

MINISTRY OF EDUCATION
SECONDARY ENGAGEMENT PROGRAMME

GRADE 11

CHEMISTRY

WEEK 7

LESSON 2

Topic: Organic Compounds

Sub-topic: Preparation and Uses of Alcohols

Objective: Given the information, students will:

- Identify the raw material used in the laboratory preparation of ethanol.
- states at least three uses of alcohol in everyday life.

Content

Preparation of Ethanol by Fermentation

This method is only applicable to the preparation of ethanol. Alcohols cannot be prepared by this method generally.

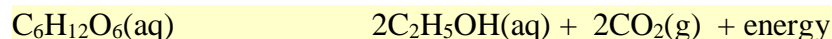
The starting material for this process varies widely, but will normally be some form of starchy plant material such as maize, corn wheat barley, potato. Starch is a complex carbohydrate, and other carbohydrates such as lab sucrose (sugar) obtained from sugar cane, are normally used to produce ethanol.

1. Break down the complex carbohydrate into simpler ones. For example, if the starch grains like wheat or barley are to be used, the grain is heated with hot water to extract the starch and then warmed with malt. Malt is germinated barley that contains enzymes that break the starch into a simpler carbohydrate called maltose, $C_{12}H_{22}O_{11}$. Maltose has the same molecular formula as sucrose but contains two glucose units joined together, whereas sucrose contains one glucose and one fructose unit.

Yeast is then added and the mixture is kept warm at approximately $35^{\circ}C$ for several days until fermentation is complete. Air is kept out of the mixture to prevent oxidation of the ethanol produced, converting it to ethanoic acid (vinegar).

Enzymes in the yeast first convert carbohydrates like maltose or sucrose into even simpler ones like glucose and fructose. They are then converted to ethanol and carbon dioxide.

The equation for the reaction



Yeast is killed by the ethanol concentrations above 15%, and that limits the purity of the ethanol that can be produced. The ethanol is separated from the mixture by fractional distillation to give 96% pure ethanol.

Wine is made by adding yeast to grapes. Zymase from the yeast cells ferments the glucose in the grape juice. Air must not come into contact with the wine, since certain bacteria oxidize ethanol to ethanoic acid (vinegar) which causes the wine to become sour.

The equation below shows the oxidization of ethanol.



Aerobic bacteria Ethanoic acid

Rum is made by adding yeast to molasses. The yeast cells produce the enzyme invertase which digests the sucrose in the molasses into glucose and fructose. The yeast then ferments the glucose and fructose and the mixture is distilled.

Ethene from ethanol

Another method used to prepare ethanol is the hydration of ethane. The reaction of ethene with steam to form ethanol can be reversed. This allows ethanol to be converted into ethene. A catalyst of hot **aluminum oxide** is used to speed up the reaction.

Hydration of ethene v Fermentation

These are some of the advantages and disadvantages of making ethanol by hydration of ethene and by fermentation.

The table compares making ethanol by hydration of ethene (ethene and steam) to making ethanol by fermentation (sugar from plant material).

	Fermentation	Hydration of Ethene
Type of raw materials	Renewable (glucose from plants)	Non-renewable (ethene from crude oil)
Type of process	Batch (stop-start)	Continuous (runs all the time)
Labour	A lot of workers needed	Few workers needed
Rate of reaction	Slow	Fast
Conditions needed	Warm (30°C), normal pressure (1 atm)	High temperature (300°C) and high pressure (60-70 atm)
Purity of product	Impure (needs treatment)	Pure (no by-products made)
Energy needed	A little	A lot

Uses of Alcohols

1. Alcoholic Drinks

The word "alcohol" in alcoholic drinks refers to ethanol ($\text{CH}_3\text{CH}_2\text{OH}$).



2. Used to produce methylated spirit (meth)

Methylated spirit is ethanol mixed with small amounts of methanol, which is poisonous, making it unfit for consumption.

Methylated spirit is combustible so it can be used in lamps and stoves, especially those made for camping.

Methylated spirit is used to remove ink from non-porous surfaces. E.g. removing permanent ink from various kinds of surfaces, such as metals and plastics.

Methylated spirit is used as a component of household cleaning products, usually glass cleaners.

3. Used as a fuel

Ethanol burns cleanly to form carbon dioxide and water. Using ethanol as fuel does not contribute much to pollution.

Ethanol is usually mixed with the gasoline to produce 'gasohol', which is about 10-20% ethanol. Using ethanol as a fuel reduces our reliance on natural fossil fuels such as petrol.

4. Used as a solvent

Ethanol is commonly used as an organic solvent to dissolve organic compounds that are insoluble in water. E.g. used in cosmetics such as perfumes; used in medicines such as disinfectants; used in toiletries such as after-shave lotions

The advantage of ethanol as a solvent is that it is volatile, colourless and has a relatively high boiling point of 78°C. It is also miscible in both water and other organic solvents.

Reference

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