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## LABORATORY WORK NO. 26

### HYDROXYL DERIVATIVES – ALCOHOLS

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- **PRINCIPLE:** Hydroxyl derivatives are oxygenous derivatives of hydrocarbons which are formed by a substitution of one or more atoms of hydrogen in the hydrocarbon molecule with the hydroxyl group  $-OH$ . Alcohols and phenols belong to the group of hydroxyderivates.

ALCOHOLS are acyclic and cyclic (aromatic) compounds. Aromatic alcohol is such a compound which has the  $-OH$  group bound to the side chain and never bound to the benzene core directly.

#### DIVISION OF ALCOHOLS:

Alcohols are divided according to different viewpoints:

According to the number of  $-OH$  groups:

monohydric  
dihydric  
multihydric

According to the placement of  $-OH$  group:

primary  
secondary  
tertiary

According to the length of the carbon chain:

lower  
higher

#### PROPERTIES OF ALCOHOLS:

- They have higher boiling point (hydrogen bridges) than corresponds to their chemical composition.
- The boiling temperature rises with the number of hydroxyl groups in a molecule.
- Lower alcohols can be unlimitedly mixed with water, higher less and the highest are not soluble in water at all.
- They have amphoteric character; the primary alcohols are the most acidic.
- They react with alkali metals while alcoholate is formed.
- When primary alcohols oxidize, aldehydes and carboxyl acids are formed.
- When secondary alcohols oxidize, ketones are formed; tertiary alcohols do not react with common oxidation agents.



### ***TASK N. 1 PROPERTIES OF HYDROXYDERIVATES - ALCOHOLS***

- **CHEMICALS:** ethanol, butanol, glycerol, distilled water  $H_2O$ , waterless  $CuSO_4$ , wine,  $H_2SO_4$  ( $c = 1\text{mol/l}$ ), 1% solution of  $KMnO_4$ , solid borax  $Na_2B_4O_7 \cdot 10H_2O$ , solid  $KMnO_4$ , phenolphthalein, pH paper, sodium, copper wire
- **AIDS:** test tubes, burette, beakers, thermometer, porcelain dish, burner, holder, net, PET bottle, protection aids, scales, skewer, iron bowl, mortar

#### **A) Solubility of alcohols in water**

- **PROCEDURE:** We prepare 3 test tubes. We pour 2 ml of ethanol into the first test tube, 2 ml of butanol and into the second test tube and 2 ml of glycerol into the third one. We add slowly distilled water and observe the solubility of the particular alcohol with water.

#### **B) Temperature dependency of alcohol dilution**

- **PROCEDURE:** We prepare a small beaker and pour 5 ml of ethanol into it. We measure the actual temperature. We add 5 ml of distilled water and we observe the temperature changes. We write both temperatures down.

#### **C) Proof of water in ethanol**

- **PROCEDURE:** We put 2 ml of ethanol into a test tube and we add  $\frac{1}{2}$  spoon of annealed  $CuSO_4$ . We shake the mixture and watch the colouring changes of  $CuSO_4$ .

#### **D) Observation of reactivity of sodium with water and alcohols – a demonstrative test of a teacher in a fume cupboard with protective glasses.**

- **PROCEDURE:** First we test the reaction of sodium with water. We pour water into the beaker and we add a small piece of sodium. We observe the reaction progress. We prepare 2 test tubes. We pour 2 ml of ethanol into the first test tube and 2 ml of butanol into the second test tube. We add a small piece of sodium into both test tubes and we observe the reaction progress.

#### **E) Preparation of sodium ethanolate**

- **PROCEDURE:** In the test tube where the reaction of ethanol with sodium takes place, sodium ethanolate and hydrogen are formed. After the reaction is completed, we pour the solution into a porcelain bowl and we vapour it. We add 4 ml of distilled water to the sodium ethanolate and we determine (using pH paper), the basic reaction which is formed by an ethanolate hydrolysis.

#### **F) Inflammability test of ethanol fumes – a teacher's demo experiment in a fume cupboard with protective glasses.**

- **PROCEDURE:** We pour a little amount of ethanol into the PET bottle. We close the bottle and shake it. The ethanol fumes will be mixed with oxygen. We pour out the rest of



ethanol. We light the skewer and we put it to the neck of the bottle which is saturated with ethanol fumes. We observe the burning of ethanol fumes in the bottle.

### G) Proof of alcohol in wine

**PROCEDURE:** We prepare a test tube and we pour 5 ml of wine into it. We close the test tube with a curved glass tube. We warm it up carefully until alcohol fumes emerge. These will leak through the glass tube. The emerged fumes can be proven by lighting the end of the tube by a skewer.

### H) Reduction properties of alcohol

■ **PROCEDURE:** We pour 5 ml of ethanol into a test tube. We warm up a copper wire over the burner until it's red. Then we dip the still hot copper wire into the ethanol in the test tube and we observe the reaction.

### I) Oxidation of alcohols by potassium permanganate

■ **PROCEDURE:** We pour 2 ml of ethanol into each of 2 test tubes. We pour 1 ml of 1 % solution of potassium permanganate and a few drops of diluted  $H_2SO_4$  into the first test tube and we add the solution of potassium permanganate into the second one. We observe the reactions in the test tubes.

### J) Proof of polyhydric alcohols

■ **PROCEDURE:** We put 2 ml of borax ( $\frac{1}{2}$  spoon of borax in 2 ml of water) and a drop of phenolphthalein on the porcelain dish. The colour will become red. We add 0,5 ml of glycerol and we observe the colouring of the solution. The emerged acid can be tested with pH paper.

### K) Self-igniting mixture – a teacher's demo experiment in a fume cupboard with protective glasses.

■ **PROCEDURE:** We weigh 5 g of potassium permanganate that we crush in the mortar. We put it into the iron dish and we add a little of glycerol. After a while, the mixture will ignite.

#### ■ CONCLUSIONS:

- Write down which alcohol mixes with water the best.
- Write down how the ethanol temperature has changed after water being added. What is the reaction and why?
- Write down what was the colour change of copper sulfate and why?
- What was the reaction of water, ethanol and butanol with sodium like? Compare those reactions.
- Write down how you prove the emerged ethanolate.
- Write down what happened after putting the skewer to the bottle neck.
- Write down how long ethanol fumes emerge from wine.
- Write down how the colour of the copper wire changed and what is the oxidation reduction equation.
- CH. Write down the equations of the reaction progress in both test tubes.



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- I. What was the pH of the solution?
- J. Write down why did the mixture ignite itself?

- **SAFETY:** Generally, alcohols are inflammable substances, therefore it is important to keep all safety precautions while working with them!



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**STUDENT'S SHEET No. 26**  
**HYDROXYL DERIVATIVES – ALCOHOLS**

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**1. VOCABULARY**

Translate the Czech words into English. The first letter is given.

Uhlovodíky	hydrocarbons
Chemické složení	chemical composition
Vznikat	emerge
Špejle	skewer
Vznítit se	ignite
Měděný drátek	copper wire
Vícesytná kyselina	polyhydric acid
Manganistan draselný	potassium permanganate
Samozápalný	self-igniting
Etanolát sodný	sodium ethanolate

**2. Complete the text with the right choice of words.**

- We .... 2 ml of ethanol into the first test tube.  
a) Pour b) pur c) fill d) add
- We weigh 5 g of potassium permanganate that we .... in a mortar.  
a) Put b) crush c) bring d) rub
- Then we dip the still hot .... wire into the ethanol in the test tube.  
a) Aluminium b) potassium c) iron d) copper
- After the reaction is completed, we pour the solution into a porcelain ... and we vapour it.  
a) Plate b) spoon c) bowl d) fork
- We warm it up carefully until alcohol .... emerge.  
a) Acid b) fumes c) gases d) beverage

**3. Translate the Czech word into English**

- |                         |                |
|-------------------------|----------------|
| a) kyselina             | acid           |
| b) pára                 | fume           |
| c) síran měďnatý        | copper sulfate |
| d) digestoř             | fume cupboard  |
| e) hydrolýza            | hydrolysis     |
| f) karboxylová kyselina | carboxyl acid  |

**4. Choose the right word.**

- To increase in amount  
a) to rose b) to rise c) to rich d) to reach
- To separate something  
a) to divide b) to divine c) to dovine d) to diline
- To make something into very small pieces  
a) to crusch b) to crisch c) to crush d) to crawl
- To heat up something  
a) to warm up b) to cold up c) to hot up d) to haul
- A chemical, usually a liquid, that contains hydrogen and has a pH of less than seven.  
a) hydrogen b) copper c) acid d) oxygen



5. Find the seven following words and translate them:  
HYDROLYSIS, SODIUM ETHANOLATE, POLYHYDRIC, HYDROGEN, REDUCTION,  
FUME CUPBOARD, COMPOSITION

O	T	J	D	E	R	U	R	G	U	J	P	S
T	R	H	P	S	G	M	G	A	P	I	O	O
F	E	Y	O	C	C	J	Z	L	O	U	L	D
R	D	D	L	C	X	L	H	U	L	N	K	I
H	U	R	H	O	S	P	H	A	T	E	Z	U
Y	C	O	M	P	O	S	I	T	I	O	N	M
D	T	L	J	R	E	O	T	I	J	R	T	E
R	I	Y	I	O	T	I	I	C	N	C	V	T
O	O	S	U	S	M	J	N	C	M	W	D	H
G	N	I	Z	I	I	H	M	E	T	V	G	A
E	D	S	F	O	P	F	U	L	Z	B	H	N
N	C	P	O	L	Y	H	Y	D	R	I	C	O
O	V	I	H	T	O	E	D	T	F	R	F	L
L	R	D	R	I	K	Y	C	R	V	F	D	A
P	T	K	E	M	J	T	X	E	E	U	E	T
F	U	M	E	C	U	P	B	O	A	R	D	A

6. Correct the spelling and write the word right:
- Inflammability      fainbyilmm
  - Copper                  pepocr
  - Fume cupboard        femu cpuordab
  - Carboxyl acid          cyxlarbo cida
  - Skewer                  weersk