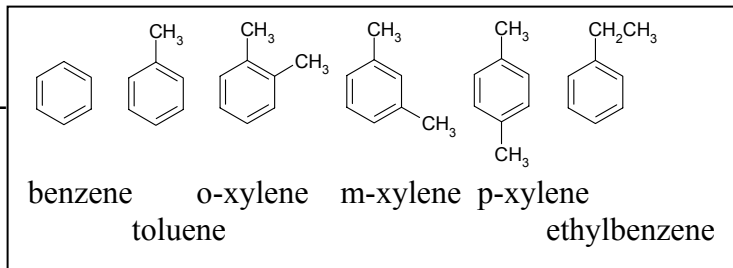


Four Major Processes in Crude Oil Refining:

1. **Fractional Distillation:**

Crude oil is separated into fractions according to boiling point.

- Gases (C1 to C4) – BP below 20°C
- Naphtha (C5 to C12) – BP 20-200°C
- Kerosene (C12-C16) – BP 175-275°C
- Diesel or Fuel Oil (C16-C18) – BP 250-400°C
- Lubricating Oil (D18- C20) – BP above 350°C
- Residue/asphalt (nondistilling)



2. **Hydrocracking** (breaking large molecules into smaller pieces)

Heat in presence of H₂ gas, using a catalyst such as Pt. Major products are jet fuel, diesel, high octane rating gasoline and LPG (Liquified Petroleum Gas).

3. **Reforming process to convert straight chain to branched**

usually using HF or H₂SO₄ catalyst

4. **Reforming process to convert straight chain to BTX:**

BTX is a mix of benzene, toluene, 3 isomers of xylene and ethylbenzene (see structures shown above). This is done by using a cyclodehydrogenation catalyst.

What is the purpose of the reforming processes? In the US, 80% of the output of refineries is to produce gasoline. Only 15% of crude oil is in the gasoline range. Reformation is necessary to convert the non-gasoline fractions into higher octane rating gasoline.

What is in the gasoline that we pump into our automobile tanks? Gasoline is a mix of hydrocarbons containing C5 to C10. 20% of the mixture is aromatic (BTX), the rest is straight-run gasoline from fractional distillation, which is mostly straight chain saturated HC.

In the winter (Nov-March), 2% of the gasoline contains MTBE (methyl t-butyl ether). This is referred to as “oxygenated” gasoline. Ether contains the element O and the presence of MTBE reduces the production of CO which is formed at a higher percentage when the catalytic converter is cold (as in the winter).

What is BTX used for? Benzene is used to form important phenyl related compounds such as styrene (monomer of polystyrene used as Styrofoam, etc), and aspirin.

p-Xylene is used to make PET polyesters such as Dacron and Mylar

These two are isolated from the BTX mix because of their importance in industry. 90% of these compounds used in the industry comes from this process. Also, benzene is toxic and so its presence in gasoline should be minimized.

The rest of BTX is used to blend into the gasoline fraction from the refinery to increase the octane rating.

What is octane rating? The higher the octane rating, the smoother the engine will run (with less knocking). The rating was increased with the presence of lead, but now because of the toxicity of lead, it has been replaced by BTX.