19CH101– ENGINEERING CHEMISTRY

Unit-4

FUELS AND COMBUSTION

MANUFACTURING OF SYNTHETIC PETROL

Petrol can be synthesized by any one of the following methods.

I. Polymerization

a. Thermal Polymerization

b. Catalytic Polymerization

II. Hydrogenation of Coal

a. Bergius Process (or) Direct Process.

b. Fisher Tropsch Process (or) Indirect Process.

III. Alkylation

I. Polymerisation

The gases produced in cracking contain C3 and C4 olefins (iso propylene, iso butylene etc) and alkanes (methane, ethane, propane, butane). These gases undergo polymerisation in presence of catalyst, (H3 PO4) at suitable temperature and pressure to give gasoline (Polymer petrol), rich in branched chain hydrocarbons.

Hence, polymerisation is mainly for the production of superior gasoline and is complementary to catalytic cracking.

Polymerisation is of two types

i) Thermal Polymerisation

Polymerisation of cracked gases is carried out at 500 - 600o C and 70 - 350 kg/cm2 pressure. The product is the gasoline and gas oil mixture, from which gasoline is separated by fractionation.

ii) Catalytic Polymerisation

This process is carried out in presence of catalyst like H3 PO4 . By this method isobutylene can be polymerised to give higher olefin's which is hydrogenated to gasoline hydrocarbons

II. Hydrogenation of Coal

Coal contains 4.5 % of Hydrogen, where as petrolium contains 18 % of hydrogen. So coal is a hydrogen deficient compound, if coal is heated with hydrogen at high temperature and high

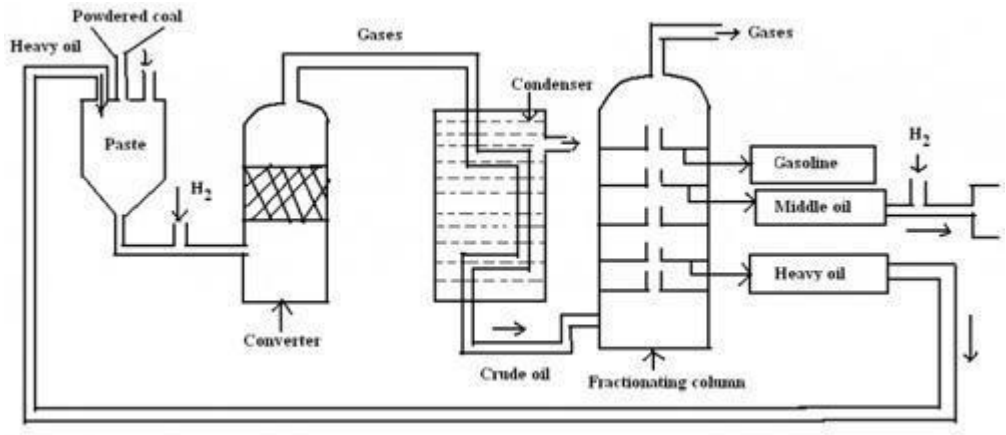
pressure, it is converted in to gasoline. The preparation of liquid fuels from solid coal is called Hydrogenation of coal.

Petrol can be synthesised by destructive hydrogenation of coal (Bergius process) and liquification of coal (Fischer - Tropsch process).

i) Bergius Process (or) Direct Process

The raw materials used in this process are coal dust, heavy oil and nickel oleate or tin oleate.

A coal paste is prepared by mixing coal dust with heavy oil and catalyst. It is then pumped into the converter where the paste is heated to 450 - 500o C under 200 - 250 atm in presence of hydrogen.



Since the reaction is exothermic the vapours leaving the converter are condensed in the condenser to give synthetic petroleum or crude oil.

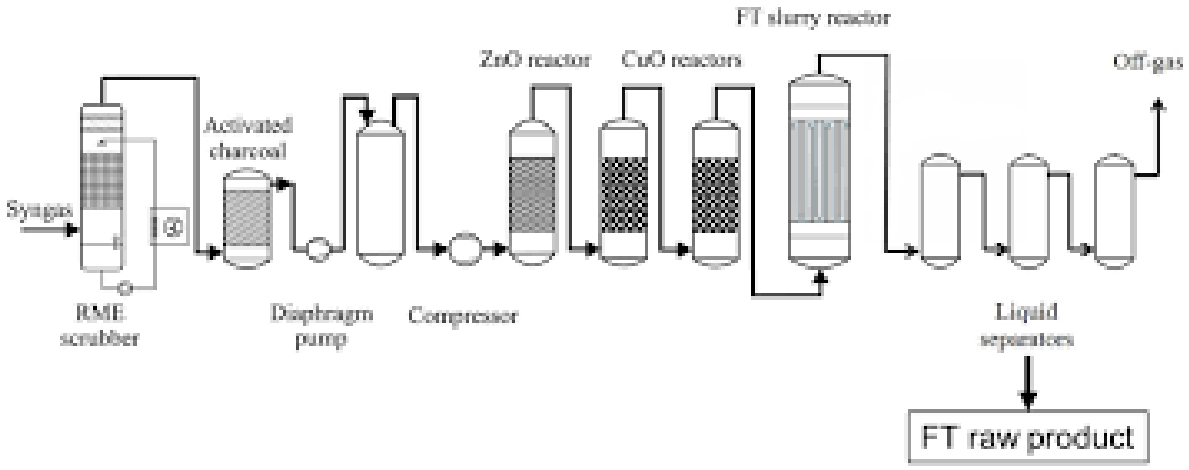
The oil is then fractionally distilled to give

(i) Petrol
(ii) Middle oil
(iii) Heavy oil.

Middle oil is again hydrogenated in presence of solid catalysts to produce more amount of gasoline. Heavy oil is used for making paste with fresh coal dust. Yield is about 60 %.

II Fischer - Tropsch Process

The raw materials used in this process are hard coke, steam to produce water gas i.e., water gas is obtained, by passing steam over red hot coke.



$C + H_2O \longrightarrow CO + H_2$

The first step in this process is purification of gas. To remove H_2S, the gas is passed through Fe_2O_3 and to remove organic sulphur compounds, the gas is again passed through a mixture of Fe_2O_3 and Na_2CO_3 .

The purified gas is compressed to 5 - 25 atm. and passed over a catalyst bed containing oxides of Th, Co and Mg at 200 - 300o C. While passing the purified gas through this catalyst bed, it is converted to straight chain paraffin and olefins.

$n\,CO + (2n + 1)\,H_2 \longrightarrow C_nH_{2n+2} + n\,H_2O$

$n\,CO + 2n\,H_2 \longrightarrow C_nH_{2n} + n\,H_2O$

Since the reactions are exothermic, the vapours leaving the vessel are condensed in the condenser to give petroleum. It is fractionally distilled to yield petrol and heavy oil.