SULPHUROUS ACID AS A DISINFECTANT.

By THOMAS W. KEATES, Consulting Chemist to the Metropolitan Board of Works, London.

FROM the remotest time burning sulphur has been employed to fumigate and purify infected air, and to destroy fermentative and putrefactive action. There is no agent more powerful in its effects than this. Unlike chlorine, it not only acts as a disinfectant or destroyer of disease germs and of the results of putrefaction, but it is also a powerful preservative agent, and, like carbolic acid, is a preventive of chemical changes in dead organic matter of every kind.

Although the value of sulphurous acid is thoroughly understood, its use is necessarily limited by the difficulty which exists in the way of producing it in a form in which it can be readily applied. The ordinary method of generating it by burning sulphur is cumbersome and very uncertain, owing to the difficulty of keeping up the combustion; there are also many situations in which the process cannot be carried on at all, and under the best circumstances it is inconvenient and but little under control. The evolution of the gas from its solution in water is scarcely more convenient, while it is much less effective; indeed, it may be said that there is no ready, convenient, and easily controllable way of producing this valuable agent in use at present; and this is the more remarkable when it is considered what a ready and simple means we really have at hand for this purpose.

Most of the readers of *The Lancet* are no doubt familiar, at least theoretically, with the substance called bisulphide of carbon. This is a compound of one atom of carbon with two atoms of sulphur (CS_2); it is a dense, mobile liquid, heavier than water, and intensely inflammable, burning in the air like spirit of wine. During combustion the constituents of the bisulphide combine with the oxygen of the air, producing sulphurous and carbonic acid gases; but as 100 parts contain, by weight, as much as 84 parts of sulphur, which will give, in burning, 168 parts of sulphurous acid, it will be seen that the volume of this gas from a given quantity of bisulphide greatly exceeds that of the carbonic acid, and is comparatively very large. Suppose the above quantities to be in grains: as 100 cubic inches of sulphurous acid weigh 68.5 grs., the 168 grs. will measure upwards of 245 cubic inches, or about one seventh of a cubic foot, which is the volume of sulphurous acid obtainable from 100 grs. of bisulphide.

The bisulphide of carbon can be burned in a common spirit lamp, and in that case the products are sulphurous acid and carbonic acid only, in relative proportion to the atomic composition of the bisulphide, as I have stated; but, by a modification of the method of burning, the amount of sulphurous acid produced in a given time can be regulated to any desired extent.

It is a property of the bisulphide of carbon to dissolve in fat oils and hydrocarbon liquids, such as petroleum; so, by mixing it with any one of these liquids and burning the mixture in a properly constructed oil or petroleum lamp, sulphurous acid will be generated with the other usual products of the combustion of such materials, and in proportion to the quantity of bisulphide present in the mixture of combustible liquids; any proportionate quantity of sulphurous acid can in this way be thrown into an atmosphere, and the action may be continued for any length of time.

As the sulphurous gas is generated *pari passu* during the combustion of the bisulphide, it diffuses itself in the air, which in a short time will become completely impregnated with it. In a room containing about 1,300 cubic feet of air it was found that by burning 280 grs. of the bisulphide the atmosphere was so far charged with sulphurous acid that it was impossible to remain in the room for more than a few seconds. In five minutes after the lamp was lighted litmus paper began to be reddened at some distance from it; in ten minutes the air had become very oppressive, and the litmus paper was reddened in the extreme corners of the room; in fifteen minutes the air was so charged with the gas that it could scarcely be breathed, and in twenty minutes it was unbearable. In that time, as I have said, 280 grs. of bisulphide were consumed in a simple single-wick lamp.

Sulphurous acid generated in this manner can be applied with facility to the disinfection of any place or object. In the case of rooms in which infectious or contagious disease has prevailed, it is only necessary to light the lamp and allow it to burn until the atmosphere has become impregnated with the gas to any desired extent, and then to remove or extinguish it just like a common spirit lamp. In the simple form of apparatus which I suggest for this purpose, the lamp is enclosed in a metal case, about 3 inches in diameter and 8 or 9 inches high, furnished with holes near the bottom for the admission of air, and others in the top for the emission of the sulphurous gas. This can be conveniently moved about, and placed, while the lamp is burning, in almost any locality. Receptacles for infected clothing, or the clothes or linen used in connection with disease, or carriages which have conveyed fever or other patients, can be thoroughly purified without difficulty and with very little trouble. For the disinfection of ships, too, the lamp is particularly suitable, as it can be carried into the remotest part of a ship and burned without the least danger, and with the certainty of effecting its object completely.

It must be observed that the bisulphide of carbon is extremely volatile, having its boiling point as low as 110°F ; it is therefore necessary that the lamp in which it is burned should be furnished with a well fitting screw cap, to prevent the liquid from evaporating, and at the same time to keep its peculiar odor from escaping. This odor is often very nauseous, but the bisulphide is now manufactured by Messrs. C. Price & Co., of Thames Street, London, England, so pure, that it possesses very little smell, and can be used without the least inconvenience.—*The Lancet*.

NEW TEST PAPER.

M. PIERRE MIQUEL.

THE author finds that sulphyocyanic acid produces upon paper free from iron a carmine red spot, which disappears spontaneously on exposure to the air, and more rapidly if a gentle heat be applied. Ammoniacal vapors destroy the color immediately, and hydrochloric gas restores it. Thus a test paper is obtained far more sensitive than litmus.

WATERPROOFING WOOLLEN MATERIALS.

THE following method of rendering woollen textures waterproof is recommended: Boil 125 grammes (about $4\frac{1}{2}$ ozs.) of white soap in 12 litres (about 2½ gallons) of water, and separately dissolve 165 grammes (about 5½ ozs.) of alum in 12 litres (about 2½ gallons) of water. Heat these two solutions to 190°Fahr ; then pass the woollen fabric once through the soap bath, and afterwards through the alum solution. Lastly, dry it in the open air.

DECOLORATION OF INDIGO.

M. E. SCHAEER.

It is generally admitted that the decoloration of indigo by these agents is due to its transformation into white indigo, and, in fact, mere agitation in the air suffices to restore the blue color. But certain experiments seem to show that the decoloration is produced by the formation of a colorless molecular compound. For indigo decolorized by hydro-sulphurous acid is regenerated, not only by the action of air and oxidizing agents, but also by decided reducing agents, such as sulphuretted hydrogen. Further, indigo bleached by the persulphide of hydrogen is restored by the action of sulphurous acid. These phenomena are explained by the decomposing action of sulphuretted hydrogen upon hydro-sulphurous acid, and of sulphurous acid upon persulphide of hydrogen. We may, then, admit that indigo combines with hydro-sulphurous acid and persulphide of hydrogen, forming colorless compounds, which are destroyed with liberation of the indigo by all agents capable of destroying either hydro-sulphurous acid or persulphide of hydrogen.

STILL'S GAS PURIFIER.

FIG. 1 is a longitudinal section of this purifier. A A is a cylindrical case, and B a shaft, which runs the whole length of the cylinder, A; it has its bearings in stuffing boxes which are placed around it, where it passes through the ends, C C, of the cylinder; and also in the upright bars, D, D, D. E, E, E are a set of wooden rollers, affixed on the shaft B; they are studded with strips of whalebone, or other flexible material, throughout their whole length. A cross section of one of them is given in Fig. 2. The cylinder A, is filled to the height of the line *a b* with water, or a mixture

STILL'S GAS PURIFIER.

of lime and water, or any other suitable liquid or solution; the shaft, B, is made to rotate by means of a band from some prime moving power passed over the pulley, F. The gas to be purified is then allowed to escape through the pipe, G, and after passing through the machine it escapes by the pipe, H. When a fresh supply of water, or lime and water, is required, the previous or exhausted charge is allowed to flow into the vessel, I, by means of the valve, K, from which vessel it can be subsequently removed through the door, L. The fresh material is supplied to the cylinder through the pipe, M.—*Journal of Gas Lighting*.

SENSITIVE FLAME APPARATUS FOR ORDINARY GAS PRESSURE.

A GLASS or metallic tube, about 5 inches long, and $\frac{1}{2}$ in diameter, is closed at one end with a perforated cork, through this cork slides a piece of $\frac{1}{4}$ inch tubing, about 6 inches long. One end of this is either drawn out to a jet, or closed in the blowpipe flame to reduce its diameter to about $\frac{1}{8}$ inch, and the other end is connected to a gas supply. (Fig. 1.)

The outer tube is held in a suitable support, and the inner tube is pushed through the cork, till it nearly reaches the mouth of the outer one, and a light then supplied. It now gives a long steady flame.

EXPERIMENT I.—Lower the inner tube till the flame is on the point of roaring. It will now be found very sensitive to noise. Snapping the fingers at a distance of eight or ten yards will cause it to contract fully $\frac{1}{2}$ of its height. The most suitable flame for this is about 6 inches high.

EXPERIMENT II.—Adjust the gas to give a flame of about $4\frac{1}{2}$ inches high, and gradually raise the inner tube. A point will be reached at which the flame becomes sensitive, not to noise, but note; and it will be found to respond to a certain note by dividing into two portions, and while this note is produced it will continue divided. It is difficult to keep the exact note by whistling with the mouth, and therefore a glass whistle with paper slider should be used, or, better still, a singing tube with adjustment.

EXPERIMENT III.—Arrange two singing tubes to give the responding note. The flame divides. Now make one tube a little sharper than the other, so as to beat slowly. The apex of the flame alternately recedes and coalesces.

EXPERIMENT IV.—Using the whistle; blow it so hard as to produce higher octaves of the responding note. The flame will be unaffected as though in perfect silence.

The dimensions of the instrument are open to great variation, and also the size of the flame. For lecture work, a flame $1\frac{1}{2}$ or 2 feet would be more suitable, though less sensitive, and neither dividing nor shortening so perfectly as the sizes given above. It will act effectively with any pressure of gas, from $\frac{1}{16}$ inch (of water) upwards, and the sliding jet makes it equally sensitive with a large or small gas supply.

ESCAPE OF GAS FROM CONTRACTED OPENINGS.

Glass tubes of about $\frac{1}{4}$ inch bore are joined, as shown in Fig. 2. At D the tube is slightly bent so as to retain a little drop of water. The gas enters at C, and then divides into two channels, one towards B, the other towards A. If one of the exits be contracted, say B, then the water moves towards A. Certain precautions have to be observed, the conditional arrangements of which need not be mentioned here.

EXPERIMENT I.—Connect to each, A and B, a tapering jet, and C with the gas supply. Get the water stationary. Now light, say B, the water will move towards A, showing that the exit of the gas is retarded by being ignited.

This is rather a remarkable result, seeing that the gas is hotter, and therefore more mobile, and also that the heat must enlarge the aperture. Now light A, and the water will return to zero.

EXPERIMENT II.—Connect B with a sensitive flame appa-

FIG. 2.

ratus, A remaining as before, light and adjust to zero. Now sound the responding note and the water moves towards A, showing that the outflow of gas is retarded by a certain note. Now adjust the sensitive flame for noise, and rapidly snap the fingers or stamp the foot, and the water will still move towards A.

EXPERIMENT III.—Arrange as in II., then extinguish the sensitive flame and readjust to zero. Produce the responding note, and the same movement of water will be observed.

This shows that an issuing jet is affected in the same manner by a sound, whether ignited or otherwise.

EXPERIMENT IV.—Fix the sensitive flame apparatus adjusted for note under a large jar open at both ends. A large stoppered gas jar answers very well. Fix three balls of spongy platinum, *a*, *b*, and *c*, upon a piece of thin platinum wire so that the point of the quiescent flame just reaches *b*, and the points of the responding flame reach *a* and *c* respectively. Now extinguish the flame without turning off the gas. The issuing gas will cause the ignition of *b*. Now sound the responding note, and *b* will cool, and *a* and *c* will be ignited. This confirms the previous observations, and forms a rather pretty lecture experiment. The object of the gas jar is merely to protect from air currents.—*Nature*.

R. H. RIDOUT.

THE CHEMISTRY OF COAL.

A COURSE of six lectures to workmen on the above subject was lately given by Dr. Frankland, F.R.S., in the Chemical Lecture Theatre, South Kensington, in connection with the Royal School of Mines, London. The lecturer said there is no substance in nature, however common or apparently uninteresting it may be, which will not prove itself worthy of our attention if we examine it carefully, though it be merely a piece of sandstone, or even a brickbat. All of them have wonderful histories to tell us if we only apply to them those powers of observation and experiment which are always at hand; but no substance in nature, perhaps, has such a wonderful history and extraordinary properties as coal. To ascertain this history and these properties it will require more minute observation than is ordinarily bestowed upon it. Simple observation will readily show us that it is an opaque, brittle, hardish black substance; thrown on the fire it swells, gives off dense smoke, glows, and eventually burns. Coal is found embedded almost exclusively in certain rocks, named by geologists "coal measures," and the carboniferous system, in which these coal measures occur, stands far down in the geological series, as will be seen in the diagram. The coal is found interstratified with the other rocks of the coal measures in very thin seams compared with those rocks. The amount of this coal is, after all, very enormous, even the quantity we have in this country, and we have a very large share of the total coal worked in Europe at the present time. Arranged in order according to the amount of coal raised per annum, commencing with the highest, the following countries stand thus: British Isles, Germany, United States, Belgium, France, Russia, Austria, Spain. The following statements as to the amount raised yearly in the British Isles will, perhaps, be striking to some. If we were to dig a hole through the centre of the earth that hole would be 8,000 miles long; now, if the coal raised in one year in Great Britain were made into a bar 1 yard square, each yard of the bar weighing about 1 ton, the portion of the bar within the hole mentioned would represent about one seventh of the total quantity. Again, the circumference of the earth is about 24,000 miles, and if the coal raised in Great Britain in a year were made into a band 1 yard thick and 7 yards wide (each yard weighing, therefore, about 7 tons), that band would go all round the earth and leave about 3,000,000 yards to spare. The coal raised in four and a half years would bridge the space between the earth and the moon with a bar 1 yard square. The quantity raised in Great Britain yearly is between 100,000,000 and 107,000,000 tons. The quantity we possess is, after all, limited, and if we go on digging coal in this way it will before very long become a pressing problem how we are to prevent any waste of this valuable material. From the best sources of information, although it is very difficult to make an estimate, we have still to get, at less depths than 4,000 ft., only about 83,000,000,000 tons.

When closely examined coal is found to consist of vege-