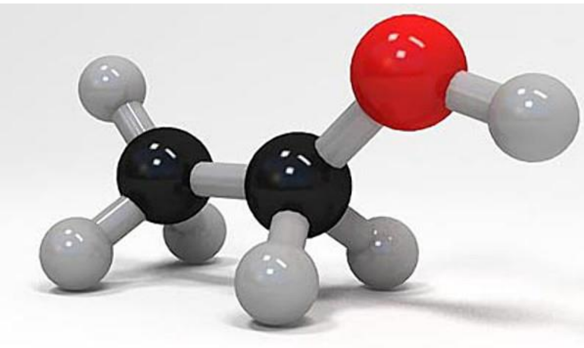
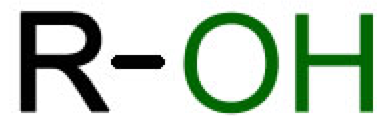


Chemistry

Chapter 9- Alcohols

LS-GS



Presented by :
Bassam ZAAROUR

Submitted to students
Presented in Wednesday 25 March 2020

Overview

1- Definition

2- general Formula

3- Mass and atomic percentage

4- Class of alcohols

5- Nomenclature of alcohols

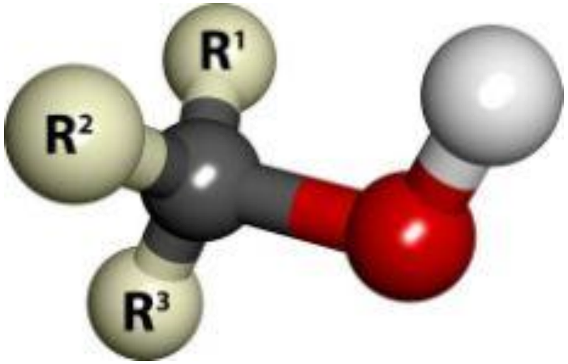
6- chemical reactions

6-1- Mild oxidation

7- Applications

1- Definition

The alcohol is an organic compound that contains a hydroxyl group OH



2- General formula

The general formula of a monoalcohol is R-OH and in the case where R is an alkyl group it becomes $C_nH_{2n+2}O$

3- Mass and atomic percentage

The mass percentage of an element is the partial mass of this element over the total mass of the compound that contains it multiplied by 100

$P_{m(O)} = m_{(O)} \times 100 / m_{total} = 16 \times 100 /(14n + 18)$

$P_{m(C)} = m_{(C)} \times 100 / m_{total} = 12\, n \times 100 /(14n + 18)$

$P_{m(H)} = m_{(H)} \times 100 / m_{total} = (2\, n + 2) \times 100 /(14n + 18)$

The atomic percentage of an element is the number of atoms of this element over the total number of atoms of this molecule multiplied by 100

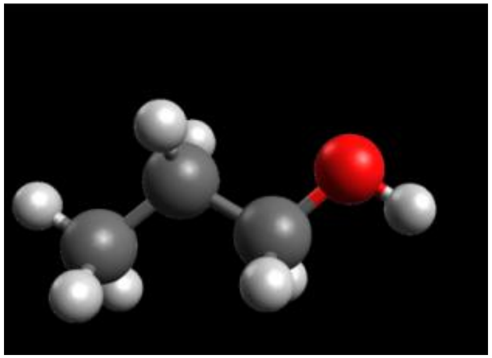
$P_{a(O)} = n_{(O)} \times 100 / n_{total} = 1 \times 100 /(3n + 3)$

$P_{a(C)} = n_{(C)} \times 100 / n_{total} = n \times 100 /(3n + 3)$

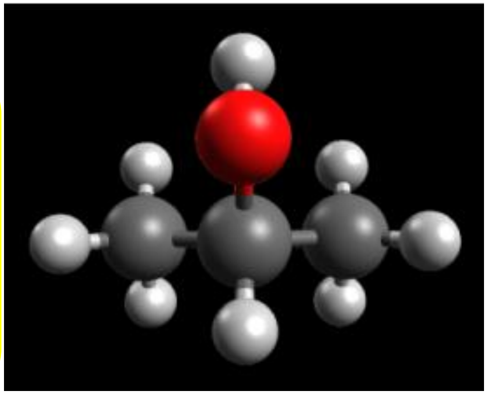
$P_{a(H)} = n_{(H)} \times 100 / n_{total} = (2\, n + 2) \times 100 /(3n + 3)$

4- Classes of alcohols

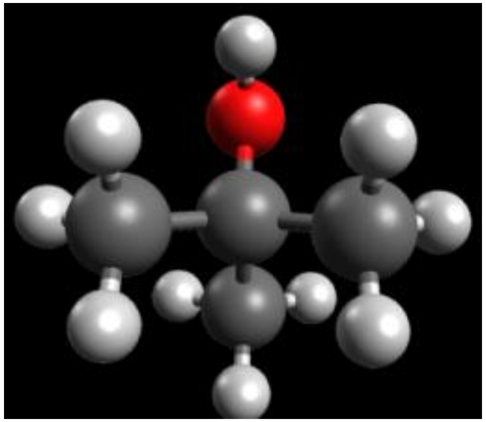
The primary alcohol has as general formula R-CH_2OH, the carbon atom which carries hydroxyl group binds maximum to one carbon atom



The secondary alcohol has as general formula
R-CHOH-R‘, the carbon which carries the hydroxyl group binds to two carbon atoms



The tertiary alcohol has as general formula RR'R''C-OH, the carbon which carries the hydroxyl group binds to three carbon atoms



5- Nomenclature of alcohols

Identify the main carbon chain (which carries the functional group, the longest and the most branched)

Number the main carbon chain starting with the end closest to the functional group

Identify the alkyl groups and the others and classify them according to the alphabetical order

The name ends with the suffix “ ol ” with the number of the carbon carrying the hydroxyl group

5- Nomenclature of alcohols

Condensed structural formula	Name	Class
CH_3OH	methanol	primary
CH_3-CH_2OH	ethanol	primary
CH_3- CH_2-CH_2OH	1-propanol	primary
CH_3- CHOH-CH_3	2-propanol	secondary
CH_3- CH_2- CH_2-CH_2OH	1-butanol	primary
CH_3- CHOH- CH_2-CH_3	2-butanol	secondary
$(CH_3)_2CH$-CH_2OH	2-methyl-1-propanol	primary
$(CH_3)_3COH$	2-methyl-2-propanol	**tertiary**

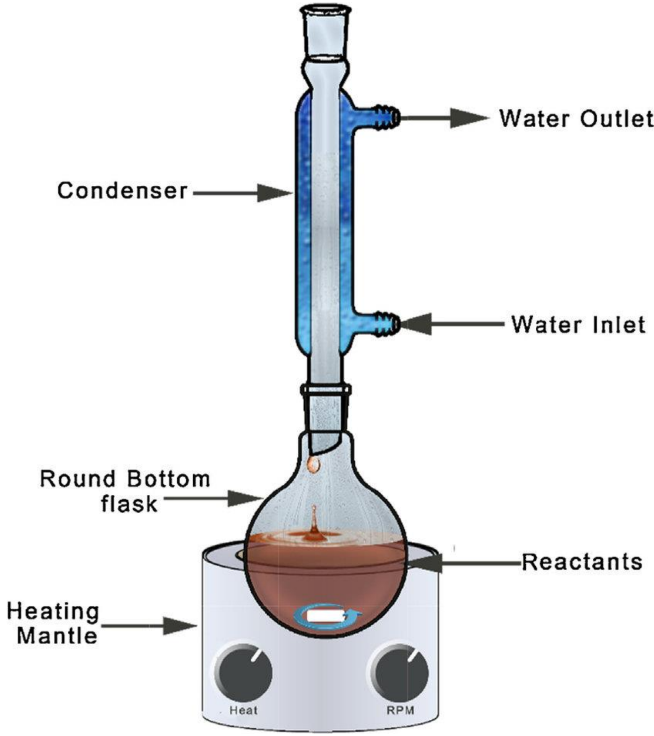
5- Nomenclature des alcools

Condensed structural formula	Name	Class
CH_3-CH_2- CH_2- CH_2-CH_2OH	1-Pentanol	primary
CH_3-CH_2- CH_2-CHOH- CH_3	2-Pentanol	secondary
CH_3-CH_2- CHOH-CH_2- CH_3	3-Pentanol	secondary
$(C_2H_5)(CH_3)$CH-CH_2OH	2-methyl-1-butanol	primary
$(CH_3)_2$CH- CH_2-CH_2OH	3-methyl-1-butanol	primary
$(CH_3)_2$CH-CHOH- CH_3	3-methyl-2-butanol	secondary
$(C_2H_5)(CH_3)_2$COH	3-methyl-2-butanol	**tertiary**
$(CH_3)_3$C-CH_2OH	2,2-dimethyl-1-propanol	primary

6- Chemical reactions

6-1- Esterification reaction

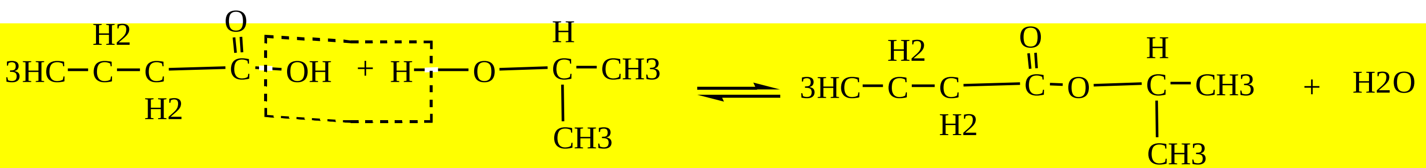
It is a reaction between a carboxylic acid R-COOH and an alcohol R’-OH which gives an ester R-COO-R 'and water



$$R\text{-}COOH + R'\text{-}OH \rightleftharpoons R\text{-}COO\text{-}R' + H_2O$$

It is a reversible, slow and athermic reaction

Example $CH_3\text{-}CH_2\text{-}CH_2\text{-}COOH + CH_3\text{-}CHOH\text{-}CH_3$

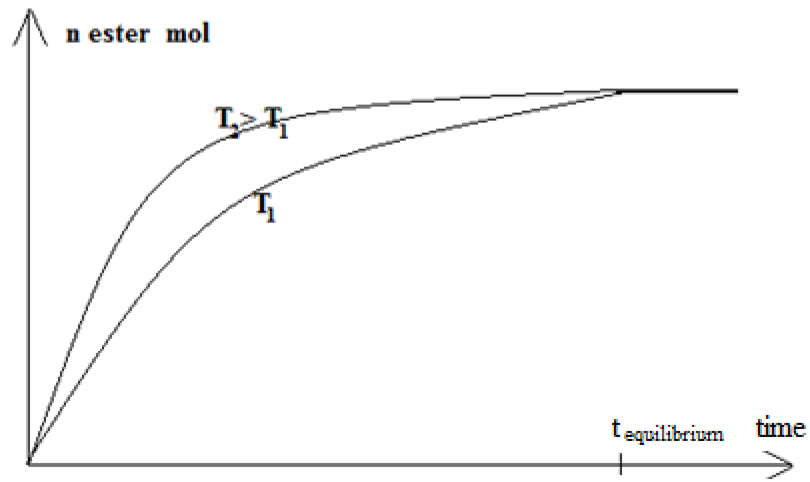


6- Chemical reactions

6-2- Esterification reaction

Effect of the temperature

The temperature is a kinetic factor, it increases the initial rate of the reaction



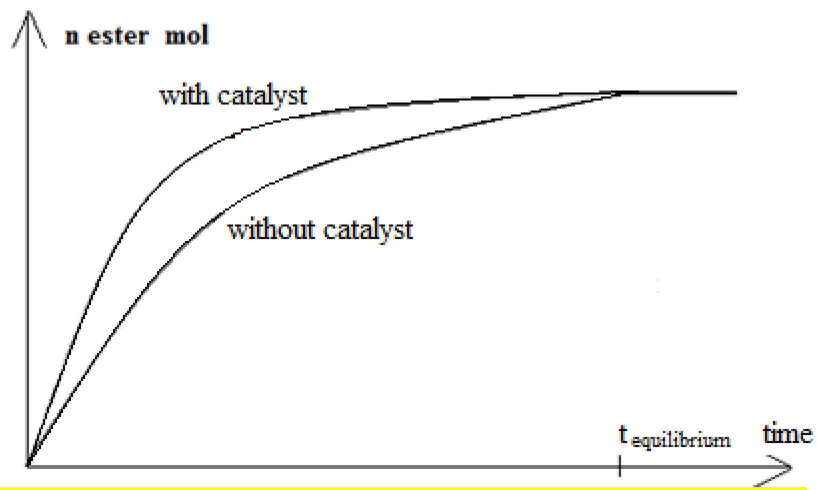
At an instant ($t < t_{equilibrium}$) at a temperature $T_2 > T_1$, $n_{2(ester)} > n_{1(ester)}$, the yield $y_2 > y_1$ et $\alpha_2 > \alpha_1$

At $t_{equilibrium}$ the increase in temperature has no effect on the equilibrium, on α and on the yield because this reaction is athermic

6- Chemical reactions

6-2- Esterification reaction

Effect of a catalyst like H_2SO_4



The catalyst is a kinetic factor, it increases the initial rate of the reaction

At an instant ($t < t_{equilibrium}$) $n_{2(ester)(with\ catalyst)} > n_{1(ester)\ (without\ catalyst)}$, the yield $r_{2\ (with\ catalyst)} > r_{1(without\ catalyst)}$ et $\alpha_{2(with\ catalyst)} > \alpha_{1(without\ catalyst)}$

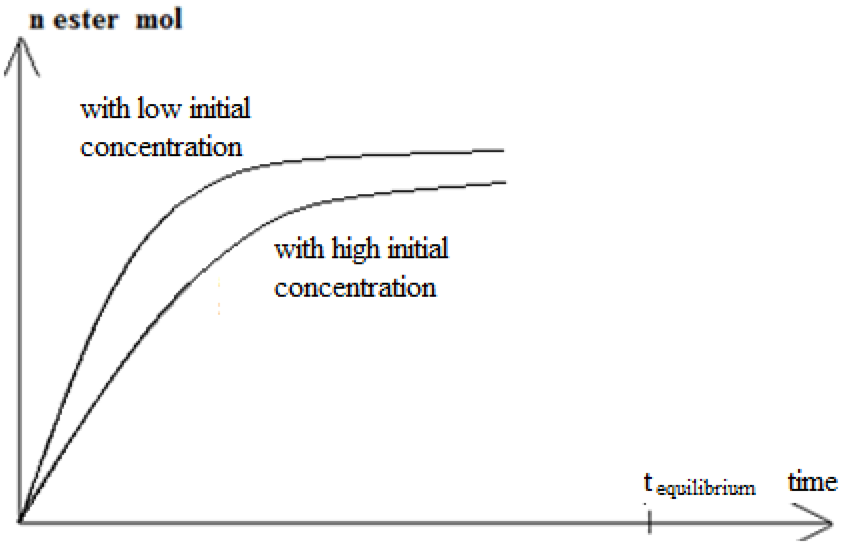
À $t_{equilibrium}$ the use of a catalyst increases the rate in both directions but has no effect on the equilibrium, on α and on the yield

6- Chemical reactions

6-2- Esterification reaction

Effect of the initial concentration

If we start from a higher concentration (with the same volume) the equilibrium is established at a value greater than the old value



If the initial concentration of excess reactant is increased, the yield increases, $\alpha_{\text{(limiting reactant)}}$ increases and $\alpha_{\text{(reactant in excess)}}$ decreases

If the initial concentration of the limiting reagent is increased, the yield decreases, $\alpha_{\text{(limiting reactant)}}$ decreases and $\alpha_{\text{(reactant in excess)}}$ increases

6- Application

1- An alcohol "A" of formula R-OH where R is an alkyl group, the complete combustion of 10 g of "A" leads to the formation of 23.78 g of CO_2 and 12.16 g of H_2O.

M in $g.mol^{-1}$ of C: 12, H: 1 and O: 16

1-1- Show that the molecular formula of "A" is $C_4H_{10}O$.

1-2- Write for "A" the possible condensed structural formulas, their names and their classes.

2- To identify alcohol "A", an esterification reaction was carried out between alcohol "A" (C_4H_9OH) and ethanoic acid CH_3-COOH

Given: For an equimolar mixture of a primary alcohol and an ethanoic acid the percentage yield of the esterification reaction at equilibrium is 67 %, it is 60 % for a secondary alcohol and from (1 to 5) % for tertiary alcohol.

6- Application

If the mixture is non-stoichiometric the yield will increase.
The equilibrium constant K_C for this equation is 2.25.
If we start with 4 mol of "A" (C_4H_9OH) and 5 mol of "B" (CH_3-$COOH$) we obtain at equilibrium x mol of E (ester) and x mol of water (W).

2-1- Make a table showing the number of moles of each constituent of the reaction mixture at equilibrium as a function of x. Determine the numerical values.

2-2- Determine the percentage yield of this reaction.

2-3- Identify the alcohol "A". Explain.

2-4- Write the equation for the esterification reaction using the condensed structural formulas.

Thank you