3. It has a high calorific intensity; that is to say, a higher temperature can be obtained by burning coke than by burning coal, although a given weight of coal will naturally evolve a larger quantity of heat than will the coke produced from it.

Coke is the main product of cokeoven plants, and is a by-product of gas plants. A coke manufacturer selects coal that is capable of giving good coke, and treats it in such a way—with regard to the mass coked, temperature of oven, and duration of coking—as will produce a good quality of coke. The gas manufacturer naturally regards the quantity and quality of gas produced as his chief consideration, the quality of coke being only of secondary importance; his choices of coal, etc., are, therefore, all made from the viewpoint of gas production. Consequently gas or retort coke is practically always inferior to oven coke, as regards hardness, strength, lustre, etc.; but the former has advantages over oven coke for certain purposes, since it contains more volatile matter, and consequently burns more readily.

The most important uses of coke are in metallurgical operations, such as the smelting of iron in blast furnaces; the remelting of iron in the iron foundry; and the smelting of copper, lead, nickel, silver, etc. Oven coke is always used for these purposes, as a strong, hard coke is required. For blast furnaces, great compressive strength is essential; but for copper smelters, porosity is important. During 1913, 1,417,148 tons of coke was used in the blast furnaces of Canada; this amounted to about 65 per cent. of the total consumption of metallurgical coke in the Dominion.

Gas coke is chiefly used for steam raising, domestic heating, etc. It has the great advantage over soft coal that it can be burned in an ordinary grate without producing smoke and soot; this is a matter of great importance for the cleanliness of our cities even now, and will become more so as the cities increase in size. Where hard coal is burned, nothing is gained as regards smoke reduction by a change to coke; there is, however, a great deal to be said in favor of coking all bituminous coal that will form a commercial coke, thus obtaining the two clean fuels coke and gas, and recovering the valuable by-products tar and ammonia.

Gas coke can prove satisfactory for steam raising only where it is burned under suitable conditions. It has a comparatively high temperature of ignition—although not so high as that of oven coke—and requires a good draught. It gives a more localized heat than coal, on account of the absence of flame, and when burning freely gives a more intense heat; it is therefore liable to cause troubles such as the burning of the firebars and the formation of clinker. The latter trouble is accentuated by the fact that coke naturally contains a higher percentage of ash than the coal from which it is made. The difficulties attending its use are, however, not unsurmountable, as is shown by its successful use in many plants. A suitable furnace should be employed, and the method of stoking adapted to the fuel. Crushing the coke to a small uniform size is generally advantageous. Troubles due to ash and clinker would be reduced if the coal for use in gas plants were first washed, as is frequently done with coal for coke-oven plants. Washing the coal would also reduce the sulphur in the resulting coke.

Ammonia is obtained as a by-product in the distillation of coal in gas works, in coke-oven plants, and in producer gas plants. The quantity depends on the percentage of nitrogen present in the coal; but other factors, e.g., the temperature and shape of the retorts, ovens or producers have also an influence on the fraction of the nitrogen which is evolved as ammonia. Generally nitrogen is present in coals to the extent of one or two per cent., but in gas works only about 14 per cent. of this is recovered as ammonia in the gas; this latter percentage may be sensibly increased by adding lime to the coal, or by passing steam through the retort during distillation. Increasing the steam used also increases the ammonia yield from gas producers. The Mond producers are run so that a very high yield of ammonia, amounting to about 60 per cent. of the nitrogen of the coal, is obtained by means of the large excess of steam which is passed through the fuel bed; the steam favors the increased percentage of ammonia by lowering the temperature of the producer below the point at which ammonia decomposes, and also by acting as a diluent to the gases evolved.

In gas and coke-oven plants some of the ammonia is washed out from the gas in the hydraulic main, purifiers, etc., but the bulk of it is recovered from washers and scrubbers installed for the purpose. As small a volume of wash liquor as possible is used in these washers, to prevent undue dilution of the ammonia in the resulting ammoniacal liquor.

Coal gas and coke-oven gas contain ammonia, carbon dioxide, sulphuretted hydrogen, cyanides, etc. As these gases combine chemically and dissolve in water, the ammoniacal liquor obtained is a complicated solution containing the following ammonium salts: acid and neutral carbonates, acid and neutral sulphides, thiocarbonate, cyanide, thiocyanate, ferrocyanide, sulphate, thiosulphate, sulphite, chloride and acetate. Because solutions of the carbonates, sulphides, cyanide and acetate readily give up their ammonia when boiled the ammonia in these salts is called "volatile." The other compounds require the addition of lime to liberate the ammonia, which in these salts is said to be "fixed." The ratio between the "volatile" and "fixed" ammonia in gas liquors varies widely, but that liquor with the largest proportion of "volatile," is naturally the most valuable. In producer-gas plants the gas is washed in towers by dilute sulphuric acid, and ammonium sulphate is directly produced.

The ammoniacal liquor obtained as above is distilled before and after the addition of lime, and the ammonia liberated is passed into sulphuric acid yielding ammonium sulphate, or into water yielding the ammonia solution generally known as ammonia, ammonium hydroxide, ammonia water, etc. This treatment of the gas liquor is not profitable in smaller plants, and from such places the liquor is generally shipped to central plants for distillation.

Uses of Ammonia.—A strong solution containing about 10 per cent. ammonia, as obtained by simple distillation, is largely used for the manufacture of ammonia soda, and for cleaning purposes; while the more concentrated solution "liquor ammoniae," and anhydrous liquid ammonia, are used in refrigerating machinery. Ammonium nitrate, which is usually made from ammonium sulphate and sodium nitrate, is being increasingly used in explosives. Ammonium chloride, which is produced directly from the gas liquor, or from ammonium sulphate by boiling with common salt, or obtained from waste liquors of ammonia-soda works, is used for soldering, for galvanizing iron, for calico printing and for Leclanche cells and dry batteries. A process by which ammonia is converted into nitric acid has recently been patented by Ostwald, and will probably prove to be a very important applica-