Coke

Carbonisation or coking bituminous coal leads to the formation of coke. Coke obtained from coal with high volatile matter forms swelling coke which is soft coke, and from a mixture of high and low volatile coking bituminous coal (non-swelling) in coke ovens hard coke is obtained. Both soft and hard cokes are obtained by *high temperature carbonisation*. A smokeless fuel or semicoke is obtained from *low temperature carbonisation*.

Coke and Coal

- Coke possesses much strength and porosity compared to coal.
- By coking the undesirable sulfur content of coal is removed from coke and due to lower volatile matter content of coke it burns with a short flame. All these properties of coke make it suitable for metallurgical processes compared to coal.

Carbonisation of Coal

Depending on the operation temperature there are mainly two types of carbonisation processes, namely,

(*i*) Low temperature carbonisation (LTC) and (*ii*) High temperature carbonisation (HTC). Coarsely powdered coal taken in a closed retort and heated out of contact with air leads to the breakdown of coal with the formation of water, ammonia, other volatile matters, gases and coke. This process is called the *carbonisation of coal* or *coking of coal*.

Table 18.1: By-products of carbonisation of coal

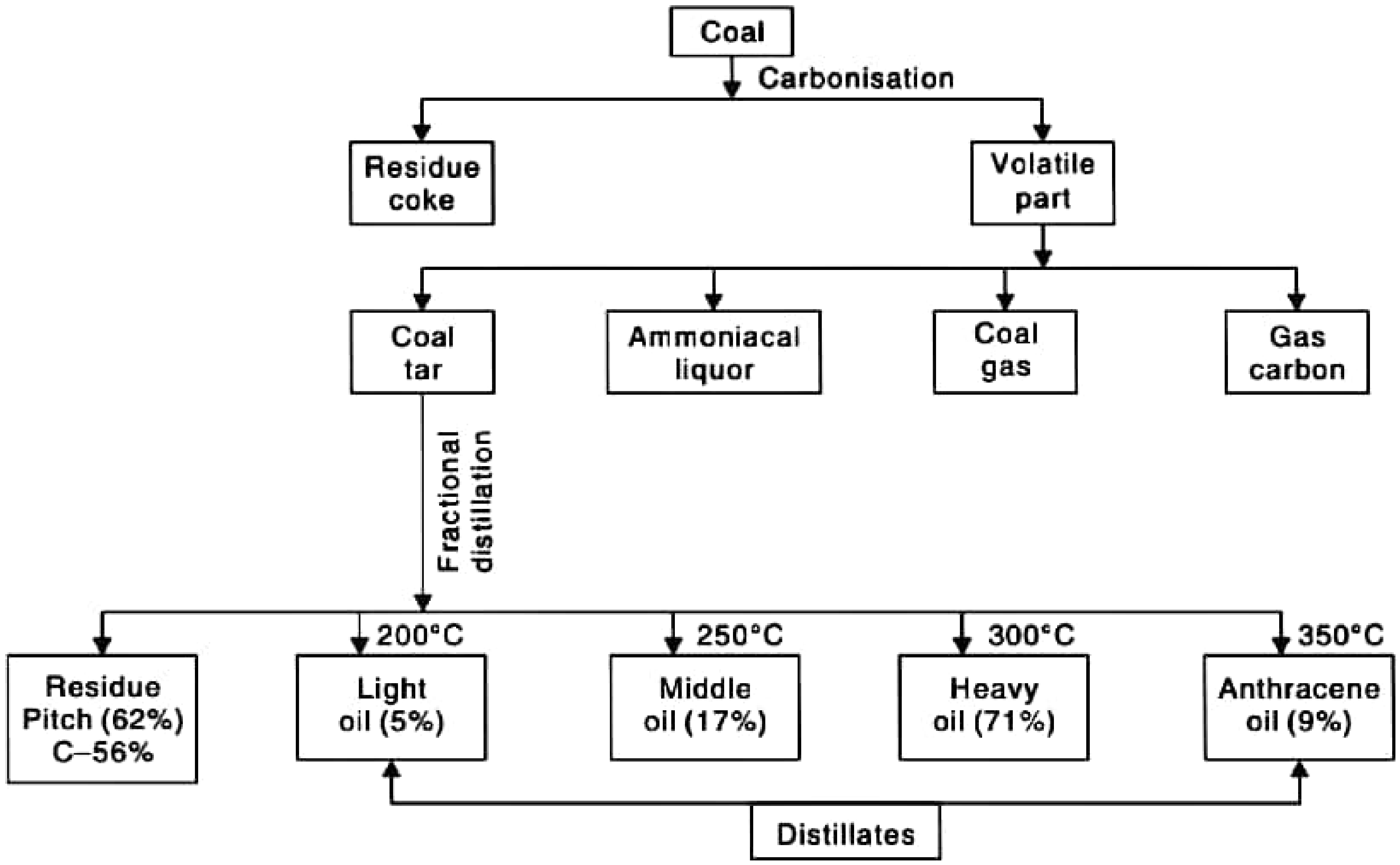

Table 18.2: Products (by fractional distillation)

Light oil	Benzene, Toluene, Xylene, Cumene etc.
Middle oil	Naphthalene, Phenol, Cresol, Pyridine etc.
Heavy oil	Cresol, Xylene, Naphthalene etc.
Anthracene oil	Phenanthrene, Anthracene, Quinoline etc.

(*i*) *Low temperature carbonisation (LTC).* In this process, coal is heated in steel retorts at 500°C–700°C. The yield of coke is 75–80% and it contains 8–12% volatile matter. The coke obtained is not mechanically strong but highly reactive and can be easily ignited to give smokeless flame and used as a domestic fuel. Low temperature carbonisation yields a very complex mixture of higher phenols, substituted aromatic hydrocarbons and other N and O containing compounds. Disinfectants are made from this tar. The coal gas obtained has calorific value of 6500 kcal/m^3 and is richer in hydrocarbons and poorer in hydrogen compared to the gas produced by HTC. The crude spirit corresponds to crude benzol of HTC but contains greater amount of paraffins, naphthalene and olefin.

(*ii*) *High temperature carbonisation (HTC).* It is carried out at 900°C–1200°C producing coke of good porosity, hardness, purity and strength and can be used in metallurgy. As all the volatile matters are driven off, the yield of coke is 65–75% containing 1–3% volatile matter. The retorts used are made of brick. The gas and tar yields are lower. The calorific value is lower, about 4500 kcal/m^3.

Distinction between high temperature carbonisation (H.T.C.) and low temperature carbonisation (L.T.C.) at a glance:

- Temperature ⇒ L.T.C. = 400–600°C
  H.T.C. = 1000–1400°C
- Economy ⇒ In L.T.C. less costly steel retorts are used whereas in the case of H.T.C. retorts made of fire bricks are used. The expenditure due to fuel is also less in the case of L.T.C. than that of H.T.C. as the working temperature is less.
- Nature of tar ⇒ The liquid volatile products are larger in quantity in the case of L.T.C., on the other hand the quantity of gaseous products is greater in the case of H.T.C. The formation of lower amount of paraffin and alicycilc compounds and higher amounts of aromatic compounds in the case of H.T.C. indicates that the process of aromatisation is greater in the case of H.T.C.
- Nature of other products ⇒ The amount of ammonia formed greatly increases with the rise of temperature showing that nitrogenous complexes are broken at higher temperature. The Tables 18.1 and 18.2 show the amount and nature of various products.
- Physical characteristics of tar ⇒ H.T.C. tars are darker in colour and more viscous than that of L.T.C. tars.
- Yield of tar ⇒ The yield of L.T.C. tar per ton of coal is much greater than that of H.T.C. tar.

There are two main types of oven for the manufacturing of coke:

(*a*) **Beehive oven:** It is a batch process and now obsolete. The firebrick chambers are of 2 m height and 3.5 m diameter and form the shape of a beehive. There are two openings, one at the top for charging the coals and the other on one side for the entry of air and also for removal of coke. Coal forms a layer of 60–90 cm depth. Carbonisation proceeds from the top to bottom and completes in 2–3 days. Heat is supplied by the burning of the volatile matter and hence no byproducts are recovered. The hot exhaust gases are utilised to run waste heat boilers to increase the heat efficiency. At the end of carbonisation, the coke is quenched by water and raked out through the side door, leaving the oven hot enough to start the next batch. The yield of coke is 80% of the coal charged (Fig. 18.3).

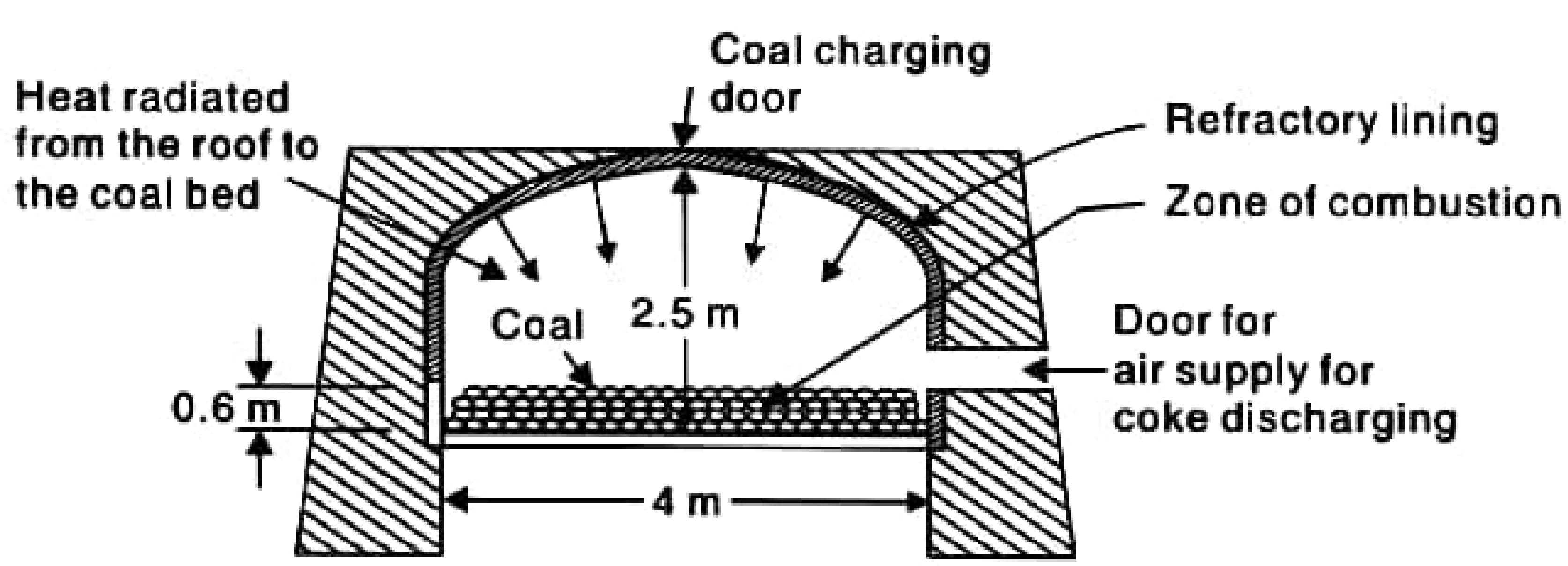

Fig. 18.3 Beehive coke oven.

The limitations of the process are (*i*) no recovery of byproducts, (*ii*) coke yield is low, (*iii*) the exhaust gases cause pollution, (*iv*) process is not flexible.