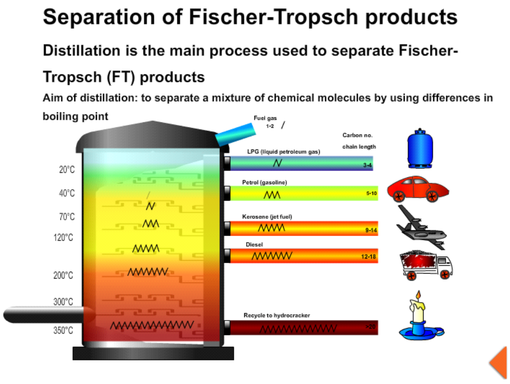
PETROCHEMICALS MEMO

Distillation

1 Why is distillation important in the petrochemical industry after the Fischer-Tropsch reaction?
Distillation separates the hydrocarbon mixture resulting from the Fischer-Tropsch reaction into its components, which are more useful once isolated.

2 Complete the explanation by filling the gaps or choosing from the options. Do this before, or after, but not during, watching the animations. Mark during re-watching.



Distillation is the separation of a mixture into its components by using their differences in **boiling** points. Boiling point is the **temperature** at which a substance boils. This is also the temperature at which it [freezes/melts/**condenses**/sublimes]. During condensation, a substance changes from **gas** to **liquid**. Long-chained hydrocarbons condense at [**higher**/lower] temperatures than short-chained hydrocarbons.

A distillation column has different temperatures throughout its height. At the bottom it is very [cold/**hot**]. It gets cooler and cooler [**higher up**/lower down]. The hydrocarbon mixture formed by the Fischer-Tropsch process is heated to over 350°C, making all its components vaporise, that is, turn to **gas**. This hot mixture is fed into the bottom of the **distillation** column.

Even though the temperature at the bottom of the column is hot, it is not hot enough to keep the [shortest/**longest**]-chained hydrocarbons in the gaseous phase. They **condense** and sink to the bottom. These hydrocarbons have more than 20 carbon atoms per molecule. They are then led off. They may be used, for example in **wax**, or they may be sent back to the **hydrocracker** to be split into shorter chains.

The [**shorter**/longer] hydrocarbons, still in the **gaseous** phase, rise. As they do so they come to cooler parts of the distillation column. At about 200°C, **diesel** condenses, and is led off. **Diesel** is made of a mixture of hydrocarbons having from 12 to 18 carbon atoms per molecule. It is used in some vehicles. At about 120°C, kerosene condenses. Kerosene is used as **jet** fuel. Kerosene is a mixture of hydrocarbons having 9 to 14 carbon atoms per molecule. At 40°C, **petrol** also called gasoline, condenses. It is made of a mixture of hydrocarbons having from 5 to 10 carbon atoms per molecule. This is used to power many vehicles. At 20°C **liquid petroleum gas** (LPG) condenses. LPG is often sold in gas bottles and might be used in gas heaters or stoves. It contains very [**short**/long] hydrocarbon chains which have only 3 or 4 carbon atoms per molecule. Even smaller molecules, consisting of only 1 or 2 carbon atoms per molecule, form **fuel gas**. This exits at the top of the distillation column, still in the **gaseous** phase.

So by cooling the heated hydrocarbon mixture to different **temperatures**, it is separated into its components as each component **condenses** at a different temperature, and therefore a different **height**, in the distillation column. A similar process is used in the separation of crude oil into its components. The temperatures used and products formed would, however, differ slightly from those given here.

Hydrocracker

3 What is the purpose of the hydrocracker?
To break long hydrocarbon chains into shorter chains when these are needed.

4 Which chemical, in the presence of a catalyst, cracks the chains?
Hydrogen

Methane, Ethane, Ethene, Wax

5 Give the formulae of:
a. Methane **CH_4** b. Ethane **C_2H_6** c. Ethene **C_2H_4**

6 Tick the relevant blocks in this table to show the classification of these chemicals.

Chemical	Hydrocarbon?	Alkane?	Alkene?	Polymer?
Methane	✓	✓		
Ethane	✓	✓		
Ethene	✓		✓	
Wax	✓	✓	✓	✓

General

7 Link each element from Column A with its corresponding element in Column B.
Write the letter from A next to each item in B in the last column.

Column A	Column B	A
a hydrocarbons	bonds break	**e**
b alkanes	a single unit	**h**
c alkenes	energy needed to start a reaction	**k**
d adsorbed	consists of a long chain of repeated units	**g**
e dissociate	consist of only hydrogen and carbon atoms bonded together	**a**
f intramolecular	the process by which monomers bond with one another	**i**
g polymer	attaches to	**d**
h monomer	hydrocarbons with only single bonds	**b**
i polymerisation	between two atoms within a molecule	**f**
j catalyst	hydrocarbons with a double bond in them	**c**
k activation energy	a chemical which speeds up a reaction without itself being permanently changed by the reaction	**j**

Catalysts

8 Complete the explanation by filling the gaps or choosing from the options. Do this before, or after, but not during, watching the animations. Mark during re-watching.

A catalyst speeds up a reaction without itself being permanently **changed** by the reaction. It serves as a **binding** site for a reaction to take place. Reactants are **adsorbed** onto a catalyst surface. They then **dissociate**, breaking into their component atoms as their [inter/**intra**]molecular bonds break. The loosened [molecules/**atoms**] can then bond with other atoms to form a [reactant/**product**]. The catalyst allows this reaction to occur more easily than if it wasn't there. Reactants can only bond with one another if they can hit against one another with enough **energy** and the right **positioning**/**orientation** to stay together. We say they need **activation** energy in order to start them reacting. But if a catalyst holds the reactants in place to make reacting easier, the reactants need [more/**less**] energy to get to react. In other words, a catalyst [**reduces**/increases] the **activation** energy needed to cause a reaction. Because of this, the reaction will occur more [slowly/**quickly**] with a catalyst than without one.