Alkene Chemical Reaction

Overview

Chemical Properties

Fats and Oils

Cracking

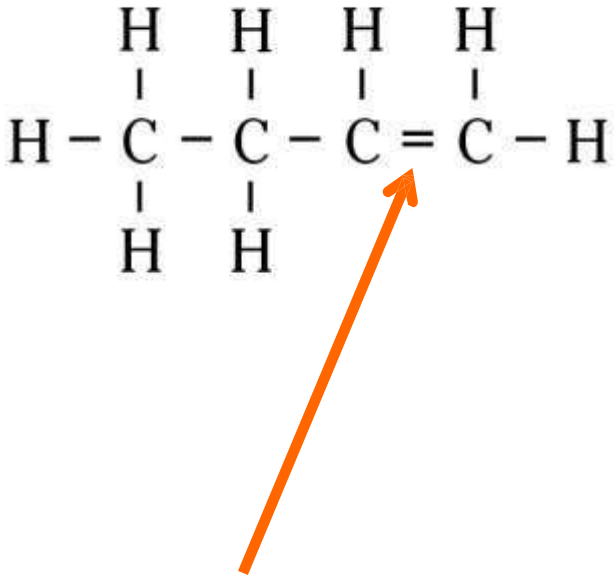
Chemical Properties of Alkenes

Addition Reactions

Combustion Reactions

Addition Reactions

Why do alkenes undergo addition reactions?



Carbon-carbon double bonds in alkenes are reactive.

readily undergoes addition reactions

Addition Reactions

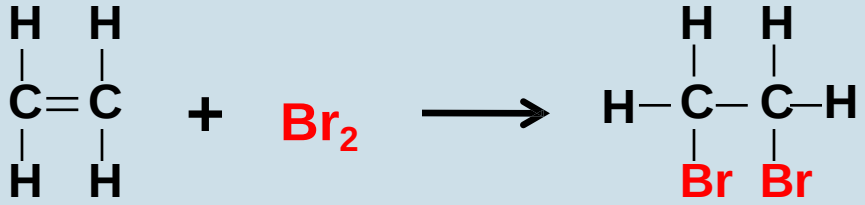
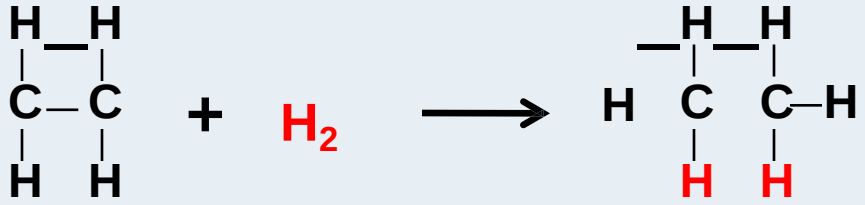
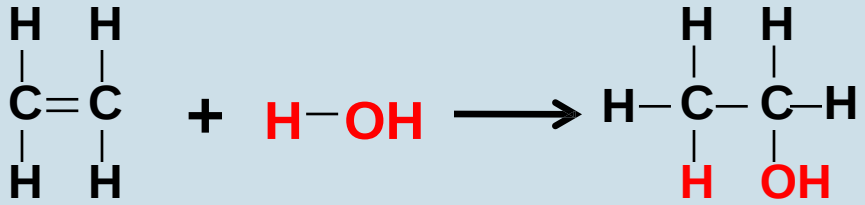
Unsaturated hydrocarbon

Saturated organic compound

In an addition reaction, **carbon-carbon double bonds become single bonds**. This means that an unsaturated hydrocarbon becomes a saturated organic compound.

Types of Addition Reactions

General Equation:

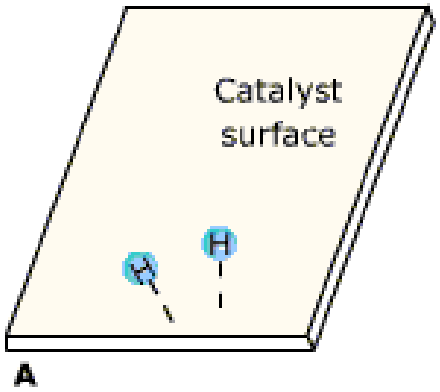
Reaction with ethene	Reaction Conditions	Equation (Write it yourself)
Bromination (Addition of bromine)	-	
Hydrogenation (Addition of hydrogen)	200 °C, nickel catalyst	
Hydration (Addition of steam)	phosphoric(V) acid catalyst, 300 °C, 60 atm	

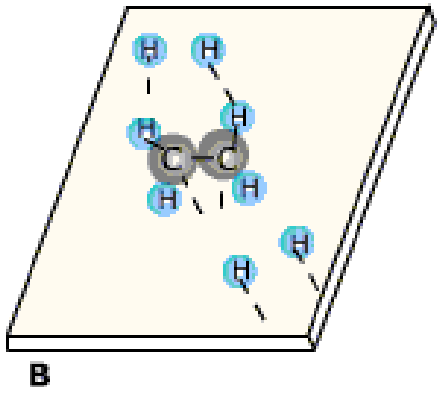
More on Bromination…

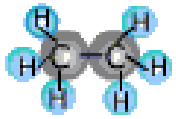
- Used to test for the presence of an alkene or unsaturation.

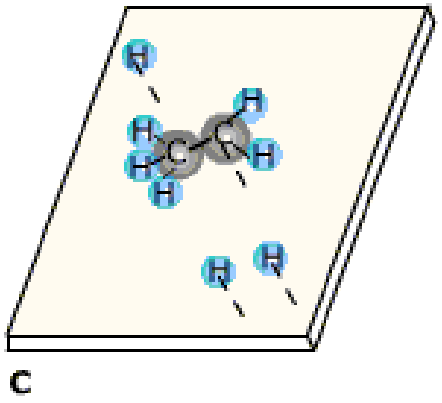
- If an alkene or unsaturation is present, bromine solution will be rapidly decolourised
- The “bromine number” is used to test for degree of unsaturation in gasoline samples!

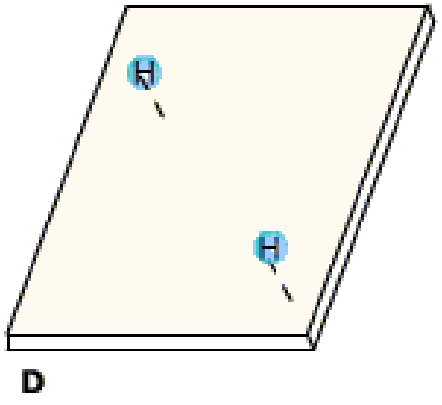
More on Hydrogenation…











More on hydrogenation…

- Used in the production of margarine

Hydrogen + vegetable oil —(200 °C, nickel catalyst)→ **Margarine**

- The greater the amount of hydrogen used, the more **saturated** the fat and the more **solid** the margarine becomes.

Combustion Reactions

- Alkenes can also undergo combustion reactions
- From your knowledge on combustion of alkanes, write the equation for the combustion of ethene:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

- Any difference between the combustion of alkanes and alkenes?

Ans: Alkenes burn with a **smokier** flame than alkanes with a similar number of carbon atoms. (Due to the relatively higher percentages of carbon in alkenes)

Fats and Oils

- Saturated fats

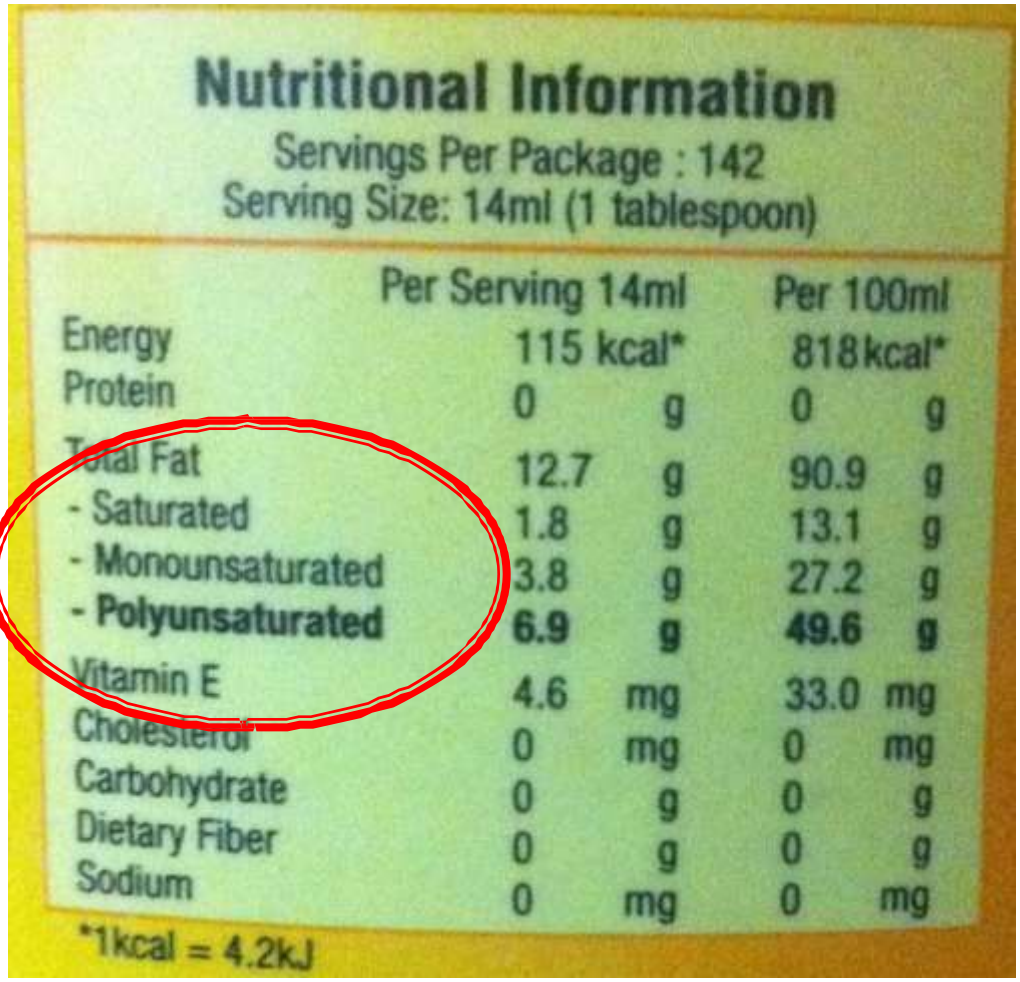
  No double bond in the fat molecules

- Monounsaturated fats

  One double bond per fat molecule

- Polyunsaturated fats

  More than one double bond per fat molecule



Nutritional Information

Servings Per Package : 142
Serving Size: 14ml (1 tablespoon)

	Per Serving 14ml	Per 100ml
Energy	115 kcal*	818 kcal*
Protein	0 g	0 g
Total Fat	12.7 g	90.9 g
- Saturated	1.8 g	13.1 g
- Monounsaturated	3.8 g	27.2 g
- **Polyunsaturated**	**6.9 g**	**49.6 g**
Vitamin E	4.6 mg	33.0 mg
Cholesterol	0 mg	0 mg
Carbohydrate	0 g	0 g
Dietary Fiber	0 g	0 g
Sodium	0 mg	0 mg

*1kcal = 4.2kJ

A label from sunflower oil

Nutritional Facts

Type of fat structure	Remarks
 Saturated fat	- the least healthy type of fat
 Monounsaturated	- decreases the LDL (bad) cholesterol and increases the HDL (good) cholesterol
 Polyunsaturated	- lowers the overall cholesterol level - lowers blood pressure and reduces risk of heart disease

Avoid foods high in saturated fat!

Nutritional data

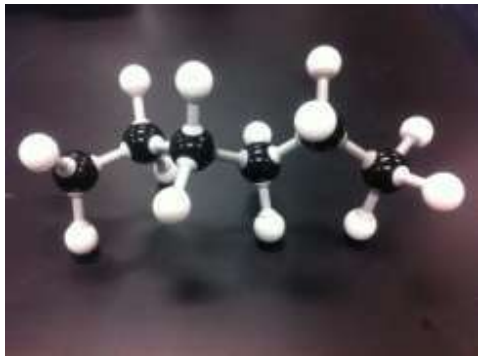
Type of oil/fat	Saturated	Monounsaturated	Polyunsaturated
 Sunflower oil	11	20	69
Corn oil	13	25	62
Olive oil	14	77	9
Soybean oil	15	24	61
Peanut oil	18	49	33
Margarine (soft)	20	47	33
Lard	41	47	12
Palm oil	52	38	10
Butter	66	30	4
 Coconut oil	92	6	2

Avoid oils high in saturated fat.
Opt for healthier options like sunflower oil!

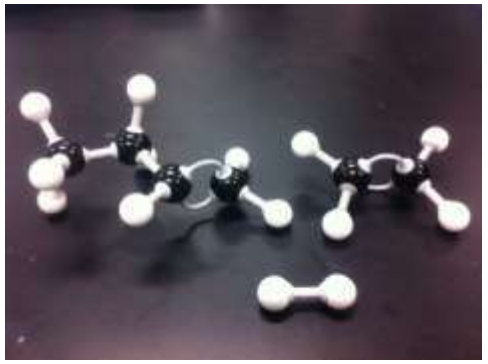
Manufacture of Alkenes

Short-chain alkenes are useful as starting materials for making ethanol and plastics. How can we manufacture alkenes?

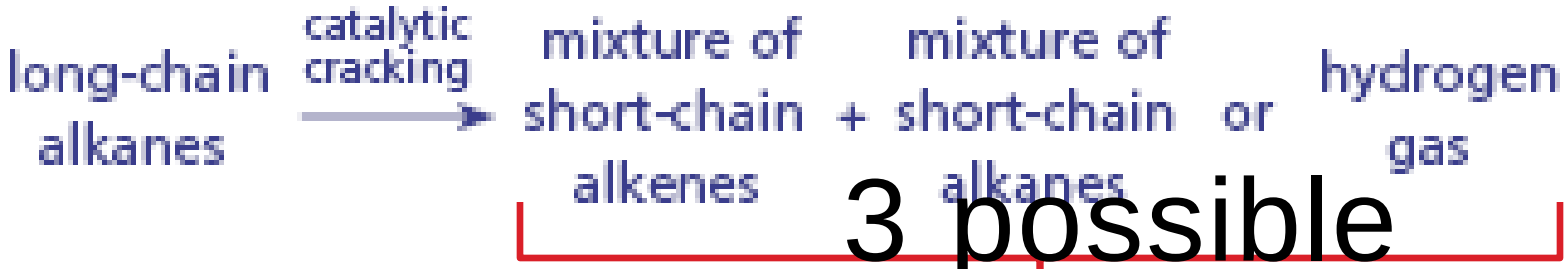
- By cracking of petroleum
- Cracking is the **breaking down** of long-chain hydrocarbons into **smaller molecules**.
- On the industrial scale, cracking is done by passing the petroleum fraction over a **catalyst** (aluminium oxide or silicon(IV) oxide) at a **temperature** of 600 C.



Cracking



Products of Cracking



Try this:

Write an equation for the cracking of heptane (C_7H_{16}).

(Note: There are a few possible answers)

One possible answer: $C_7H_{16} \rightarrow C_3H_6 + C_4H_8 + H_2$

Video time: Cracking in the school laboratory

1. **What is the compound that is cracked?**

   Paraffin

2. **What is the catalyst used?**

   Pumice stones / broken flower pots

3. **Describe some characteristics of the gases collected.**

   They have a smell, are flammable and unsaturated (contain C=C bonds).

4. **Which other test can be used to test for unsaturation?**

   Add acidified potassium permanganate to the unknown. If it turns brown or colourless, the unknown is unsaturated.

5. **Why is the displacement of water method used to collect the products?**

   The organic products are insoluble in water.

Why the need for cracking?

Fraction	Amt. of fraction from petroleum	Amt. needed by industry
Gases (Lightest)	5%	5%
Petrol	10% <	25%
Naptha	5%	5%
Kerosene	20%	25%
Diesel	15%	35%
Fuel Oil (Heaviest)	45% >	5%

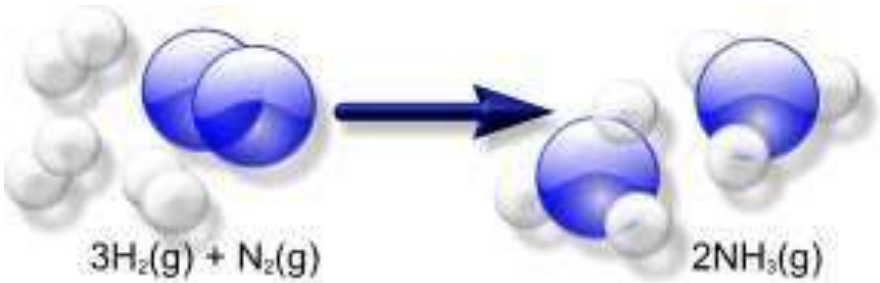
Shortfall of petrol

Excess of fuel oil

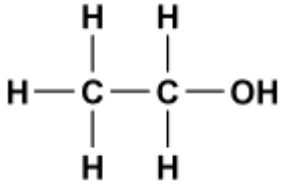
Cracking of heavier fractions like fuel oil can be used to make up for the shortfall of lighter fractions like petrol.

In short, cracking is used to produce:

Petrol (fuel)



and raw material for Haber process)



Short-chain alkenes (starting materials for making ethanol and plastics)

In the Singapore context

- Steam cracking adopted
- Produce large amounts of ethene, propene and butene for making plastics
- Cracking plants in Jurong island and Pulau Bukom

Jurong island

Pulau Bukom

Summary

10 minutes to construct concept maps!

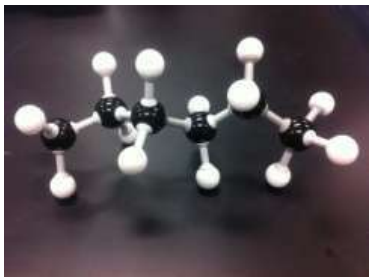
1

- Chemical Properties of Alkenes
  - Addition Reactions
    - Bromination
    - Hydrogenation
    - Hydration
  - Combustion Reactions

2

- Saturated Fats
- Monounsaturated Fats
- Polyunsaturated Fats

3



Cracking