## Lesson 16. Chemical-toxicological analysis of organic and inorganic fluorine compounds.

**Fluorine -** is an element of group VII of the periodic system, belongs to halogens, it is the strongest nonmetal

In small amounts, fluoride is part of chemical composition of the body: it participates in the formation of tooth enamel, bone tissue, in the activation of certain enzymes

Poisoning with fluorine compounds can occur in production in the metallurgical and chemical industries. Gaseous and liquid hydrogen fluoride, in turn, is the main raw material for the production of inorganic fluorides and fluorocarbons

The main compounds of fluorine:

1) **Hydrogen fluoride**- causes a burn of the mucous membranes of the oral cavity, larynx, bronchi, lungs,

*Inhalation of hydrogen fluoride can cause:* cough, choking attacks, fever, cyanosis and pulmonary edema.

If hydrofluoric acid is swallowed, there may cause : nausea, vomiting, diarrhea and abdominal pain,

In case of skin contact - ulceration.

- Sodium fluoride- used in dentistry and as an insecticide and zoocide <u>Poisoning:</u> weakness, dizziness, nausea, diarrhea, drooling, convulsions. <u>At autopsy:</u> liquid blood in the cavities of the heart, kidneys, severe dystrophic phenomena. <u>Chronic poisoning -</u> fluorosis - tooth damage (spots on tooth enamel), lameness
- 3) **Sodium silicofluoride -** used in agriculture to control pests of sugar beet, grain crops. It can be absorbed through the skin.

<u>*Poisoning:*</u> nervous system damage, salivation, vomiting, abdominal pain, skin cracks, purulent rash, rapid breathing.

<u>Chronic poisoning</u>: diseases of teeth and bones.

4) **Fluorophosphates -** fluorinated toxic substances

*Dialkyl fluorophosphate.* - exhibit anticholinesterase activity. Signs of poisoning - constriction of the pupils (miosis) and difficulty breathing.

*<u>Diisopropyl fluorophosphate</u>* - используют как эталонное антихолинэстеразное вещество при токсикологических исследованиях.

Sarin and soman- have a nerve-paralytic effect.



<u>Sarin</u>

<u>Soman</u>

<u>Soman</u> - cumulative properties and poisoning are more difficult to treat

5) Fluoroacetates – used as insecticides. Highly toxic, cause myocardial depression, arrhythmias and ventricular fibrillation, damage to the central nervous system .

The toxic effect is associated with blocking the tricarboxylic acid cycle.

## 6) Fluorinated hydrocarbons

<u>*Refrigerants (freons)*</u> - used as a refrigerant in refrigerators. Does not cause loss of consciousness, but there is a loss of sensitivity and anxiety..

Halothane - used as a means for inhalation anesthesia.

Perfluoroalkanes (Teflon) – used for high-temperature plastics. Non-toxic, but if heated to 500-800  $^{\circ}$  C, toxic products are formed.

Poisoning : cough, chest tightness, shortness of breath, convulsions.

#### Objects of research: organs of corpses, vomit, stomach contents..

## **Isolation of fluorides and silicofluorides:**

- 1) The crushed object is placed in a crucible,
- 2) A suspension of calcium oxide is added
- 3) Moistened with a solution of ammonium nitrate
- 4) Dried and burned
- 5) The ash is washed with water, dried

## **Detection of fluorides and silicofluorides**

## • <u>Glass etching reaction:</u>

- 1) Part of the ash is placed in a crucible + concentrated sulfuric acid.
- 2) The top is covered with a watch glass (the lower surface of the glass is covered with wax or paraffin, on which an inscription is made)
- 3) Leave for a day at room temperature
- 4) Remove the watch glass
- 5) Cleaned of wax
- 6) If there is an inscription on the glass- there are fluorides and silicofluorides in the object

CaF<sub>2</sub> + H<sub>2</sub>SO<sub>4</sub> 
$$\rightarrow$$
 CaSO<sub>4</sub> + 2HFT  
CaSiF<sub>6</sub> + H<sub>2</sub>SO<sub>4</sub>  $\rightarrow$  CaSO<sub>4</sub> + 2HF $\uparrow$  + SiF<sub>4</sub>  
SiF<sub>4</sub> + 3H<sub>2</sub>O  $\xrightarrow{H_2SO_4}$  H<sub>2</sub>SiO<sub>3</sub> + 4HF $\uparrow$   
конц.

$$\rm 4HF + SiO_2 \rightarrow SiF_4 + 2H_2O$$

## • Formation of orthosilicic acid gel

- 1) Concentrated sulfuric acid is added to a part of the ash in a test tube
- 2) A stick with a drop of water is brought to the opening of the test tube
- 3) Turbidity of the drop means that fluorides and silicofluorides are detected in the object

 $Na_2SiO_3 \cdot CaSiO_3 \cdot 4SiO_2 + 28HF \rightarrow 4SiF_4^{\uparrow} + Na_2[SiF_6] + Ca[SiF_6] + 14H_2O$ 

$$\begin{split} 3SiF_4 + 2H_2O \rightarrow SiO_2 + 2H_2SiF_6 \\ 3SiF_4 + 3H_2O \rightarrow H_2SiO_3 + 2H_2SiF_6 \end{split}$$

## • <u>Reaction with zirconium alizarin s complex</u>.

- 1) Alizarin red + zirconium nitrate solution is applied to the filter paper
- 2) Dry. A red spot forms on the filter paper
- 3) A drop of the test solution is applied to the stain
- 4) The yellow color of the spot indicates the presence of fluoride and silicofluoride



## **Distinctive reactions of fluorides and silicofluorides**

• With ammonia solution - gelatinous precipitate - means the presence of silicofluoride

# $Na_2[SiF_6] + 4NH_4OH \rightarrow H_4SiO_4 \downarrow + 4NH_4F + 2NaF$

- *With a solution of sodium hydroxide* a white gelatinous precipitate means the presence of silicofluoride
- With potassium salts white precipitate K<sub>2</sub>SiF<sub>6</sub> the presence of silicofluoride
- *Formation of orthosilicic acid gel-* necessarily in an iron crucible fluorides will not react, and silicofluorides will

#### Quantitative determination

The spectrophotometric method is based on the formation of the alizarin complex of cerium and fluorine

