Alkane

INDUSTRY

bp	C's	Name	Uses
< 20°C	1-4	LPG (liquefied petroleum gas)	calor gas, camping gas
	6-12	Gasoline	petrol
	7-14	Naphtha	petrochemicals
	11-15	Kerosine	Aviation fuel
	15-19	gas oil	Central Heating fuel
	20-30	lubricating oil	lubrication oil
	30-40	fuel oil	power station / ship fuel
	40-50	wax, grease	candles, grease for bearings
	>50	bitumen	road surfaces / roofing

WHAT ARE ALKANES?

- saturated hydrocarbons
  - ↳ contain no double or triple bond.
- all C have 4 sigma bonds
- contain max amount of H
- used as fuels / solvents. (liquid)
- C_nH_{2n+2}

PHYSICAL PROPERTIES

- Bp. of STRAIGHT CHAIN alkane ↑ smoothly as no. of C atoms in the molecule ↑
  - ↳ C↑, e⁻↑, vdw↑
- colourless gas / liquid, white waxy solids.
- Bp. of branched chain isomers decreases as branching ↑,
  - ↳ more shperical, area of contact↓, vdw↓ ∴ bp↓
- Branched molecules have lower bp than straight chain
  - ↳ Straight chains have larger surface area ∴ greater interaction between molecules
  - ↳ highly branched molecules are more spherical & packed less closely ∴ vdw↓ ∴ bp↓
- insoluble in H_2O cuz non polar (but can mix w/ each other)

ISOMERISM

- structural (branching)

ISOMERISATION / REFORMING

- platinum catalyst
- why?
  - ↳ branched chain much more efficient fuel than straight chain
    - ↳ does not cause 'knocking'
    - ↳ branched chain does not ignite easily ∴ combustion controllable.
- unbranched → branched / cyclo + H_2

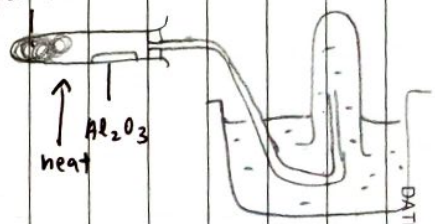
CRACKING

- into 2 alkene, 1 alkane
- Two types:

THERMAL CRACKING	CATALYTIC CRACKING
High pressure (700 kPa)	Slight pressure
High Temp (400°C-900°C) (break strong C-C)	High Temp (450°C)
Homolytic fission	Heterolytic fission
Advantages → produces smaller alkanes (better fuel) → produces alkenes (polymers) → produces H_2 (Haber)	Advantages → branched / cyclic alkanes → aromatic hydrocarbons → cheapter than thermal ↳ less energy (lower temp & pressure) ↳ catalyst reused
	zeolite catalyst → crystalline aluminosilicates

- In lab cracking:

paraffin oil & mineral wool



REACTIONS OF ALKANES

- unreactive due to low bond polarity, high bond energy of C-C & C-H
  - ↳ non-polar ∴ unreactive to polar / ionic reagents)
  - ↳ reacts w/ non-polar only in UV light
- 2 main reactions
  - ↳ combustion
  - ↳ halogenation (homolytic free radical substitution reaction)

COMBUSTION

- react w/ air only when heated.
- complete:

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

- incomplete products
  - ↳ $CO + H_2O$ or $C + H_2O$

POP bazic™

NAME

DATE

Alkane

HOMOLYTIC FREE RADICAL SUBSTITUTION

→ in presence of UV light

→ Step 1: initiation → free radicals created

$Cl_2 \rightarrow 2Cl^{\cdot}$

→ Step 2: propagation → free radicals used up then regenerated.

$Cl^{\cdot} + CH_4 \rightarrow CH_3^{\cdot} + HCl$

$CH_3^{\cdot} + Cl_2 \rightarrow CH_3Cl + Cl^{\cdot}$

→ Step 3: termination → radicals removed

$CH_3^{\cdot} + CH_3^{\cdot} \rightarrow C_2H_6$

$CH_3^{\cdot} + Cl^{\cdot} \rightarrow CH_3Cl$

$Cl^{\cdot} + Cl^{\cdot} \rightarrow Cl_2$

→ if excess chlorine / bromine used, further substitution occurs.

↳ can form up to CCl_4

↳ % yield of CH_3Cl ↓ due to many side reactions

→ if excess alkanes present, no further substitution occurs

↳ % yield of CH_3Cl ↑ due to almost no side reactions.

USES OF ALKANES

→ primarily as fuels

→ best fuel: → high energy / unit mass
→ renewable abundant

POLLUTION

→ SO_2 => react w/ basic compound

→ CO, NO_x => catalytic converter

CATALYTIC CONVERTER

→ $CO \rightarrow CO_2$

$NO_x \rightarrow N_2$

unburnt hydrocarbons $\rightarrow CO_2 + H_2O$

→ eg. $2NO + 2CO \rightarrow N_2 + 2CO_2$

→ catalyst finely divided platinum, rhodium

→ leaded petrol must not pass through catalyst as lead deposits on catalyst's surface & "poisons" it, blocking sites for reactions to take place.