

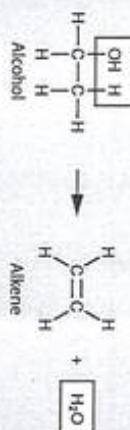
ALCOHOLS

ELIMINATION

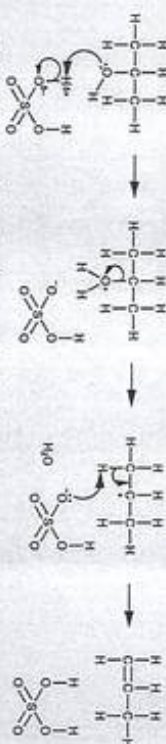
OXIDATION

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Alcohols can be converted into alkenes by elimination. Elimination reactions involve removing the OH group and an H atom to form an alkene.



This reaction requires an acid catalyst such as conc. H_2SO_4 or conc. H_3PO_4 with heating.



This reaction is useful as the alkenes produced can be used to make addition polymers. This means that natural alcohols can be used to create polymers without using crude oil.

Alcohol can be oxidised by acidified potassium dichromate, $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$. Acidified dichromate is an 'oxidising agent', and is represented as $[\text{O}]$ in reaction equations. Primary, secondary and tertiary alcohols are oxidised differently.

PRIMARY

Primary alcohols are oxidised to form aldehydes and then carboxylic acids.

When the mixture is distilled, an aldehyde is collected:



When the mixture is left to reflux with excess $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$, the aldehyde formed continues reacting, and a carboxylic acid is formed:



Overall, the reaction under reflux conditions is:



SECONDARY

Secondary alcohols are oxidised to form a ketone:



TERTIARY

Tertiary alcohols cannot be oxidised.

ALCOHOL PRODUCTION

HYDRATION OF ALKENES

Alcohols are produced industrially using the addition reaction between alkenes and water with an acid catalyst (e.g. H_2SO_4).



FERMENTATION

Fermentation is used to produce ethanol industrially. This process involves using yeast to convert sugar into ethanol:



CARBON NEUTRAL FUELS

Reactions can be used to show that ethanol biofuel is carbon-neutral, meaning that as much carbon dioxide is used up making the fuel as is produced when the fuel is burned:



Production of ethanol:



Burning ethanol:



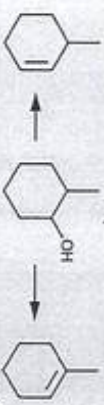
FRACTIONAL DISTILLATION

Once the ethanol solution is produced, it is purified using fractional distillation. The pure ethanol can be used as a biofuel, meaning that it is made from plants (rather than from fossil fuels such as crude oil).

CONDITIONS

1. Yeast provides the enzymes which convert sugar to ethanol.
2. Anaerobic (without air/oxygen) to prevent the oxidation of ethanol to ethanoic acid.
3. 35 °C, which is the optimum temperature for yeast. The enzymes in the yeast can be denatured by temperatures higher than this. However, lower temperatures lower the reaction rate.

Elimination of water from asymmetrical alcohols can lead to two different alkene products:



PRACTICAL TIP

During oxidation of alcohols and aldehydes by potassium dichromate, the oxidising agent changes colour from orange to green.

ALCOHOLS AS FUELS

ETHICAL ISSUES

Pros
Biofuels are a renewable, carbon-neutral fuel.

Cons
Biofuels are produced from crops, and so use land which might otherwise be used to make food.

ENVIRONMENTAL ISSUES

Biofuels are, in theory, carbon-neutral, but this does not take into account other factors and energy use. For example, energy is required to:

1. produce crops
2. transport the crops and fuels
3. heat the fermentation process
4. perform fractional distillation

In reality, biofuels are not actually completely carbon-neutral, and this may affect the decision as to whether to use them.

TOLLENS' REAGENT

Tollens' reagent forms a silver mirror when warmed with an aldehyde but not a ketone. The silver oxidises the aldehyde to a carboxylic acid.



The silver ions are reduced from Ag^+ to Ag .

reduction

aldehyde

ketone

FEHLING'S SOLUTION

Fehling's solution can be used to distinguish an aldehyde from a ketone. Aldehydes form a brick-red precipitate with Fehling's solution, but Fehling's solution remains blue with ketones.

