communicate fire to the adjacent ground: but if the earth is dug up with a spade, and a torch brought near it, an extensive but instantaneous conflagration takes place, in which houses have often been destroyed, and the lives of the people exposed to imminent danger.

When the sky is clear and the weather serene, the springs in their ebullition do not rise higher than two or three feet; but in gloomy weather, and during the prevalence of stormy clouds, the springs are in a state of the greatest ebullition, and the naphtha, which often takes fire spontaneously at the earth's surface, flows burning in great quantities to the sea, which is frequently covered with it, in a state of flame, to the distance of several leagues from the shore. Besides the fires in the temple, there is a large one which springs from a natural cliff in an open situation, and which continually burns. The general space in which this volcanic fire is most abundant is somewhat less than a mile in circuit. It forms a low flat hill, sloping to the sea, the soil of which is a sandy earth, mixed with stones.

Mr. Forster did not observe any violent eruption of flame in the country around the Attush Kudda; but Kinneir informs us, that the whole country round Badku has at times the appearance of being enveloped in flames. "It often seems," he adds, "as if the fire rolled down from the mountains in large masses, and with incredible velocity; and during the clear moonshine nights of November and December, a bright blue light is observed at times to cover the whole western range. The fire does not consume; and if a person finds himself in the middle of it, no warmth is felt." The inhabitants apply these natural fires to domestic purposes, by sinking a hollow cane or merely a tube of paper, about two inches in the ground, and by blowing upon a burning coal held near the orifice of the tube, there issues a slight flame, which neither burns the cane nor the paper.

By means of these canes or paper tubes, from which the fire issues, the inhabitants boil the water in their coffee-urns, and even cook different articles of food. The flame is put out by merely plugging up the orifice. The same tubes are employed for illuminating houses that are not paved. The smell of naphtha is of course diffused through the house: but after any person is accustomed to it, it ceases to be disagreeable. The inhabitants also employ this natural fire in calcining lime. The quantity of naphtha procured in the plain to the south-east of Badku is enormous. It is drawn from wells, some of which yield from. per day. As soon as these wells are emptied, they fill again till the naphtha rises to its original level. 36 Inflammable gases issuing from the earth have been used both in the old and the new world for domestic purposes. In the salt mine of Gottesgabe, at Rheims, in the county of Fecklenburg, there is a pit called the Pit of the Wind, from which a constant current of inflammable gas has issued for sixty years.

M. Roeder, the inspector of the mines, has used this gas for two years, not only as a light, but for all the purposes of domestic economy. In the pits which are not worked, he collects the gas, and conveys it in tubes to his house. It burns with a white and brilliant flame, has a density of about and contains traces of carbonic acid gas and sulphuretted hydrogen. Near the village of Fredonia, in North America, on the shores of Lake Erie, are a number of burning springs, as they are called. The inflammable gas which issues from these springs is conveyed in pipes to the village, which is actually lighted by them. In the year a copious spring of inflammable gas was discovered in Scotland, in the bed of a rivulet which crosses the north road between Glasgow and Edinburgh, a little to the east of the seventh mile-stone from Glasgow, and only a few hundred yards from the house of Bedlay.

The gas is said to issue for more than half a mile along the banks of the rivulet. Dr. Thompson, who has analysed the gas, saw it issuing only within a space about fifty yards in length, and about half as much in breadth. "The emission of gas was visible in a good many places along the declivity to the rivulet in the immediate neighbourhood of a small farm-house. The farmer had set the gas on fire in one place about a yard square, out of which a great many small jets were issuing. It had burnt without interruption during five weeks, and the soil (which was clay) had assumed the appearance of pounded brick all around.

"The flame was yellow and strong, and resembled perfectly the appearance which carburetted hydrogen gas or fire-damp presents when burnt in daylight. But the greatest issue of gas was in the rivulet itself, distant about twenty yards from the place where the gas was burning. The rivulet, when I visited the place, was swollen and muddy, so as to prevent its bottom from being seen. But the gas issued up through it in one place with great violence, as if it had been in a state of compression under the surface of the earth; and the thickness of the jet could not be less than two or three inches in diameter.

We set the gas on fire as it issued through the water. It burnt for some time with a good deal of splendour; but as the rivulet was swollen, and rushing along with great impetuosity, the regularity of the issue was necessarily disturbed, and the gas was extinguished." found this gas to consist of two volumes of hydrogen gas, and one volume of vapour of carbon; and as its specific gravity was , and as it issues in great abundance, he remarks that it might be used for filling airballoons. "Were we assured," he adds, "that it would continue to issue in as great abundance as at present, it might be employed in lighting the streets of Glasgow."

A very curious natural phenomenon, called the Lantern or Natural Lighthouse of Maracaybo, has been witnessed in South America. A bright light is seen every night on a mountainous and uninhabited spot on the banks of the river Catatumbo, near its junction with the Sulia. It is easily distinguished at a greater distance than forty leagues, and as it is nearly in the meridian of the opening of the Lake of Maracaybo, navigators are guided by it as by a light-house. This phenomenon is not only seen from the sea-coast, but also from the interior of the country—at Merida, for example, where M. Palacios observed it for two years. Some persons have ascribed this remarkable phenomenon to a thunder-storm, or to electrical explosions which might take place daily in a pass in the mountains; and it has even been asserted, that the rolling of thunder is heard by those who approach the spot.

Others suppose it to be an air-volcano, like those on the Caspian Sea, and that it is caused by asphaltic soils like those of Mena. It is more probable, however, that it is a sort of carburetted hydrogen, as hydrogen gas is disengaged from the ground in the same district. Grand as the chemical operations are which are going on in the great laboratory of Nature, and alarming as their effects appear when they are displayed in the terrors of the earthquake and the volcano, yet they are not more wonderful to the philosopher than the minute though analogous operations which are often at work near our own persons, unseen and unheeded. It is not merely in the bowels of the earth that highly expansive elements are imprisoned and restrained, and occasionally called into tremendous action by the excitation of heat and other causes.

Fluids and vapours of a similar character exist in the very gems and precious stones which science has contributed to luxury and to the arts. In examining with the microscope the structure of mineral bodies, I discovered in the interior of many of the gems thousands of cavities of various forms and sizes. Some had the shape of hollow and regularly formed crystals; others possessed the most irregular outline, and consisted of many cavities and branches united without order, but all communicating with each other. These cavities sometimes occurred singly, but most frequently in groups forming strata of cavities, at one time perfectly flat and at another time curved. Several such strata were often found in the same specimen, sometimes parallel to each other, at other times inclined, and forming all varieties of angles with the faces of the original crystal.

These cavities, which occurred in sapphire, chrysoberyl, topaz, beryl, quartz, amethyst, peridot, and other substances, were sometimes sufficiently large to be distinctly seen by the naked eye, but most frequently they were so small as to require a high magnifying power to be well seen, and often they were so exceedingly minute, that the highest magnifying powers were unable to exhibit their outline. The greater number of these cavities, whether large or small, contained two new fluids different from any hitherto known, and possessing remarkable physical properties. These two fluids are in general perfectly transparent and colourless, and they exist in the same cavity in actual contact, without mixing together in the slightest degree.

One of them expands thirty times more than water, and at a temperature of about of Fahrenheit it expands so as to fill up the vacuity in the cavity. This will be understood from the annexed figure, where A B C D is the cavity, m n p o the highly expansible fluid in which at low temperatures there is always a vacuity V, like an air-bubble in common fluids, and A m n, C o p, the second fluid occupying the angles A and C. When heat such as that of the hand is applied to the specimen, the vacuity V gradually contracts in size, and wholly vanishes at a temperature of about , as shown in.

The fluids are shaded, as in these two figures, when they are seen by light reflected from their surfaces. When the cavities are large, as in, compared with the quantity of expansible fluid m n p o, the heat converts the fluid into vapour, an effect which is shown by the circular cavity V becoming larger and larger till it fills the whole space m n o p. When any of these cavities, whether they are filled with fluid or with vapour, is allowed to cool, the vacuity V reappears at a certain temperature. In the fluid cavities the fluid contracts, and the small vacuity appears, which grows larger and larger till it resumes its original size.