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THE LATEST IMPROVEMENTS IN ACETYLENE GAS.

BY W. TYREE.

Since we last had the pleasure of addressing this Association, about twelve months ago, the acetylene gas industry has made vast strides. The rapid increase in the number of carbide factories which we then reported was going on has continued, and continues still. It is probable that at the present moment the world's output of carbide is something over 200,000 tons per annum. It was confidently asserted this time last year that a big drop in the carbide market was close at hand owing to over-production, but this prediction has not been fulfilled; the demand for carbide is still ahead of the supply, the fluctuations that have taken place in the price during the past twelve months have been slight, and at the present moment the tendency of the market is upwards. Last year it was generally conceded that acetylene had more than passed its experimental stages, and had taken its place as a recognised illuminant; to-day it must be admitted that acetylene lighting and carbide manufacture promise to be one of the giant industries of the new century.

Germany has undoubtedly taken the lead of the world in acetylene matters. Some of the largest carbide factories in the world are either in Germany or owned by German firms, and there is no doubt that the output of carbide controlled by Germany is greater than that of any other country. According to the German Statistical Office there were 62,000 jets of acetylene in Germany in July, 1898, at the beginning of 1899 there were

170,000, and at the end of the year an estimate was published putting the number of jets at a quarter of a million. There are one hundred and twenty firms in Germany devoted solely to the manufacture of acetylene generators, burners, lamps, and other accessories. Twenty-seven towns are lit throughout, and the gas is being used for both heating and power. Probably one cause of the rapid growth of the business in Germany was the early adoption by the Prussian State Railways of a mixture of acetylene and oil gas for lighting their railway trains. The other German State lines are now following the example of Prussia, and it is estimated that this year no less than eight thousand tons of carbide will be required by the German railways. These details are gathered from a recent article by the British Consul at Stuttgart.

All over Europe acetylene is making vast strides. One firm in France recently reported they had contracts for lighting one hundred and twenty-five towns. In a recent British Consular report it was stated that in addition to the three carbide factories of 14,000 h.p. then at work at Norway, twenty others were in contemplation. The British patentees, the Acetylene Illuminating Co., Ltd., have increased their plant at Foyers, Scotland, to a capacity of 250 tons per month; this company are now putting up new and extensive works in Wales. In Australia, though no carbide factory has yet been erected, and the business is being conducted under the heavy handicap of imported carbide, rapid progress has been made, and the number of installations at work is increasing every day, whilst the light is being used for a greater variety of purposes.

Undoubtedly the most noteworthy installation we have put in has been that at the Sydney Cricket Ground, where, from December to March last, bicycle races were run under the light of acetylene. This installation brought acetylene into direct comparison with electric light, which was used the previous year at the same ground for the same purpose, and the comparison was altogether in favour of the acetylene. The press, the officials, and the riders were unanimous in declaring that we had lit the track more brilliantly than before, that

the light was whiter, that it was perfectly steady, whereas the electric light flickered, and that the acetylene was more comfortable to the eye. The installation was useful, too, in proving locally what had already been proved abroad, namely, that acetylene was applicable for extensive installations as for isolated buildings. There were several miles of piping, and some three thousand burners. The gas was supplied from three batteries of generators on the non-automatic principle, fourteen generators in all, each connected with its own section of the installation. One inch was the largest size of pipe used, and not the slightest difficulty was experienced as to pressure. The track was lighted by 103 shades, hung well over the track, and throwing the light directly downwards. They were sixteen feet apart, and fifteen feet above the track, supplied with gas from outside, and secured from outside by light angle iron supports The whole plant was erected in fourteen days.

Practically, this was a demonstration in town lighting that has aroused the interest of country municipalities in the subject. A number of them are now in negotiation with my company, and I hope before many weeks to be able to point to an Australian town lighted right through for both public and private lighting with acetylene. Balclutha, in New Zealand, has taken the lead, and is burning acetylene through an ex-water gas installation. The fillowing is the latest authentic list of towns lighted by acetylene I have been able to obtain; it is a list published in the London "Journal of Gas Lighting," of December 5th last, with one or two additions from other sources:—

England: Hawes, Heswell, Humanby, Hillsley. Scotland: Cordenbeath. Ireland: Boyle. America: Merchantsville, Wabash, New Milford, Milford, Milbrock, N.Y. France: Aizonne, Cremieuz, Marcenat. Hungary: Mezotur, Totis, Vesprem. Germany: Hassfurt, Schonsee, Olive, Ellerbeck, Grossenlinden, Deaden, Strelitz, Treptow, Peiskretschem, Achim, Sulzburg, Allendorf and Soden, Schlangenbad, Durenberg, Guttstadt, Johannisberg, Passenheim, Seneburg, Ratzebuhr, Friedland, Arys, Bisvhofswerder, Prauenberg, Saalfeld, Daese, Stolzenfels.

As there are probably gentlemen present to-night who did not hear my last paper, and others who have forgotten it, I propose to go to some extent over the old ground, incorporating what new information is available.

CHEMISTRY.

Crystalline carbide of calcium is carbon and calcium in the proportions of two atoms of carbon to one atom of calcium, a grey, black substance, crystalline in formation, and intensely hard. It is non-inflammable, and cannot be exploded. Water produces chemical change in carbide of calcium. It causes a double reaction. Its hydrogen enters into chemical union with the carbon in the carbide, forming acetylene gas, $C_2 H_2$., and its oxygen unites with the calcium of the carbide, forming hydrate of lime. Carbon and calcium will unite to form crystalline carbide of calcium only at a temperature of 5000 deg. Fah., a heat nowhere obtainable except in the electric furnace.

DISCOVERY.

Carbide of calcium and acetylene gas were discovered by Edmund Davy, in 1836, but his carbide was not crystalline like commercial carbide of to-day, but amorphous, and produced only by a circuitous and expensive chemical process of no commercial use. Half a century later a lining of coke and lime was adopted for the crucibles of electric furnaces used in American aluminium works These linings were turned by the heat into carbide of calcium; the furnace boys found amusement in throwing water on to them when discarded, and igniting the resulting acetylene. The recognition of the phenomenon and its vast commercial importance is due to Mr. T. H. Wilson, an experimental chemist engaged at Mr. J. T. Morehead's aluminium works, at Spray, North Carolina, U.S.A. Wilson made crystalline carbide of calcium in 1888. Till the end of 1894 he was engaged in experimenting as to the right proportions of carbon and lime to use, the right amperage and voltage of the electric current and other details, and in 1895 he filed his patents and the commercial production of carbide of calcium commenced. After Wilson had submitted samples of his carbide to various scientific friends, a similar discovery was made quite independently by a French chemist

named Moisson. Moisson submitted samples to a French Scientific Society, but clearly had no idea of the commercial value of the discovery till Wilson commenced to manufacture his carbide on a large scale.

MANUFACTURE OF CARBIDE.

The ingredients almost universally used for the manufacture of carbide are coke and lime. These, in the proportion of 6 parts of coke to 4 parts of lime, are finely ground and intimately commingled. They are then submitted to the intense heat of the electric furnace, in which they fuse, the mixture taking a crystalline form on cooling. There has been much talk, as I mentioned in my paper last year, of producing carbide of calcium without the aid of the electric furnace. The talk continues, but up to date it has remained talk, and none of the experts in the business appear in the slightest degree sanguine that carbide will ever be produced apart from the high temperature of the electric furnace, or that this high temperature can be produced and brought to bear on the raw materials by any other agency.

ACETYLENE GENERATORS.

Acetylene gas is generated the moment carbide of calcium and water come together. This simple principle has brought into the field a perfect army of inventors in every civilized country. In Germany, for instance, 617 applications for patent protection for acetylene appliances were made in 1897, and last year the number was 937. He would show a few of the different types of generators.

This is a type known as the "Plunger"; it consists of two cylinders each closed at the end, and working one within the other. The lower cylinder is filled with water, and in the top of the upper cylinder a basket of carbide is suspended. The upper cylinder sinks into the lower till the carbide contained in the former touches the water; gas is instantly formed, and the upper cylinder rises, lifting the carbide out of the water. The gas is drawn off by a pipe rising through the water to just above its level, and as the gas made is consumed, the upper cylinder again falls till the carbide touches the water and a fresh make of gas lifts it again. This process goes on

till the carbide is exhausted. This generator is very handy for portability, but it has the following defects:—
1. The charge of carbide gets extremely hot, and the chemical action of the heat on the gas is to turn some of it into benzine, styrolene tar, and other substances. Thus the yield of gas per pound of carbide is reduced, the illuminating power of the flame is lessened, water and tar may be deposited in the pipes, and the burners will soon choke and smoke.

2. Each time the generator is recharged the bell is filled with air, so that when gas is first made there is a mixture of gas and air in the generator. This is explosive, and renders the machine more liable to accident than one more scientifically devised. This mixture should be run off at the tap for a few seconds before the generator is connected to the burners.

3. Unless the carbide basket is well devised the gas will generate too rapidly; gas will escape at the sides and be wasted, besides causing an unpleasant smell.

In this particular member of the family too rapid generation is guarded against by putting the charge into separate cups perforated for water at different distances from the bottom, so that only one cup is attacked at once, the others not producing gas till the first is exhausted.

A variation of the "Plunger" generator has the carbide in a fixed instead of a moveable cylinder. As the gas cannot make room for itself upwards, it acts in the opposite direction and drives the water downwards and thus away from the carbide.

Another variation has an opening in the top of the upper cylinder secured by a gas-tight clamp, so that recharging can be done without removing the cylinder. All variations of this type are open to the objections already mentioned.

The automatic generators have this advantage, that they can be made more cheaply than a non-automatic generator; they take up less room, and therefore are more portable. To meet the wants of those who require a cheap generator, that will be fairly reliable, we have introduced what is known as the "Hercules" type; in this the carbide is passed, as you see, into the bottom of the

generator in a water jacket. The water in the top tray passes down through the tube, through the syphon, and then into the carbide chamber. The gas passes from the carbide chamber through a check valve up into the holder, is turned down into the water, and then bubbles up, being partly washed; as the holder rises, the arm regulating the supply of water cuts off the supply, and so the water is fed to the carbide automatically. In this form of generator the carbide can be recharged at any time, letting the gas out of the holder.

This represents the variety of "Drip" generator adopted for portable lamps. The carbide is in tne lower and the water in the upper half of the lamp. The turning of the small thumb screw allows the water to drip on to the carbide, the gas being burned as made. The pressure is regulated by the amount of water allowed to drip. This generator gets very hot, and unless fitted with a purifying chamber will cause an unpleasant smell and soon choke even the best type of burners.

This is a non-automatic generator of what is known as the "Chute" type. This type of machine, though more bulky and expensive than others, is recognised by all acetylene experts as scientifically the best. This is the water tank, this the gas holder, and here you notice is a tube running down the centre of the gas holder and fitted with revolving doors at top and bottom; the doors are connected by a rod, and work together. To charge the machine the door is opened, the carbide is thrown down the tube and allowed a second or two to sink through. The door is then drawn back over the tube. The carbide is now on the grating, and as the gas is formed it rises all round the tube into the holder. It cannot pass up the tube on account of the lower door which overlaps the tube an inch all round. The exhausted lime settles at the bottom, and is periodically run off at this cock. There is no overheating in this type of generator, as the immense excess of water absorbs all the heat, and the gas rises to the holder free from the damaging bye-products referred to. The bubbling of the gas through the lime-charged water in the generator also cleanses it of certain impurities, which from other types of generators pass unimpeded to the burner. No

air is admitted to the interior of this machine, either in cleaning or charging it, therefore it never contains an explosive mixture. It is simpler to charge than other types, and having fewer parts is less likely to get out of order. About ninety per cent. of the installations in these colonies are fitted with this type of generator. They have been working three years without giving the least trouble. The dust is used up by placing it in this carbide charger.

This represents an automatic generator, which has many of the good points of the type just described. The falling of the bell opens the bottom of the conical-shaped carbide holder, allowing some of the charge to fall into the water tank; this, producing gas, lifts the ball and automatically closes the carbide holder again. There would be no overheating with this type, but there would be a slight admission of air with each recharging, and if the lumps of carbide were not small and of uniform size the valve would be apt to get blocked.

All generators are more or less related to one or other of the types described, but some have a host of needless complications, and these the public should carefully avoid. A complicated generator, in the hands of an ordinary householder, is sure, sooner or later, to cause an accident. The following advice is worth notice:—Do not select a generator which gets unduly warm, nor which admits much air to its interior when chargiog, nor which is made of flimsy material. Do not buy a small machine to light a large building. Do not think because a generator produces a good light on a trial exhibition that it will necessarily work satisfactorily in every day use. Do not buy a generator from a maker or firm who has had no experience with the gas. Any tinsmith can make an acetylene generator, but it requires chemical knowledge and practical experience on acetylene lighting to devise and make a generator which will work satisfactorily and safely month after month and year after year.

Thus far I have merely summarised what I told you last year about generators. My further twelve months' experience has confirmed my conviction that this, the Chute type, is far and away the most simple and efficient; the generators have been at work for three years without any

hitch. The acetylene world as a whole is coming to the same conclusion, as witness the following extract from Professor Lewes, dated December last:—

"Wherever scientific knowledge has been allowed to govern commercial practice, those generators in which carbide falls into excess of water, or water rises slowly in contact with the carbide, have gradually ousted the drip generators, and the still worse form in which the carbide container is dipped into water and then withdrawn by the rising bell of the gas holder. In the near future it will be recognised that all forms of automatic generators have their drawbacks, and the generator of the future will be of the greatest simplicity, and will be merely used to charge a gas holder capable of containing the gas needed for the evening's consumption."

The idea was expressed, during the discussion of his last paper, that a combination of the plunging of the carbide into an excess of water with an automatic feeding of the carbide to the water would meet objection to automatic generators. Up to date, however, he had not seen such an automatic device which could be recommended as likely to work satisfactorily under the varied conditions of every day use.

PURIFIERS.

While what I have said about automatic generators is all true, there has been a development of the business which removes one of their weak points, namely, choking of pipes and smoking of burners. It has been found there are certain chemical substances which when used as a filter extract all impurities from acetylene, so that though the gas may have left an automatic generator laden with adulterations, if it is passed through one of these purifying compounds it goes to the pipes and burners comparatively pure. This is a great advance, since there are certain classes of lighting for which the bulkiness and expense of non-automatic generators render them unsuitable, and automatic generators have to be used. The purifier, however, does nothing to remedy the necessarily complicated character of all automatic generators, nor does it improve their poor yield of gas per lb. of carbide. For non-automatic generators of the Chute type we have found purifiers unnecessary in or-

dinary installations, as the bubbling of the gas through the lime water into the holder removes most of the impurities.

ACETYLENE BURNERS.

As explained last year, acetylene, to give satisfaction, must be burned in atmospheric burners, one of which he now held in his hand. The gas passes from a very tiny hole in this steatite chamber, into which air is also drawn through these holes at the side. In an ordinary burner the orifices become extremely hot, and some of the gas passing through polymerized, causing a deposit of carbon, and consequently smoky condition of the burner. In this atmospheric burner the gas does not burn at the inside gas outlet, which consequently remains cool and polymerization is avoidable. Even the atmospheric burner, however, will form a carbon deposit if the gas is burned at too low pressure, and during the past twelve months efforts have been made to devise a burner that can be turned down like ordinary gas without choking. Some progress has been made, but perfection in this direction is not yet achieved.

The incandescent mantle has been adapted for use with acetylene. He had received a sample shipment of mantles and burners, but have not yet had time to test them.

SPECIAL FEATURES OF THE ACETYLENE LIGHT.

The special features of the acetylene light are thus summarised in an article contributed to the "London Journal of Acetylene Gas Lighting," of December last:—1. Brilliancy. 2. Whiteness. 3. Actinic quality. 4. Steadiness. 5. Diffusive and penetrative power. 6. Small consumption of oxygen. 7. Small products of combustion. 8. Little vitiation of the atmosphere. 9. Coolness. 10. Simplicity of manipulation. 11. Safety. 12. Cheapness.

The first five points are the distinctive qualities of sunlight, and the other seven include all the points of excellence which an artificial light can possess. Acetylene is the only artificial light which can be said to be "strong" in "all" points, and in the matter of colour it is far ahead of any artificial light yet discovered, being, in fact, an almost exact approximation to sunlight.

USES OF ACETYLENE.

House Lighting.—Acetylene is the ideal light for a private residence, and its popularity is rapidly extending. Intensely briliant, yet deliciously soft, perfectly steady, well diffused, and showing colours of curtains, carpets, furniture, dresses, etc., in their daylight tints, it gives a charm to a drawing-room comparable only to sunlight. Further, it heats the room and vitiates the atmosphere much less than kerosene or coal gas. The house is piped throughout with ordinary black iron pipe, and the rooms are fitted with brackets, chandliers, etc., just as for coal gas. But in place of a gas company's meter, an acetylene generator is erected, usually in a shed a few feet from the building and connected with the house pipes. Given a supply of water and carbide, this house, though it be miles from any other building, is now as well lit as if connected with a city gas or electric light works. With a good generator there is less trouble in making a night's supply of gas than in trimming one kerosene lamp.

Shops.—The colour quality of acetylene makes it admirably adapted for shop lighting, especially drapers' shops, in which the ordinary illuminants so distort the colours of the goods as to make night shopping very delusive.

Halls, Theatres, Hotels, Churches, etc.—All buildings are installed as described for houses, except that for small buildings, workshops, cottages, etc., a very cheap and more or less satisfactory job can be made by using a "Plunger" or "Drip" generator, and compo., or even rubber, instead of black iron pipe.

Mining.—A mine, like a building, can be piped right through for acetylene, but for below ground a hand lamp, such as this, which we are making and supplying to mines in these colonies, is generally preferred. They will certainly make the miners' lot easier, and one employer who is using them writes that he has never bothered to enquire whether they are cheaper than oil or otherwise, since his men can get through more work under their rays.

The central generator and piping are, however, used for surface works, battery rooms, etc. For dangerous coal mines we are making Davy safety lamps.

For sluicing claims, road repairs, and many other like purposes, these portable search lights will be found most useful. They provided an intensely powerful light, which can be set in operation in a few moments, without skilled labour. For the special purpose for which it is designed it is absolutely without a competitor, electricity being unobtainable in this portable form.

Gold Dredges.—Acetylene is being largely adopted in connection with the rising industry of gold dredging, its only competitor for this business, where light is required all night, being electric light. But, while giving as much light as the latter, acetylene requires no skilled labour; if a good generator has been chosen it is almost impossible for the light to get out of order, and the sloppy state the dredge is always in does not affect the acetylene plant as it does the electric. A small point—but small points tell—is that with electricity steam has to be got up on Sunday nights after the weekly spell, in the dark; the acetylene being independent of the dredge machinery is ready at a moment's notice. The same applies if the machinery goes wrong in the night; with electricity you must do your repairs in the dark, use kerosene, or wait till the morning.

Marquees.—A "Plunger" generator, a few lengths of pipe, and some burners are the plant that is required to brilliantly light a marquee, and a kerosene lighted marquee is now-a-days considerably out of fashion. For extensive outdoor illumination, of course, a larger plant than this is required, but still it is portable and inexpensive enough to be used for a carnival extending over only a night or two. The Federal Band Contest, at Bathurst, last November, was lighted in this way, and to the satisfaction of all concerned; the officials declared the lighting proved one of the most attractive features of the carnival. At Broken Hill we have a tennis court lit up, and the players say they can carry on their game by night almost as well as in the daylight.

Magic Lanterns.—Acetylene is not quite so brilliant for magic lantern purposes as lime light. It is, however,