densers, scrubbers, etc.; and in this way ammoniacal liquor and coal tar are obtained—as in a coal-gas plant. Enough of the purified gas is then piped back to the battery and burned in flues surrounding the retorts to keep the ovens at the temperature requisite for good coking. In this type of oven, regenerators are commonly used to preheat the air and gas before they are burned in the flues. The resulting economy is such that, unless the coal is low in volatile matter, only half the purified gas is required to heat the ovens, while the remainder—a valuable by-product—can be used for other purposes. In this connection it might be pointed out that the superior economies in the working of a by-product recovery coke-oven plant, as compared with a coal-gas plant, together with the superior quality of the coke produced, make the former a rival to the coal-gas plant, even as a means of supplying city gas; but the substitution is possible only where there is a large demand for coke of high quality.

Types of Coke Ovens Compared. — Until recent years there has been a decided prejudice against retort oven coke; the product of beehive ovens has been more in demand, especially for use in blast furnaces. This preference, however, is fortunately disappearing. As a matter of fact, retort ovens can make as good coke as beehive ovens, and can make more of it from ordinary coking coals. They have, moreover, a wider range of adaptability as they can produce a commercial coke from certain classes of coal which cannot be coked in a beehive oven. Hence the retort oven is gradually displacing the beehive oven, and in some countries the change is almost completed.

Beehive ovens, as a rule, are a nuisance in the neighborhood where they are located, they burn or waste all the gases and volatile matter generated from the coal, and they give no return except that of the coke produced. Moreover, they also burn about 10 per cent. of the coke itself. In other words, if, with a certain coal, a 75 per cent. yield of coke is obtained in a retort oven, probably only 65 per cent. would be obtained in a beehive oven. In the former case 134 tons of coal would be required to produce 100 tons of coke; whereas, in the latter case, 154 tons would be required. That is to say, for every 100 tons of coke produced in a beehive oven, 20 tons of coal, approximately, are needlessly wasted through the burning of the coke. From the ethical point of view, therefore, there can be no hesitation in condemning the beehive oven; while from the practical point of view it should be remembered that, in addition to the smaller yield, the greater waste of carbon in the beehive oven results in a higher percentage of ash in the coke produced. The beehive oven has the further disadvantage that the coking period is at least one and one-half times as long as in a retort oven, so that, if the charges are the same, it takes three beehive ovens to do the work of two retort ovens. The cost of working a beehive oven is also high, as the method of drawing the coke by manual labor is slow and expensive. The beehive oven is, however, very low in first cost, and being simple in construction, is also easy to keep in repair. These facts, together with the widespread prejudice in its favor, and the great number of managers and men familiar with its use—but unfamiliar with retort-oven practice—explain the reluctance of so many coke manufacturers to adopt retort ovens.

It is probable that in nearly all cases the non-recovery retort oven is, in the long run, more profitable than the beehive oven, and that it would certainly prove to be so in all large plants. The capital outlay is greater, but the working expenses are less; while the output of coke is at least 10 per cent. more for the same amount of coal used.

In Canada, at the present time, the profits to be gained by the recovery of by-products are more doubtful. On account of the high capital cost of a by-product plant, it is essential that there should be a reasonable certainty of working full time; hence it is usual to erect large central plants, where they are capable of drawing supplies from several collieries, and where a good market for the products is of easy access. Evidence given before a Royal Commission on Coal Supplies in England would appear to show that, there, the value of the by-products will not only pay for the working of such a coke plant, and provide a profit, but will also pay for the capital outlay within ten years. Various uses for coal tar are given later; but it seems certain that by-product recovery coke-oven plants which produce tar, and the coal-tar industry which uses coal tar as a raw product, must grow up together.

At the present time, there are only two by-product recovery coke-oven plants operating in Canada; yet in 1913 these two plants were responsible for two-thirds of the total coke production of the Dominion. As coke is imported, their production, however, only amounted to half the total consumption of coke in the Dominion. We may confidently expect that the tendency of the future will be towards the recovery of coal tar and ammonia at all coke and gas plants.

Properties and Uses of Coal Products and By-products

Coke is the name given to the solid residue left by the destructive distillation of coal, or of some other carbonaceous substances. It consists mainly of carbon, together with the original ash of the coal, but always contains small amounts of volatile matter which the temperature attained in the coking process has failed to drive out during the time the heat was maintained.

When coal is strongly heated in absence of air, it is decomposed, and loses water, gases and volatile compounds. Many coals so heated first fuse or soften, and then harden as decomposition progresses, ultimately leaving a strong coke. This coke, although quite hard, is light and cellular, owing to the bubbles produced by the escaping gases while the mass is soft. Neither anthracite nor lignite coalesces when heated, hence neither is capable of making commercial coke. The fragments left after the heating might strictly be described as coke, but they are approximately the same size and shape as the original pieces of coal, and bear little or no resemblance to the hard porous substance commercially known as coke. Some bituminous coals also fail to coke, or else make so weak or impure a material as to be worthless.

Coke bears the same relation to coal that charcoal does to wood. For many purposes, such as blast furnace smelting coke is so far superior to coal as a fuel, that it is necessary to go to the trouble and expense of coking the coal before use. The chief advantages of coke as a fuel are:

1. It is strong and hard, and does not crumble or soften when burning; thus it can support a heavy charge of ore, etc., in a furnace, without crushing or melting down and obstructing the blast.

2. It burns without producing tar or smoke.