

16. SKUPINA ns²np⁴

	O	S	Se	Te	Po
\underline{Ei} eV	13,6 O ₂ 12,1	10,4	9,8	9	8,4
$-\underline{Ea}$ eV	7,3	3,4	4,2		
X	3,5	2,5	2,4	2,1	
$\underline{E^o}$ V	1,23	0,14	-0,4	-0,7	
	$X + 2 H^+ + 2 e^- \leftrightarrow H_2X$				

O_2

$$|0\rangle = |0\rangle$$

O_3

$$|0\rangle = \overset{+}{O} |0\rangle$$

$\xrightarrow{127^\circ}$ $|0\rangle$

ELEMENTARNE TVARI

O_2

S_8 (romb.)
 $\uparrow\downarrow 96^\circ C$

Se_n (metal)

Te_n

O_3

S_8 (monokl.)

Se_8 (sivi)

PORAST TEMPERATURE



$S(l)$

S_λ

S_π

S_μ

S_2

$t_t = 119^\circ C$

S_8

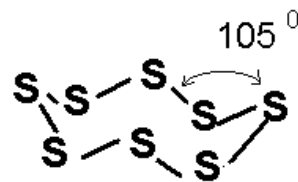
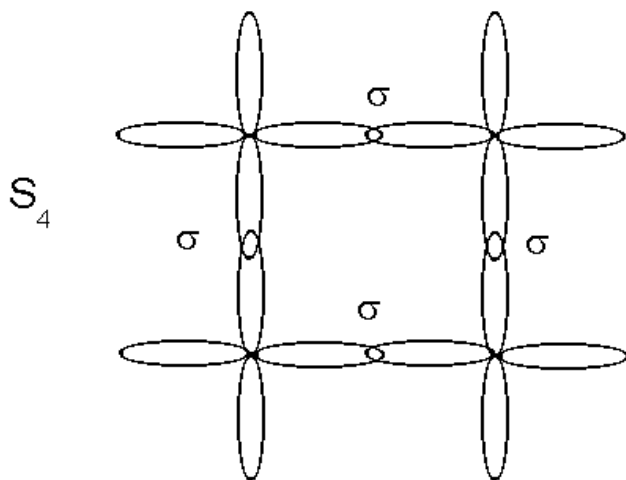
S_4

S_n

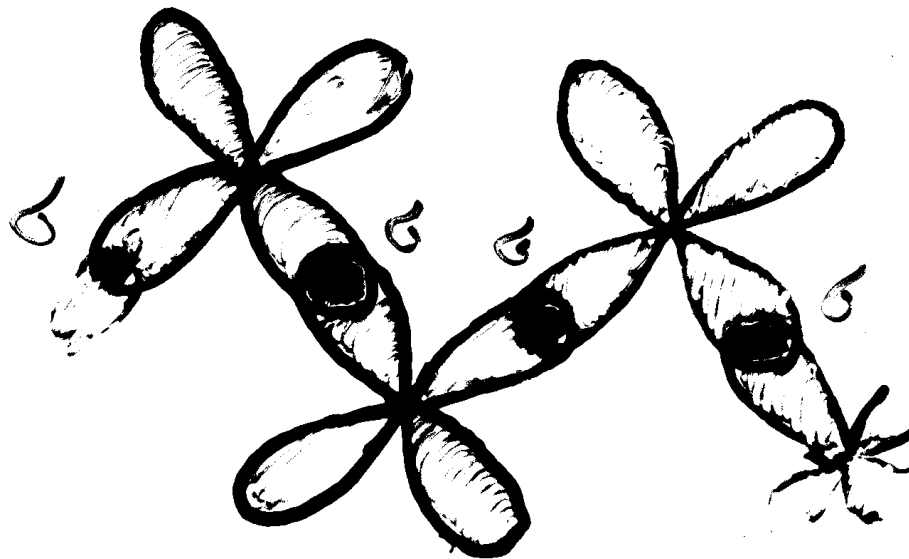
$t_v = 445^\circ C$

*viskozitet
opada*

*viskozitet
raste*



S_n
 Se_n
 Te_n



230 - 290 nm

20 - 40 km
8 ppm



$\lambda = 240 \text{ nm}$



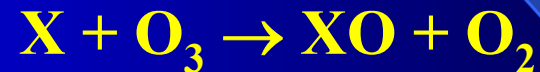
• ~1000 molekula



• 1 cm^3



• **STRATOSFERA:**



• $\text{X} \equiv \text{H, OH, Cl, NO}$

• $\underbrace{\hspace{10em}}_{\text{freoni}}$

• CH_4

• N_2O

• **GRADOVI:**

• H_2O

• $\text{NO} \rightarrow \text{NO}_2 \rightarrow \text{O}_3 \rightarrow \text{O} \rightarrow \text{OH}$

• radikal

Reaktivnost atomnog kisika

- $\text{O}_2 \leftrightarrow 2\text{O}$; $\Delta_r H = 494 \text{ kJ / mol}$
- $\text{O}_2 + \text{O} \rightarrow \text{O}_3$; $\Delta_r H = - 105 \text{ kJ / mol}$
- $3\text{O}_2 \leftrightarrow 2\text{O}_3$; $\Delta_r H = 284 \text{ kJ / mol}$
-
- $\text{O} + 2\text{H}^+ + 2\text{e}^- \leftrightarrow \text{H}_2\text{O}$; $E^\circ = 2,2 \text{ V}$

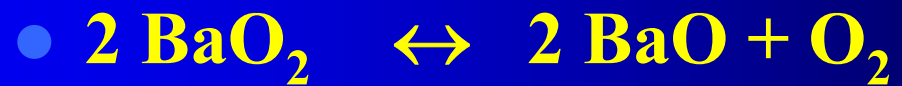
Reaktivnost ozona

- $\text{O}_3 + 2\text{H}^+ + 2\text{e}^- \leftrightarrow \text{H}_2\text{O} + \text{O}_2; \quad E^0 = 2,07 \text{ V}$
- $\text{O}_3 + \text{H}_2\text{O} + 2\text{e}^- \leftrightarrow \text{O}_2 + 2 \text{OH}^-; \quad E^0 = 1,23 \text{ V}$

DOBIVANJE:

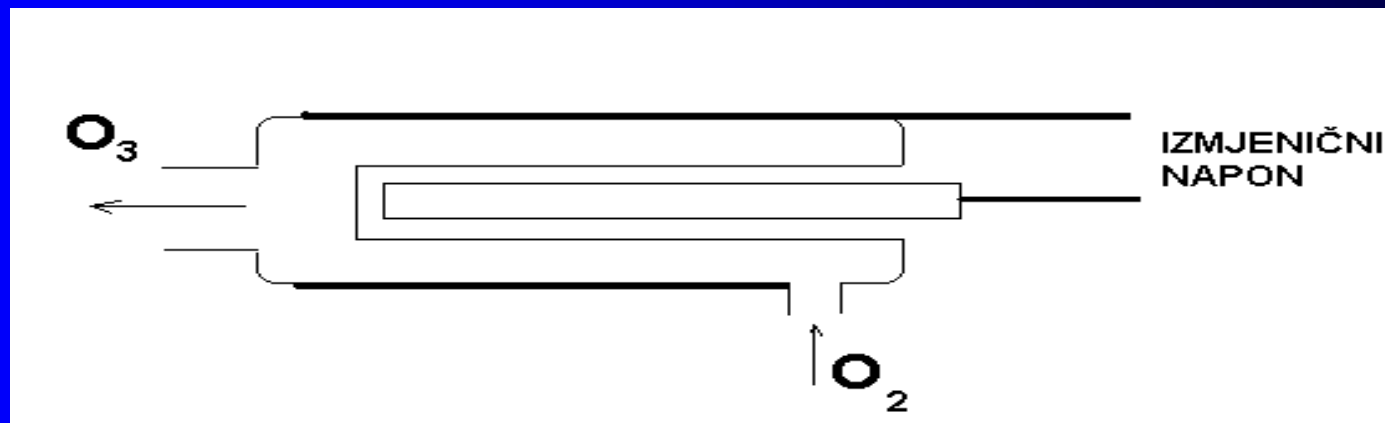
- **KISIK-iz zraka**

- 750°C



- 500°C

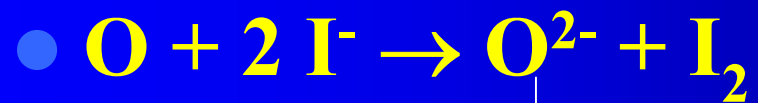
- **OZON**



- $\eta = 0.15$, O_2

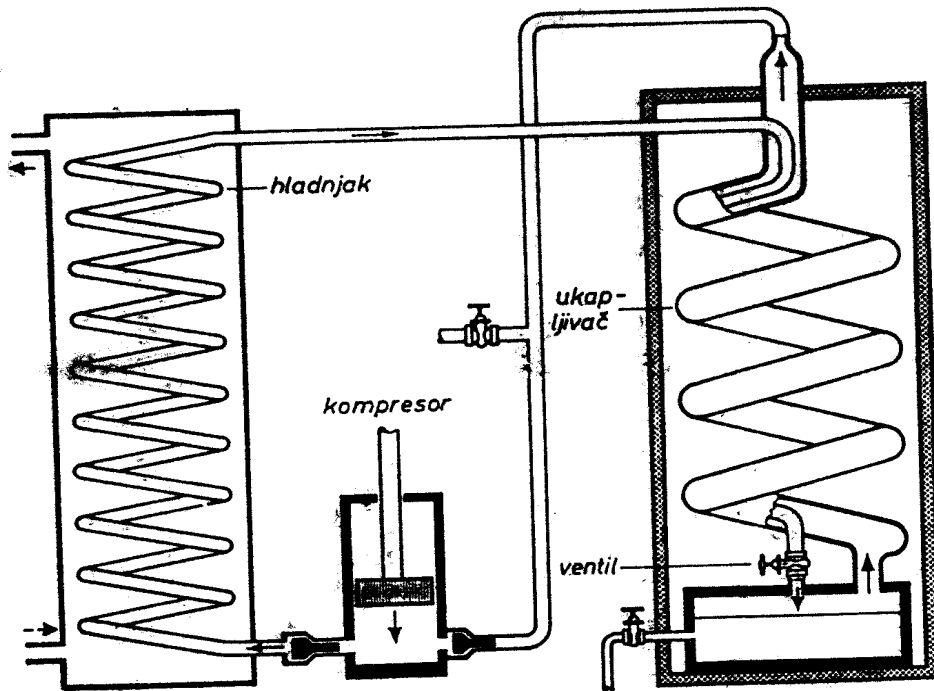
- $\eta = 0.05$, zrak

-

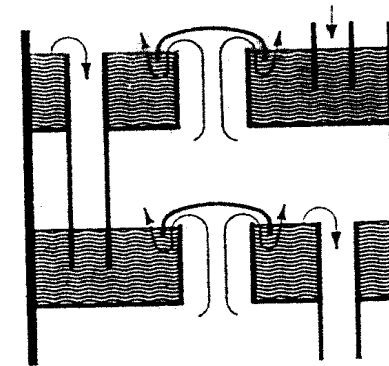


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Uklapljivanje i frakcijska destilacija zraka

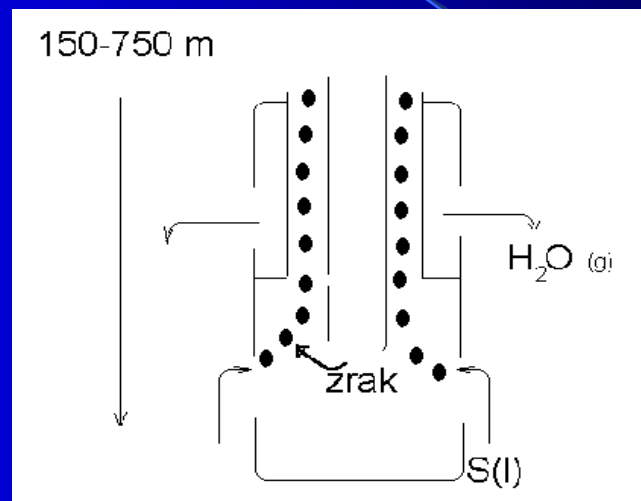


Sl. 17.4. Shema uređaja za ukapljivanje zraka po Lindeu

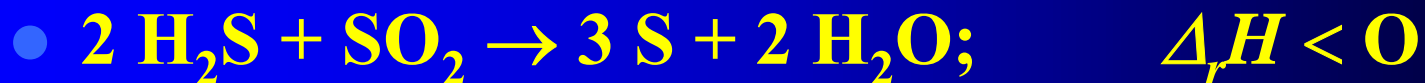


Sl. 17.5. Dio kolone za frakcionu destilaciju

SUMPOR- FRASCHOV POSTUPAK



- CLAUSOV POSTUPAK



SELEN:

- $\text{SeO}_2 + 2 \text{SO}_2 \rightarrow \text{Se} + 2 \text{SO}_3$
- $\text{Se} + 4 \text{HNO}_3 \rightarrow \text{H}_2\text{SeO}_3 + 4 \text{NO}_2 + \text{H}_2\text{O}$
- $\text{H}_2\text{SeO}_3 + 2 \text{H}_2\text{SO}_3 \rightarrow \text{Se} + 2 \text{HSO}_4^- + \text{H}_2\text{O}$
-
- TELUR: kao Se

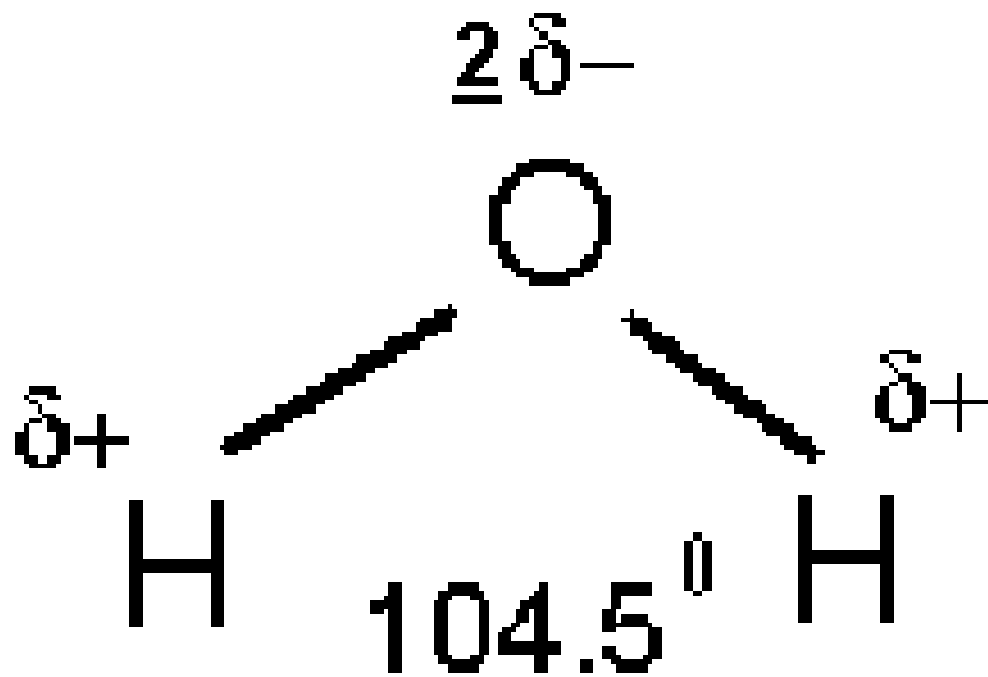
PREGLED REAKCIJA HALKOGENA

- $xX + yM \rightarrow M_yX_x$
- $zX + M_yX_y \rightarrow M_yX_{x+z}$
- $xX + X^{2-} \rightarrow X_{x+1}^{2-}$ S, Se
-
- $X + H_2 \rightarrow H_2X$
- $X + O_2 \rightarrow XO_2$
- $3X + 4HNO_3 \rightarrow 3XO_2 + 2H_2O + 4NO$
- $X + 3F_2 \rightarrow XF_6$ S; Se, Te
- $X + 2Cl_2 \rightarrow XCl_4$ S; Se, Te
-

SPOJEVI

	H_2O	H_2S	H_2Se	H_2Te
			←	
			RASTE STABILNOST	
t_f				
$^{\circ}\text{C}$	0	-85	-60	-51
\underline{K}_1				
mol L^{-1}	10^{-16}	10^{-7}	$2 \cdot 10^{-4}$	$2 \cdot 10^{-3}$
	$\text{H}_2\text{X} \leftrightarrow \text{H}^+ + \text{HX}^-$			
\underline{K}_2				
mol L^{-1}	10^{-36}	10^{-15}	10^{-10}	10^{-5}
	$\text{HX}^- \leftrightarrow \text{H}^+ + \text{X}^{2-}$			
	$\text{O}^{2-} + \text{H}_2\text{O} \leftrightarrow 2 \text{OH}^-$		$K_H > 10^{22} \text{ molL}^{-1}$	

VODA



VODA U PRIRODI

$1,385 \cdot 10^9 \text{ km}^3$

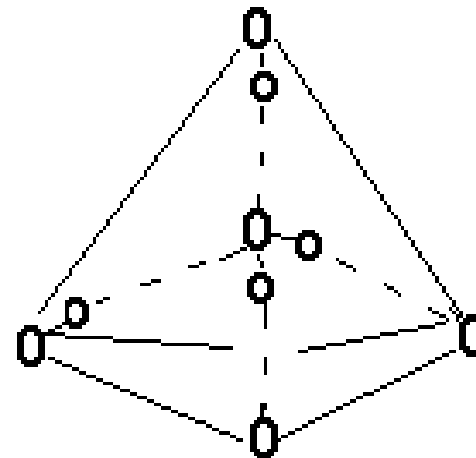
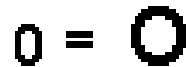
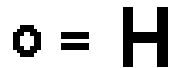
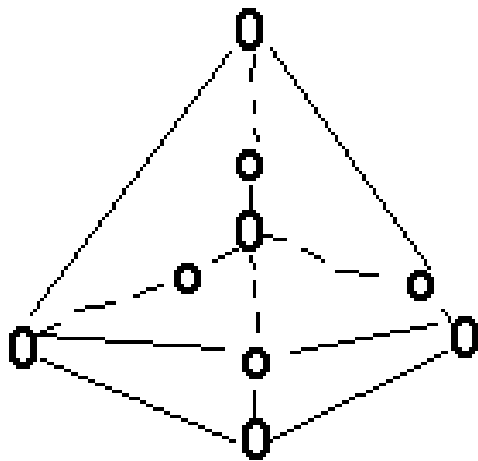
	%
● SLANA:	
● MORSKA VODA	97,33
● SLANA JEZERA	0,008
● SLATKA:	
● LEDENJACI I POLARNI LED	2,04
● VODA U ZEMLJI	0,615
● JEZERA	0,009
● VODENA PARA	0,001
● RIJEKE	0,0001

PITKA VODA

	Poželjno max.	Dopušteno max.
UKUPNO OTOPLJENIH	γ / mgl^{-1}	γ / mgl^{-1}
TVARI	500	1500
Mg	30	150
Ca	75	200
kloridi	20	60
sulfati	200	400

VODA ZA POTREBE INDUSTRIJE

- -VODA ZA VISOKOTLAČNE PARNE KOTLOVE:
- $w(\text{H}_2\text{O}) = 0,999999998$
- tj. sadržaj nečistoća $< 0,02$ ppm



TVRDOĆA VODE

- Ca^{2+} , Mg^{2+} , Fe^{2+}

-

-

- $\gamma (\text{CaO}) = 10 \text{ mgL}^{-1}$

- $\gamma (\text{CaCO}_3) = 10 \text{ mgL}^{-1}$

-

-

- $\text{CaCO}_3 (\text{s}) + \text{H}_2\text{O} + \text{CO}_2 \leftrightarrow \text{Ca}^{2+} + 2 \text{HCO}_3^-$

- $\text{Ca}^{2+} + 2 \text{HCO}_3^- + \underline{\text{Ca}^{2+}} + 2 \text{OH}^- \rightarrow 2 \text{CaCO}_3 + 2 \text{H}_2\text{O}$

-

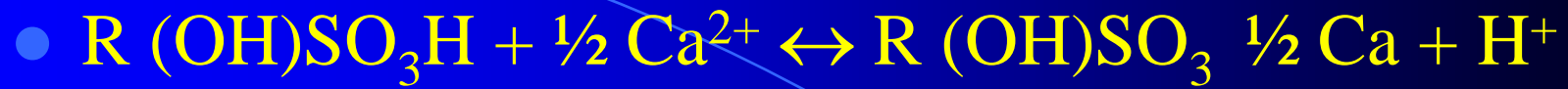
- Na_2CO_3

STUPANJ TVRDOĆE:

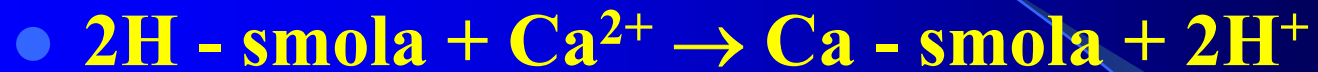
NJEMAČKI

FRANCUSKI

↑ *TROŠE* Fe^{2+} i Mg^{2+}

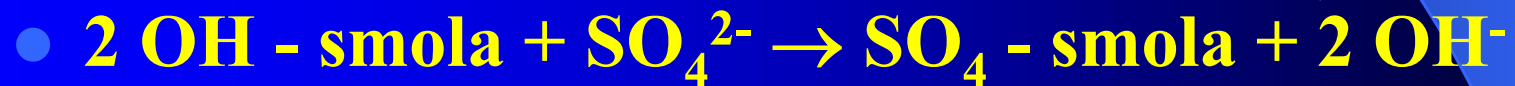


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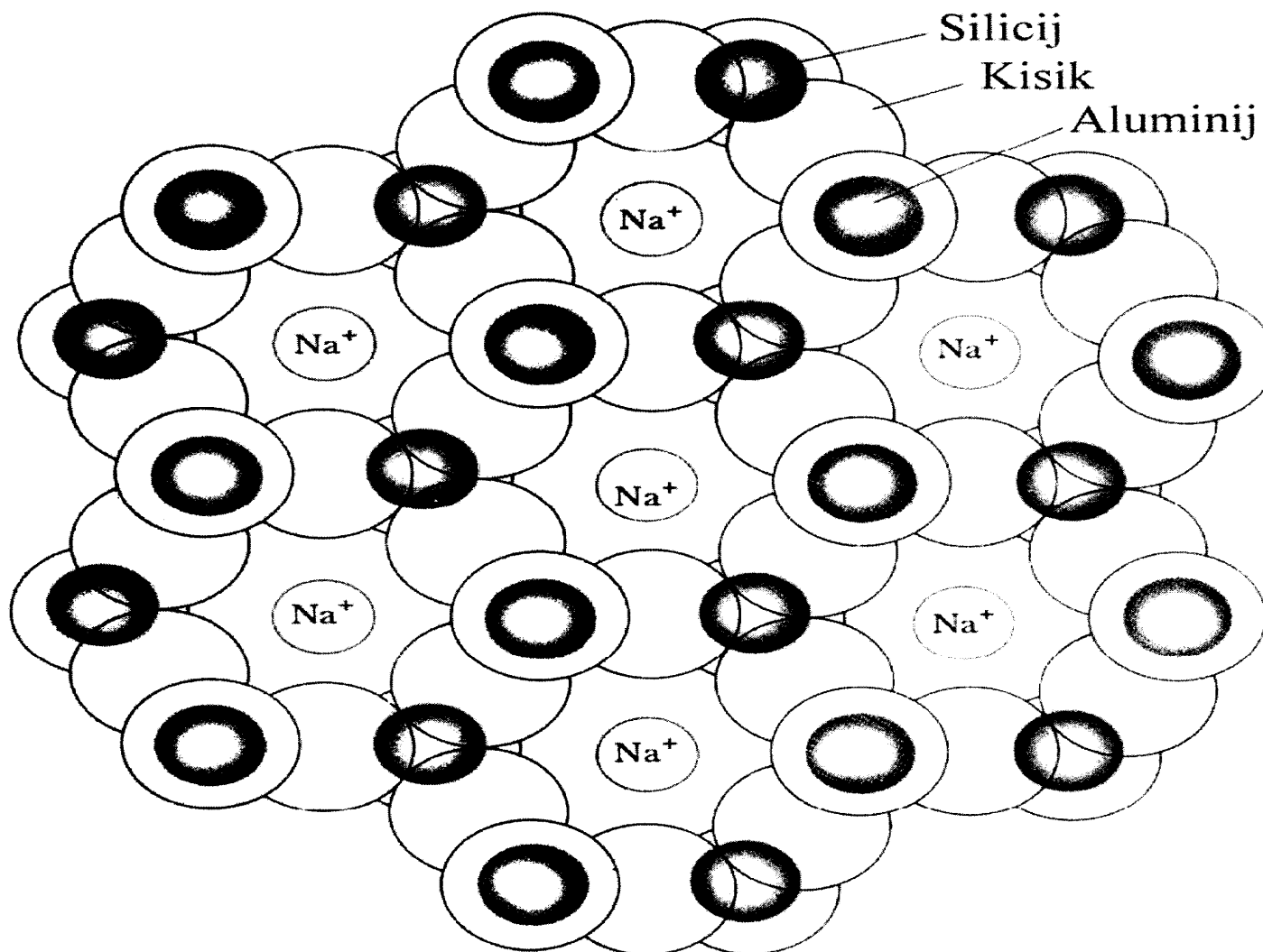
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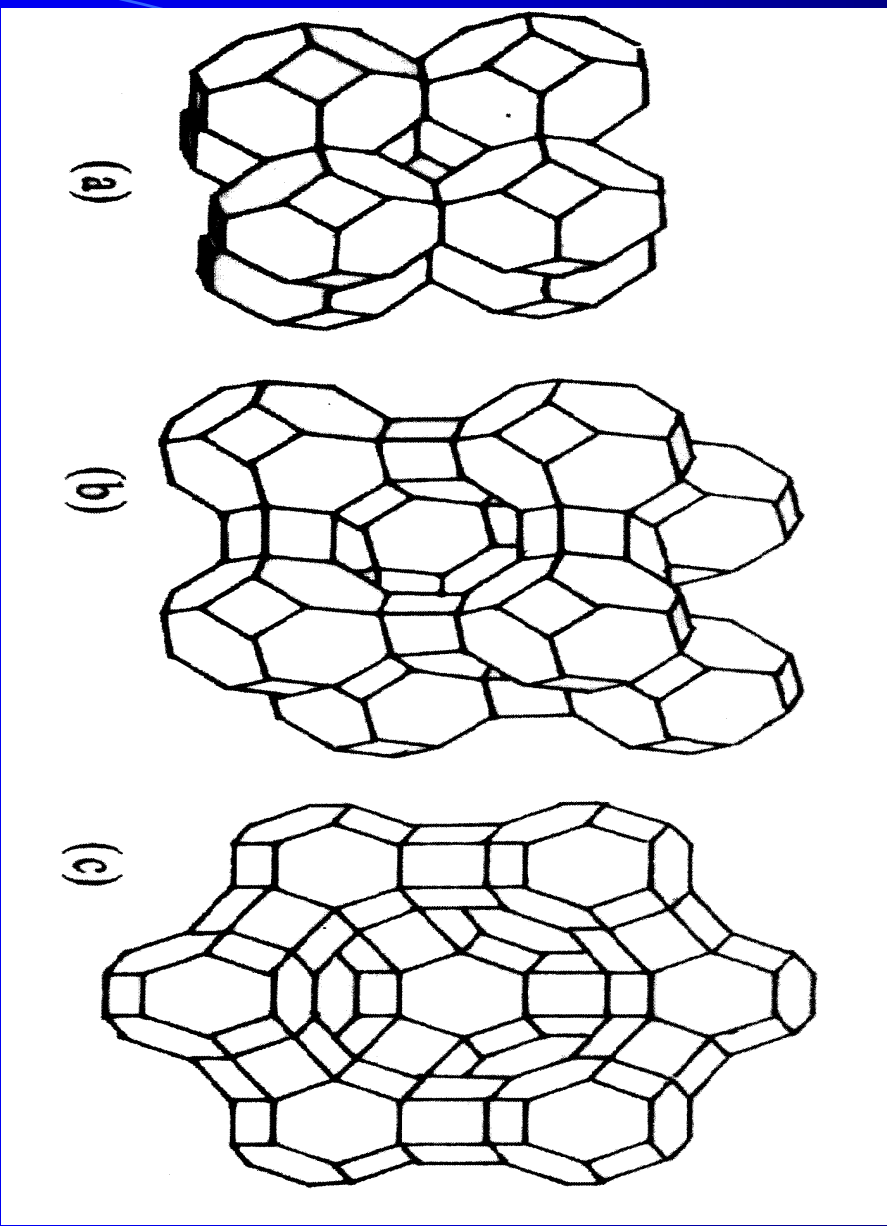
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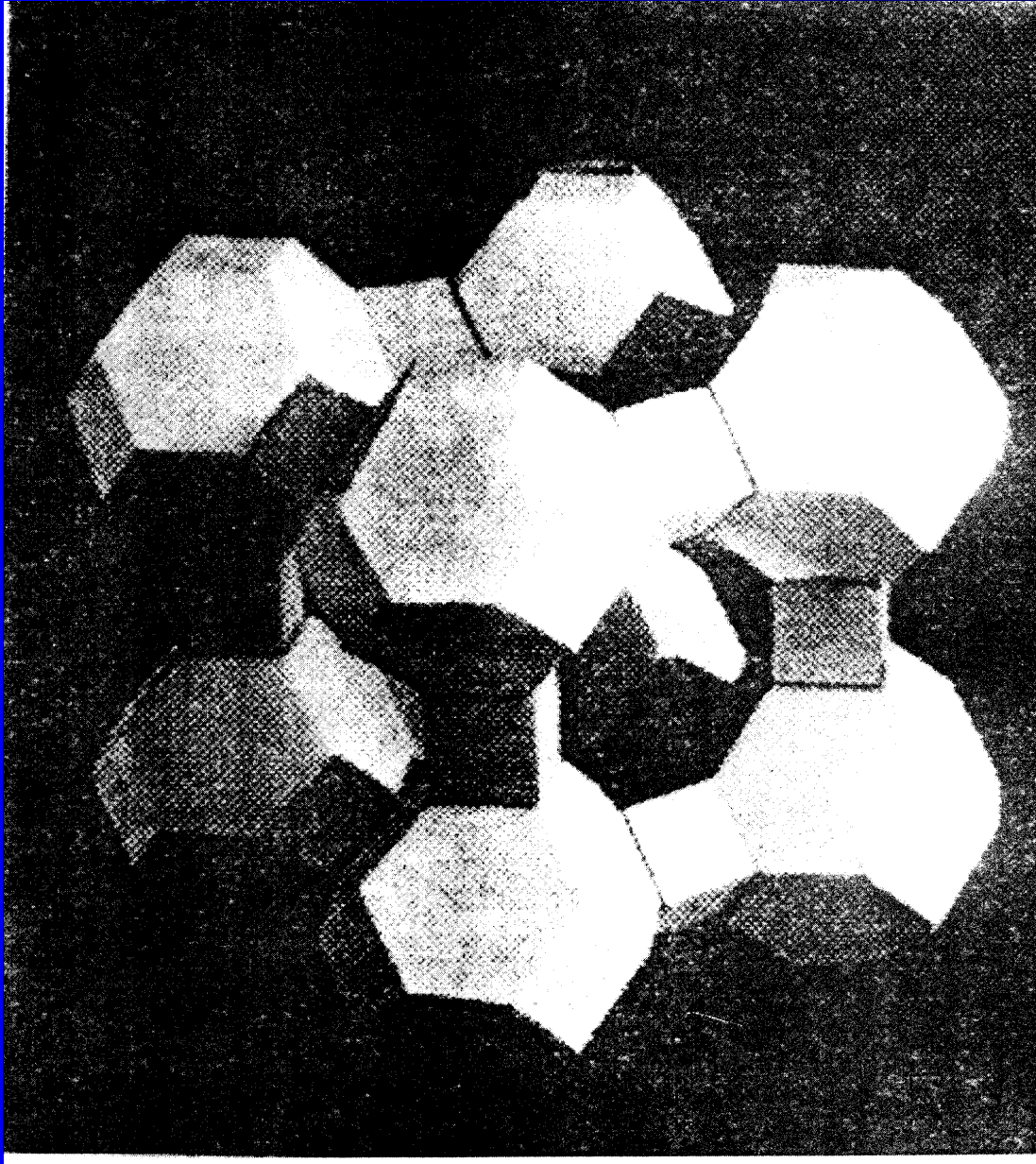


$2 H_2O$

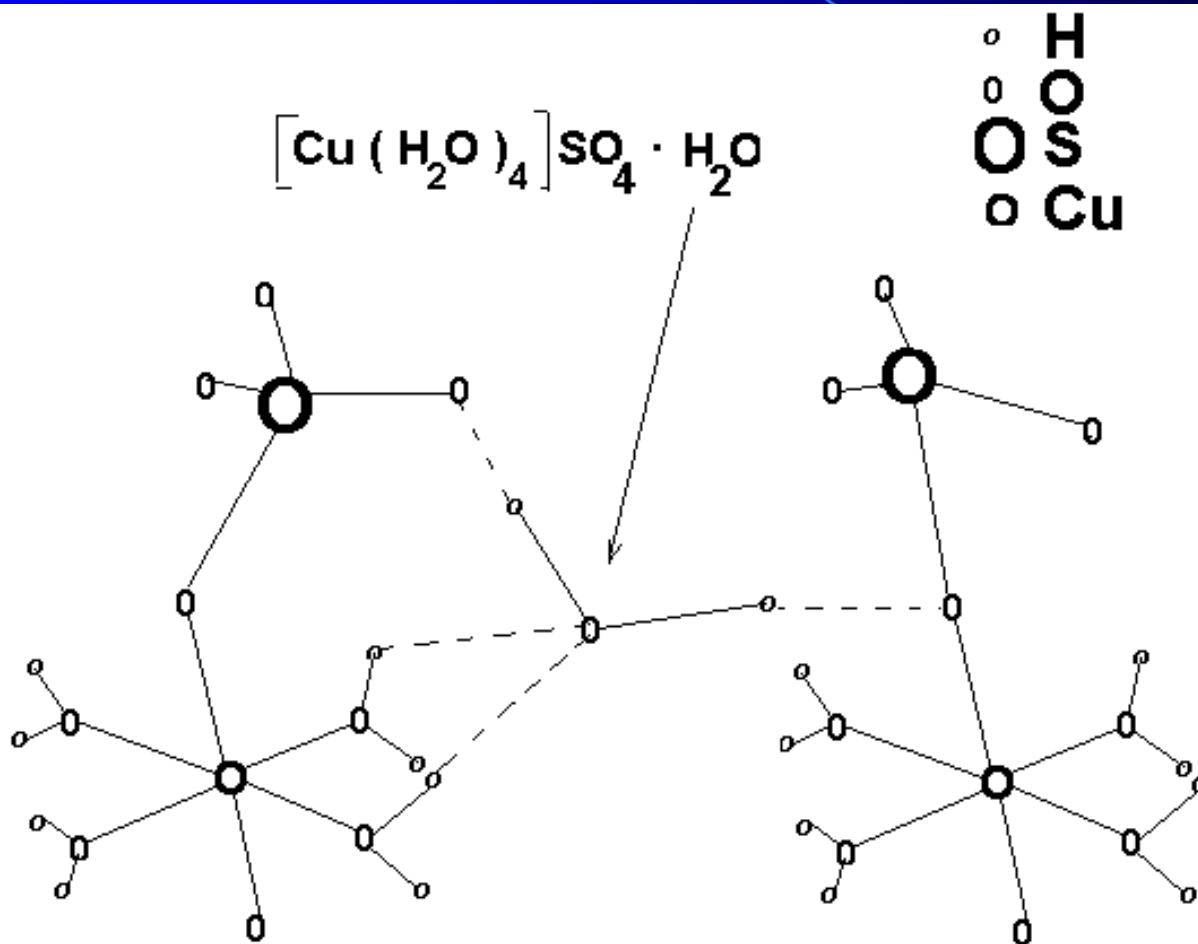
Ionski izmjenjivači







-ANION -VODIKOVA VEZA



KRISTALNA VODA

- $\text{NaCl} \cdot 2 \text{H}_2\text{O}$
- posebno kod velikih aniona
- $\text{H}_3[\text{PW}_{12}\text{O}_{40}] \cdot 29 \text{H}_2\text{O}$
- ZEOLITSKA VODA - u šupljinama (silikati)
- KLATRATI $\text{HPF}_6 \cdot 6 \text{H}_2\text{O}$

