3.3.2 Alkanes

3.3.2.1 *Alkanes are saturated hydrocarbons. Fractional distillation of crude oil.*

Saturated: only single C–C and C–H bonds. General formula: C_nH_{2n+2}.

Fractional distillation: crude oil heated; vapours rise up the fractionating column. Fractions collected at different heights based on boiling point range. Shorter chains = fewer electrons = weaker London forces = lower b.p. = collected higher up the column.

3.3.2.2 *Cracking: thermal and catalytic. Economic reasons.*

Thermal cracking: high temperature (~1000°C), high pressure. Produces alkenes (for polymers). Random bond breaking.

Catalytic cracking: zeolite catalyst, lower temperature, slight pressure. Produces branched alkanes and aromatics (for motor fuels).

Economic reasons: demand for short-chain fractions (petrol) exceeds supply; long-chain fractions are less useful; cracking converts them into high-value products.

3.3.2.3 *Combustion of alkanes. Pollutants (NOx, CO, carbon). Catalytic converters. SO_2 removal.*

Complete combustion: alkane + $O_2 \rightarrow CO_2 + H_2O$ (energy released).

Incomplete combustion: CO (toxic), C (soot/particulates), unburned hydrocarbons.

NOx: formed at high engine temperatures ($N_2 + O_2 \rightarrow 2NO$). Causes acid rain and photochemical smog.

Catalytic converters (Pt/Pd/Rh): $2CO + 2NO \rightarrow 2CO_2 + N_2$. Removes CO and NOx.

SO_2 removal from flue gases: $CaO + SO_2 \rightarrow CaSO_3$ or $CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$.

3.3.2.4 *Free-radical substitution of methane with chlorine: initiation, propagation, termination.*

Initiation: $Cl_2 \rightarrow 2Cl\bullet$ (UV light, homolytic fission)

Propagation (chain reaction):

$Cl\bullet + CH_4 \rightarrow CH_3\bullet + HCl$

$CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$

Termination: any two radicals combine:

$Cl\bullet + Cl\bullet \rightarrow Cl_2$

$CH_3\bullet + Cl\bullet \rightarrow CH_3Cl$

$CH_3\bullet + CH_3\bullet \rightarrow C_2H_6$

Limitations: further substitution gives a mixture (CH_2Cl_2, $CHCl_3$, CCl_4) — cannot control product.