

O‘zbekiston Respublikasi Sog‘liqni saqlash vazirligi
TOSHKENT FARMATSEVTIKA INSTITUTI
NOORGANIK, FIZIK VA KOLLOID KIMYO KAFEDRASI

5-MA’RUZA:

16-GURUH ELEMENTLARI. XALKOGENLAR

Ma’ruza mualliflari:

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TOSHKENT-2023

ASOSIY ADABIYOTLAR:

1. X.R.Tuxtayev, A.T.Sharipov, S.N.Aminov. Noorganik kimyo. Darslik. – Toshkent.: “Fan va texnologiya”,2018, 560 bet.
2. Shriver and Atkins, Inorganic Chemisrty, Fifth Edition, 2010/ P.W.Atkins, T.L.Owerton, J.P. Rourke, M.T. Weller and F.A. Armstrong, W.H. Freeman and Company, New York. 2010. P. 825.
3. Э.Т.Оганесян, В.А.Попков, Л.И.Щербакова, А. К. Брель; под ред. Э. Т. Оганесяна. — М. : Юрайт, 2019. — 447 с. — Серия: Специалист.
4. Общая и неорганическая химия для фармацевтов: учебник и и практикум для СПО/ под общ.ред. В.В.Негребецкого, И.Ю.Белавина, В.П.Сергеевой.- Издательство Юрайт, 2019.-357 с.-Серия: профессиональное образование.
5. Шрайвер Д., Эткинс П. Неорганическая химия. В 2-х т. Т 1/ Перевод с англ. М.Г.Розовой, С.Я. Истомина, М.Е.Тамм-Мир, 2004.-679 с.
6. Шрайвер Д., Эткинс П.. Неорганическая химия. В 2-х т. Т 2/ Перевод с англ. А.И.Жирова, Д.О.Чаркина, С.Я. Истомина, М.Е.Тамм-Мир, 2004.-486 с.
7. Thomas R. Gilbert - Chemistry_ The Science in Context-Norton (2017)

REJA:

Mavzuning ma'ruza davomida yoritiladigan qismlari:

1. Guruh elementlarining umumiy tavsifi;
2. Kislorod va uning birikmalari;
3. Oltingugurt va uning birikmalari;
4. Oltingugurtning kislorodli birikmalari.

Mavzuning talaba mustaqil o'zlashtirishi lozim bo'lgan qismlari:

1. 16-guruh elementlarining olinishi va xossalari;
2. Selen, tellur va poloniy birikmalari va xossalari;
3. 16-guruh elementlarining farmatsiyadagi ahamiyati.





Xalkogenlarning davriy jadvaldagi o'рни

IUPAC Periodic Table of the Elements

$s^2 p^4$

$-2; 0; +4; +6;$

$II; IV; VI;$

1 H hydrogen 1.008 (1.0078, 1.0082)																	2 He helium 4.0026
3 Li lithium 6.94 (6.938, 6.997)	4 Be beryllium 9.0122	Key: atomic number Symbol name conventional atomic weight standard atomic weight										5 B boron 10.81 (10.806, 10.821)	6 C carbon 12.011 (12.009, 12.012)	7 N nitrogen 14.007 (14.006, 14.009)	8 O oxygen 15.999 (15.999, 16.000)	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 (24.304, 24.307)											13 Al aluminium 26.982	14 Si silicon 28.085 (28.084, 28.086)	15 P phosphorus 30.974	16 S sulfur 32.06 (32.059, 32.076)	17 Cl chlorine 35.45 (35.446, 35.457)	18 Ar argon 39.95 (39.792, 39.963)
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 (79.901, 79.907)	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 (204.38, 204.39)	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganeson



57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

Picture taken from Dalton Trans., 2019, 48, 9408-9421;



Xalkogenlarning umumiy xossalari

	O	S	Se	Te	Po
$r_{\text{(covalent)}}$, nm	74	104	117	137	140
$r_{\text{(ion)}}$, nm	140	184	198	221	
I, kJ/mol	1310	1000	941	870	812
N.E.M.	3.4	2.6	2.6	2.1	2.0
T_s , °C	-218	113	217	450	254
T_q , °C	-183	445	685	990	960

Data source: Atkins, P. W. Shriver & Atkins' *Inorganic Chemistry*; Oxford University Press: Oxford; New York, 2010.



Kislород

Dastlab Scheele olgan. J.Pristli 1774-yilda HgO dan olgan.

A.Lavuaze havoda tarkibida topgan.



Laboratoriyada olinishi: $4\text{MnO}_2 = 2\text{Mn}_2\text{O}_3 + \text{O}_2$



Xossalari:

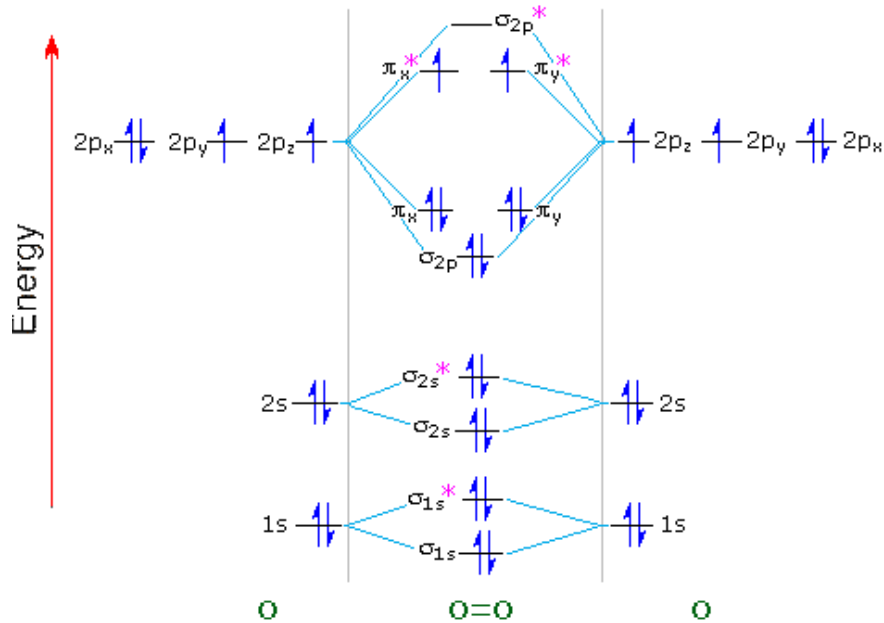


O-O bog' oralig'i 0,1207 nm.

Dissotsatsiyalanish energiyasi 494 kJ/mol.



Dikislorod



Paramagnit!

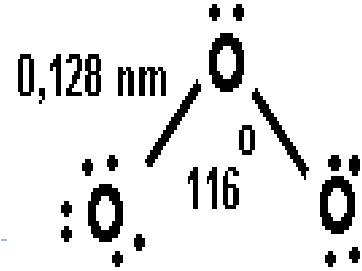


Oksidlar – kislorodning binar birikmalari.

Faol metallmas, deyarli barcha oddiy moddalarni oksidlaydi.

Pictures taken from <https://socratic.org/questions/how-do-i-fill-bonding-and-antibonding-orbitals>; <https://chem.umn.edu/magnetic-properties-liquid-oxygen>; last accessed: 22.04.2020

Kislород



-2 o.d. H_2O , oksidlar. -1 o.d. H_2O_2 , Na_2O_2 O^{-1} o.d. KO_2 (K, Na, Cs); o.d. +2 OF_2 .

OF_2 kuchli oksidlovchi, och-sariq rangli gaz.



O_2F_2 – ftorid dioksidi. Oson uchuvchan. Qizil suyuqlik.

O_2F_2 – xossalari H_2O_2 ga o'xshash. +4 -2

+4 o.d. ozon. OO_2 .

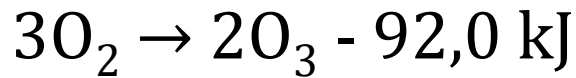
O_3 – ilk bor 1785-yil Van-Marum o'rgangan. 1922-yil toza O_3 – Razenfold va Jvab olganlar. O_3 – ko'k, o'tkir hidli gaz, qaynash.h. - $251,5^\circ\text{C}$.



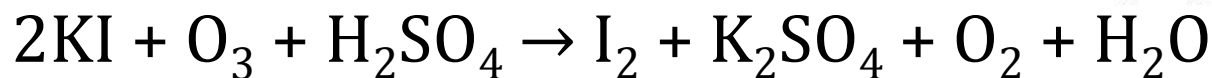
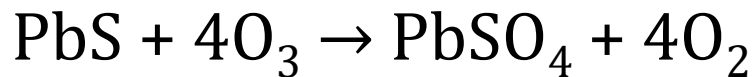
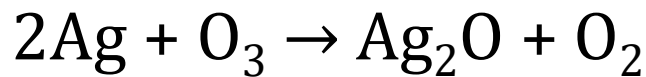
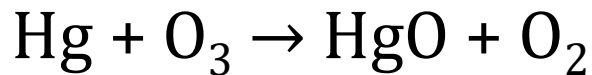


Trikislorod - ozon

Ozon tabiatda va laboratoriyada kisloroddan sintez qilinadi:



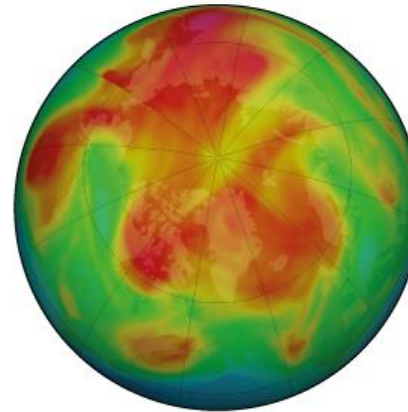
Metallarni oksidlaydi (Hg, Ag):



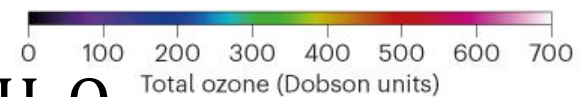
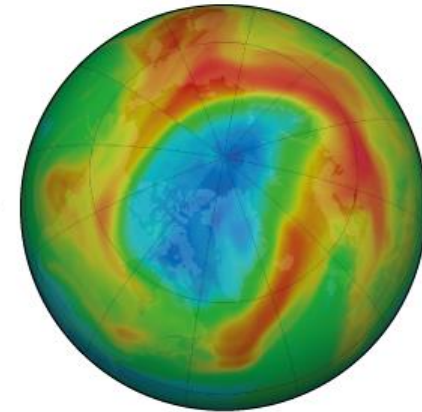
ARCTIC OPENING

A rare and record ozone hole has formed over the Arctic. An opening in the ozone layer appears each spring over the Antarctic, but the last time this phenomenon was seen in the north was in 2011.

23 March 2019



23 March 2020



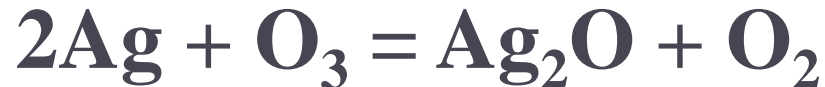
©nature

Picture taken from Nature **2020**, 580, 18-19;
<https://ozonewatch.gsfc.nasa.gov/monthly/NH.html>

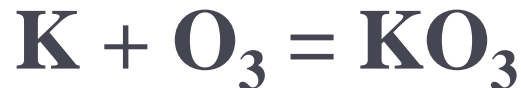
Ozon



Metallarni oksidlaydi (Hg, Ag):



Kaliy ozonid qizil rangda:



10^{-4} mg/l konsentratsiyada organizmga yomon ta'sir qiladi. Suvni sterillash maqsadida ishlatiladi.





Oltingugurt tabiatda



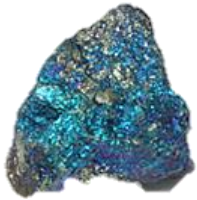
Pirit – FeS_2



Kristal S



Stibnit – Sb_2S_3



Xalkopirit – CuFeS_2



Sfalerit – $\beta\text{-ZnS}$



Kinovar – HgS

Pictures taken from <https://geology.com/minerals/chalcopyrite.shtml>; <https://www.svetmineralu.cz/magazin/sfalerit-kamen-uzemneni/>;
<https://www.pinterest.com/pin/845410161278146362/>; <https://geology.com/minerals/sulfur.shtml>; <https://en.wikipedia.org/wiki/Pyrite>;
https://en.wikipedia.org/wiki/Sulfide_mineral; last accessed: 22.04.2020

Oltingugurt

FeS – temir kolchedani; ZnS – rux aldamasi; PbS – qo'rg'oshin yaltirog'i; Bi₂S₃ – vismut yaltirog'i; CaSO₄ • 2H₂O – gips; BaSO₄; MgSO₄ • 7H₂O; Na₂SO₄ • 10H₂O – glauber tuzi.

S sariq kristall. qay.h. 112,8°C. Suvda erimaydi; CS₂, C₆H₆ da eriydi.

Rombik – S. 95,6°C dan past haroratda barqaror.

Monoklinik. yoki prizma. 96,6°C dan yuqori

Monoklinik yoki prizma.

95,6°C da uzun ignasimon kristallar hosil qiladi.

119°C da suyuqlanadi, 160 °C da qo'ng'ir, 250°C yopishqoqligi pasayadi. 400°C da oqadigan suyuqlik va 446,6°C qaynaydi.

Past haroratlarda. S₈. Bug' tarkibida S₈, S₆, (500°C), 1000°C S₂ va 2000°C – S.

S₈ – molekulasi tojsimon shaklga ega.

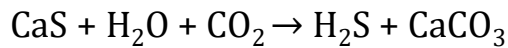
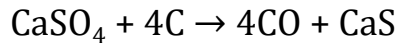




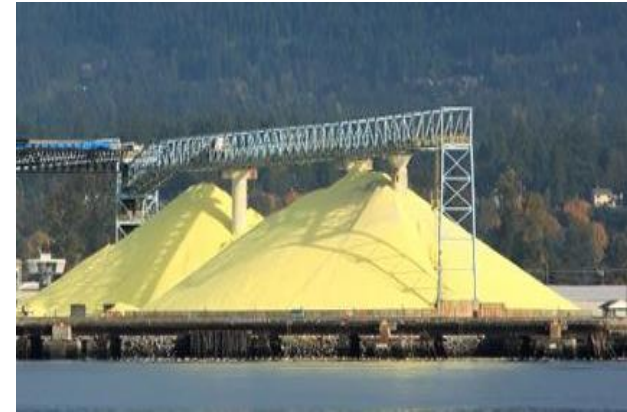
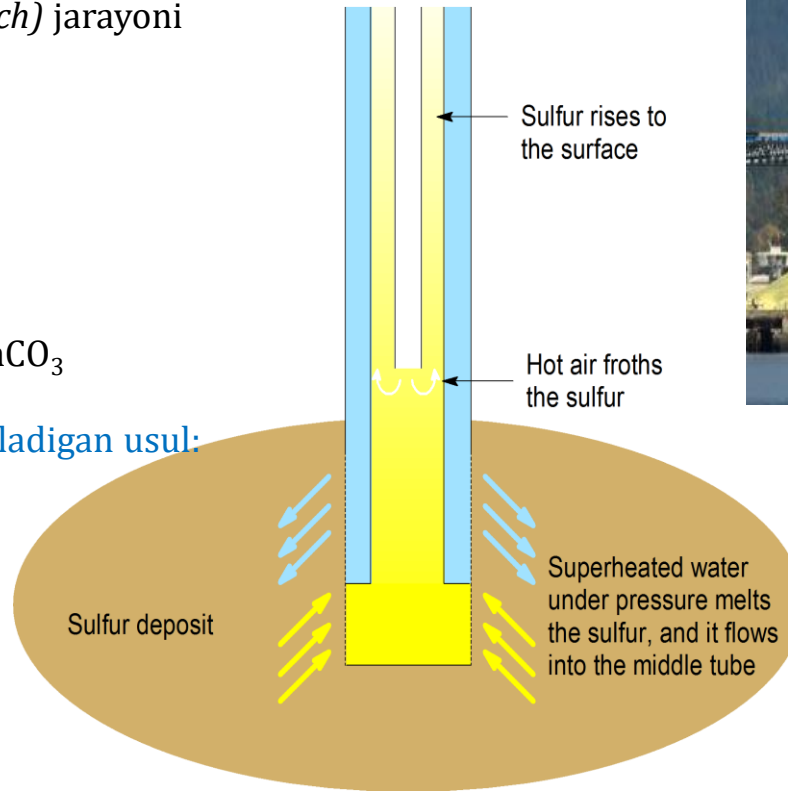
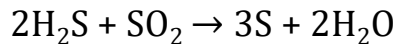
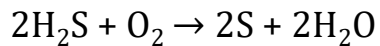
Oltingugurtning olinishi

Frash (*Frasch*) jarayoni

Boshqa usullar:



O'zbekistonda ham qo'llaniladigan usul:

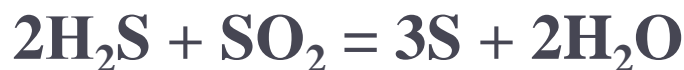


Oltingugurt tog'i

Pictures taken from from <https://geology.com/minerals/chalcopyrite.shtml>; https://en.wikipedia.org/wiki/Frasch_process;
last accessed: 22.04.2020

Oltugurt

Olinishi: Dastlab Amerikada Frash usulida olingan. 170°C da suv bug'ini quvur orqali o'tkazish. S ga tegsa, eriydi va siqilgan gaz orqali yer yuzasiga chiqariladi:



Tibbiyotda S:



CS₂, qora porox, gugurt, S li bo'yoqlar, sulfit kislota va h.k.





Oltingugurt allotropiyasi



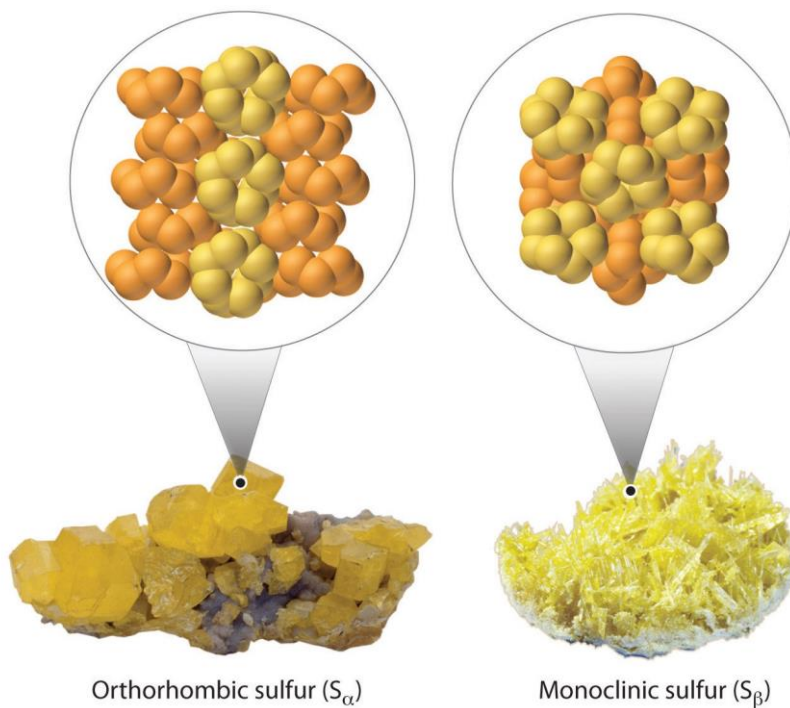
Allotropik shakllar – bir elementning turli tuzilishli shakllari.

Polimorfik o'zgarish – kimyoviy tarkibni o'zgartirmagan holda moddaning bir kristall fazadan boshqasiga o'tishi. Bunda kristall tuzilishi o'zgaradi.

Allotrope	Melting point*/°C	Appearance
S ₃	Gas	Cherry red
S ₆	50d	Orange red
S ₇	39d	Yellow
α-S ₈	113	Yellow
β-S ₈	119	Yellow
γ-S ₈	107	Pale yellow
S ₁₀	0d	Yellow green
S ₁₂	148	Pale yellow
S ₁₈	128	Lemon yellow
S ₂₀	124	Pale yellow
S _∞	104	Yellow

* d, decomposes.

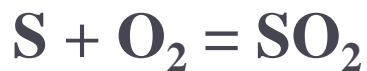
Pictures taken from <https://www.dailymail.co.uk/femail/article-6094051/Reddit-users-praise-sulfur-ointment-treat-cystic-acne.html>; IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). <https://doi.org/10.1351/goldbook>. last accessed: 22.04.2020



Oltinugurtning rombik va monoklinik allotropiyalaridagi molekular joylashuvi



Kimyoviy xossalari:



Qaytaruvchilar bilan:



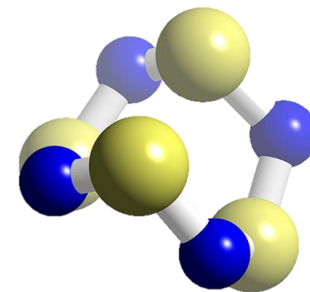
S azot bilan: S_4N_4 , S_{15}N_2 , S_{16}N_2 .

S tertanitrid sariq kristall modda, suyuql.h.=178°C. S_4N_4

Mexanik ta'sirda portlaydi:



S tetranitridni olish uchun S va NH_3 o'zaro ta'sirlashadi:



Sulfidlar va persulfidlar

H_2S va H_2S_2 beqaror, tuzlari MeS va MeS_2 .

H_2S -rangsiz. Zaharli gaz $\text{H}_2\text{S} = \text{H}_2 + \text{S}$

3 litr suvda 1 litr H_2S eriydi.

$(K_1=6 \cdot 10^{-8}; K_2=10^{-14})$. $\text{H}_2\text{S} \leftrightarrow \text{H}^+ + \text{HS}^-$; $\text{HS}^- \leftrightarrow \text{H}^+ + \text{S}^{2-}$

Na^+ , K^+ , NH_4^+ - sulfidlari eruvchan.

FeS , CoS , NiS , Ag_2S , PbS , Bi_2S_3 – qora cho'kma,

ZnS va CaS oq, CdS , SnS , As_2S_3 sariq, MnS malla rang,

Sb_2S_3 qo'ng'ir rangli.

CuS (qora) suvda va suyul.kislotalarda erimaydi.

FeS (qora) suvda erimaydi, kislotalarda eriydi.

HgS (qora) – hatto kons. HNO_3 da ham erimaydi.

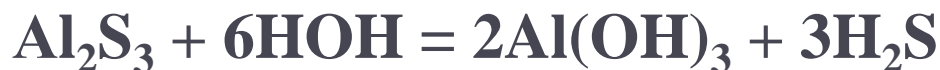
PbS , ZnS , CuS – HNO_3 da eriydi. HgS – faqatgina zar suvida eriydi. Sulfidlar $\text{FeS}_{1,01}$ dan $\text{FeS}_{1,14}$ gacha.

Na_2S , CaS va BaS terini tuklardan tozalash uchun.

ZnS – Lyuminafor bo'yoq sifatida

Sulfidlar va persulfidlar

Sulfidlar gidrolizi:



Persulfidlar. Tuzlari H_2S_2 , $(\text{H}_2\text{S})_n$,

$n=2,3,4,\dots,9$. Me₂Sn. $n=2$ dan 23 gacha.

Persulfidlar ham oksidlovchi, ham qaytaruvchi moddalardir.

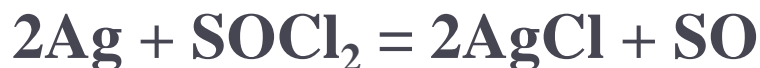


Disproporsiyalanish reaksiyasi: $\text{FeS}_2 = \text{FeS} + \text{S}$



Olinishi: $\text{Na}_2\text{S} + \text{S} = \text{Na}_2\text{S}_2$; $(\text{NH}_4)_2\text{S} + n\text{S} = (\text{NH}_4)_2\text{S}_n$

S^{2+} -. 1928-yil Gall SO ni 80% unum bilan sintez qilgan:



Oltingugurt birikmalari

SO – rangiz gaz $\text{SO} + 2\text{KOH} = \text{K}_2\text{SO}_2 + \text{H}_2\text{O}$

Sulfanil kislota **H-O-S-O-H**

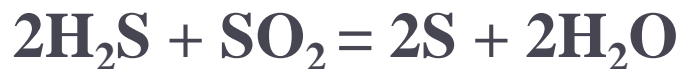
Galogenli birikmalari $2\text{SCl}_2 = \text{S}_2\text{Cl}_2 + \text{Cl}_2$

S₂Cl₂ – qizil rangli suyuqlik.

S⁺⁴ birikmalari SO₂ – o'tkir hidli, rangsiz gaz.



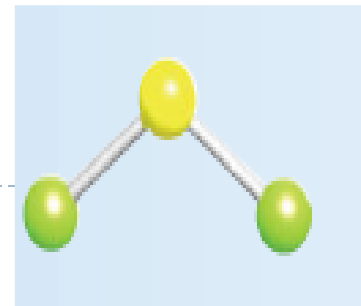
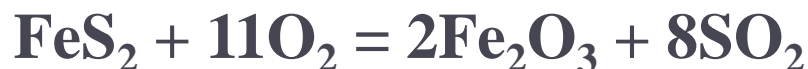
SO₂ – ham oksidlovchi, ham qaytaruvchi:



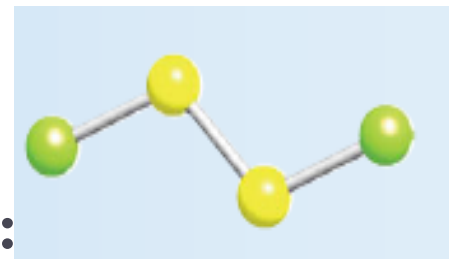
Olinishi: $\text{S} + \text{O}_2 = \text{SO}_2$



Texnikada: FeS₂, ZnS, PbS, Cu₂S larni yondirib:



S₂Cl₂



Oltugugurt birikmalari

H_2SO_3 – suyultirilgan eritmalarda uchraydi.



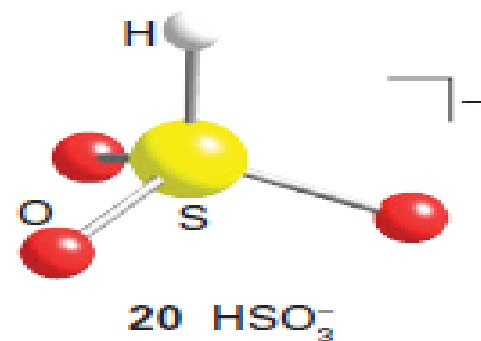
2 xil tautamer shakli mavjud:



H_2SO_3 va uning tuzlari ham oksidlovchi, ham qaytaruvchi:



Sulfitlar gidrolizi:



Oltingugurt birikmalari

Komplekslari: $\text{Na}_6[\text{Me}(\text{SO}_3)_4]$; $\text{Na}_3[\text{Me}(\text{SO}_3)_4]$; $\text{Na}_3[\text{Me}(\text{SO}_3)_2]$; $\text{Na}_5[\text{Me}(\text{SO}_3)_4]$.



Pirosulfat kislota.



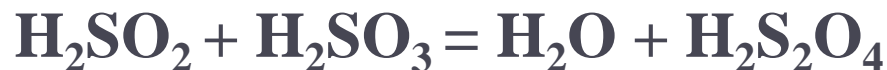
$\text{H}_2\text{S}_2\text{O}_5$ – erkin holda ushramaydi.

Pirosulfitlar - $\text{K}_2\text{S}_2\text{O}_5$

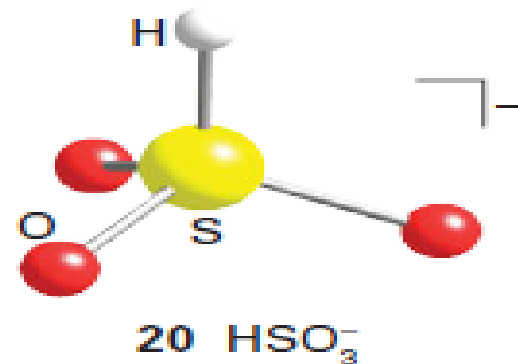


Tion kislota - $\text{H}_2\text{S}_2\text{O}_4$.

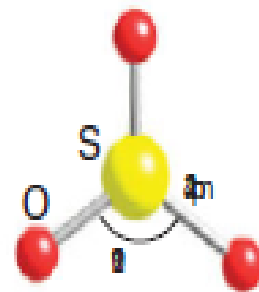
Sulfon kislota va sulfit kislota ta'sirida:



Tion kislota ($\text{H}_2\text{S}_2\text{O}_4$) va uning tuzi $\text{Na}_2\text{S}_2\text{O}_4$ – natriy ditionat.



Oltingugurt birikmalari

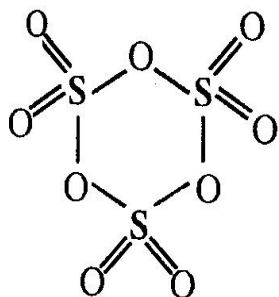
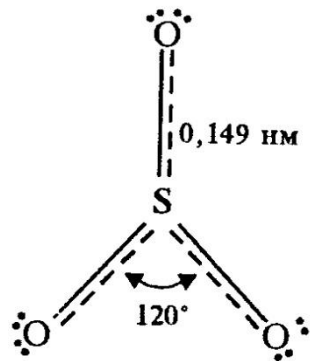
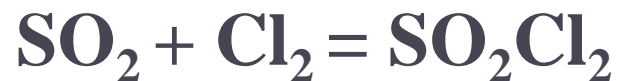


S^{+6} birikmalari. SO_3 , SF_6 , SO_2Cl_2 .

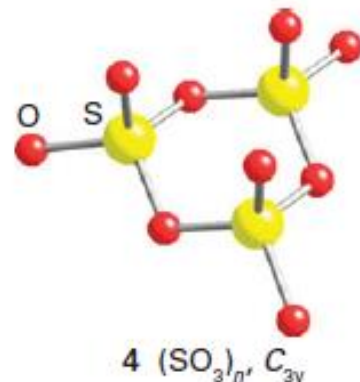
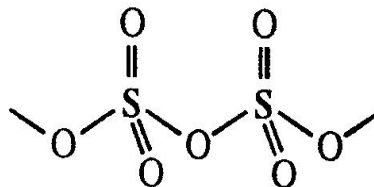
SO_3 – oson uchuvchan suyuqlik. (qaynash.h. $44,8^\circ C$).

Trimer holatda - $(SO_3)_3$.

$16,8^\circ C$ da qattiqlashadi.



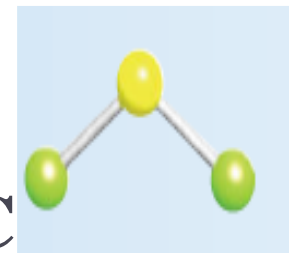
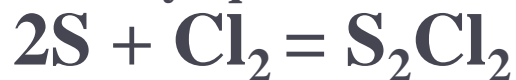
ёки



Oltingugurt galogenidlari

Oltingugurt dixlorid - S_2Cl_2 .

Qizil suyuqlik ($T_{suyuql} - 80^\circ C$). Badbo'y hidli.



Oltingugurt tetraclorod (S_2Cl_4). Suyuqlik, $-30^\circ C$

S_2F_2 – rangsiz gaz. $-35^\circ C$ da suyuqlik.

S_2Cl_2

Oltingugurt tetraftorid - SF_4 . Rangsiz gaz, $-40,4^\circ C$ da suyuqlik.

S_2Cl_2 hamda natriy ftorid reaksiyasida:



Oltingugurt monobromid (S_2Br_2).

S_2Br_2 - qora-qo'ng'ir suyuqlik. $-46^\circ C$ da muzlaydi.



Sulfat kislota

Xossalari. Suvsiz H_2SO_4 – rangsiz, yog'simon suyuqlik, $10,3^\circ\text{C}$ da kristallar hosil qiladi. Kons. H_2SO_4 - 98 %.

Gigroskopik, qurituvchi modda.

Xom ashyosi (FeS_2), metal sulfidlari, S.



SO_3 oleum hosil qiladi ($\text{H}_2\text{SO}_4 \cdot \text{SO}_3$), so'ngra H_2SO_4 .

Azotli usul. 80 % H_2SO_4 shu usulda olinadi va mineral o'g'itlar ishlab chiqishda foydalaniladi.

Kontakt usuli. V_2O_5 yoki Pt katalizator sifatida.

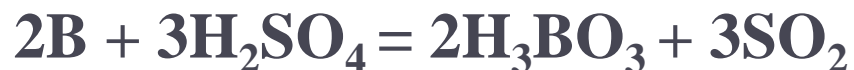
Kislorod miqdorini oshirish uchun P, As birikmalardan tozalash kerak, 450°S da unum 95-97% ni tashkil qiladi.

SO_3 ni o'ziga yutadi.



Sulfat kislota xossalari

Metallmaslar bilan:



Kons. H_2SO_4 – faol metallar (Mg, Zn, Ca) bilan SO_2 , S va H_2S gacha qaytariladi:



Kons. H_2SO_4 - (98%) Fe, Cr, Al, Au va Pt - ta'sirlashmaydi.

Zn, Mg, Fe, Al suyult. H_2SO_4 bilan: $\text{Zn} + \text{H}_2\text{SO}_4 = \text{ZnSO}_4 + \text{H}_2$

Cu, Hg, Ag, Au, Pt suyult. H_2SO_4 bilan ta'sirlashmaydi.

O'rta va nordon tuzlari mavjud ($K_1=1 \cdot 10^3$; $K_2=1,2 \cdot 10^{-2}$).

▶ **BaSO_4 , PbSO_4 , SrSO_4 , CaSO_4 – erimaydigan tuzlaridir.**

Sulfat kislota xossalari

H_2SO_4 – HNO_3 , H_3PO_4 , CH_3COOH tuzlarini, minerallar va bo'yoqlar olishda qo'llaniladi.

Tuzlari - Na_2SO_4 . $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. Glauber tuzi, soda.

Glauber tuzi – ichni yumshatuvchi vosita.

Magniy sulfat – MgSO_4 qon bosimini tushurishda qo'llaniladi.

Kalsiy sulfat – CaSO_4 . $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ – gips. $150-170^\circ\text{C}$ da qizdirilganda – alebastr. - $\text{CaSO}_4 \cdot 0,5\text{H}_2\text{O}$.

$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ga suv qo'shilganda polimerlanadi.

Xirurgiyada.

Mis kuporosi – $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

BaSO_4 – rentgenkontrast modda.

Achchiqtoshlar. Kaliy-alyuminiyli achchiqtoshlar

$\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$

$\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$. Qon to'xtatuvchi vositalardir.



Oltingugurtning murakkab kislotalari

Tiosulfat kislota. $\text{H}_2\text{S}_2\text{O}_3$. erkin holda uchramaydi

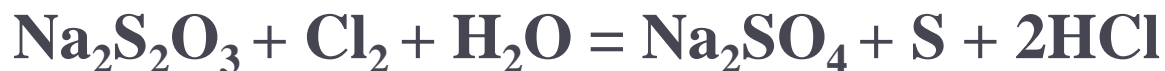


Natriy tiosulfat - $\text{Na}_2\text{S}_2\text{O}_3$.

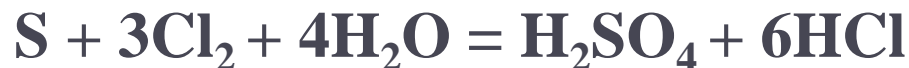


$\text{S}_2\text{O}_3^{2-}$ oltingugurt atomlarining biri -2 o.d. ega.

Xlor bilan:



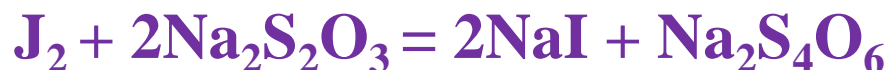
Bunda oltingugurt oksidlanadi:



Bromli suv bilan:



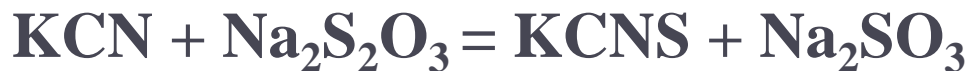
Yod bilan:



Oltugugurtning murakkab kislotalari

Analitik kimyoda $\text{Na}_2\text{S}_2\text{O}_3$ – galogenlar, sianidlar bilan zaharlanganda, shu bilan birga As, Pb, Hg ni yo'qotish maqsadida ishlatiladi. $\text{Na}_2\text{S}_2\text{O}_3$ – allergik kasalliklar va nevrozda qo'llaniladi.

SIANIDLAR TA'RISINI YO'QOTISH UCHUN:



Fotografiyada: $\text{AgCl} \downarrow + \text{Na}_2\text{S}_2\text{O}_3 = \text{Na}[\text{AgS}_2\text{O}_3] + \text{NaCl}$

Tion kislotalar. $\text{H}_2\text{S}_n\text{O}_6$ – polition kislotalari (n=3, ...dan 20 gacha)

$\text{H}_2\text{S}_2\text{O}_6$ - dition, $\text{H}_2\text{S}_4\text{O}_6$ - tetracion, $\text{H}_2\text{S}_5\text{O}_6$ - pentacion.

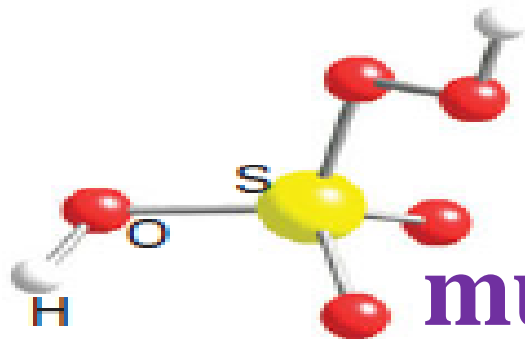
Sulfanil va sulfit kislotalarining ta'siridan dition kislotasi hosil bo'ladi: $\text{H}_2\text{SO}_2 + \text{H}_2\text{SO}_3 \rightarrow \text{H}_2\text{O} + \text{H}_2\text{S}_2\text{O}_4$; kislota erkin holda mavjudmas. Tuzlari esa bor.

$\text{HSO}_3\text{-Cl}$ – xlorosulfon kislota $\text{SO}_3 + \text{HCl} = \text{HSO}_3\text{Cl}$

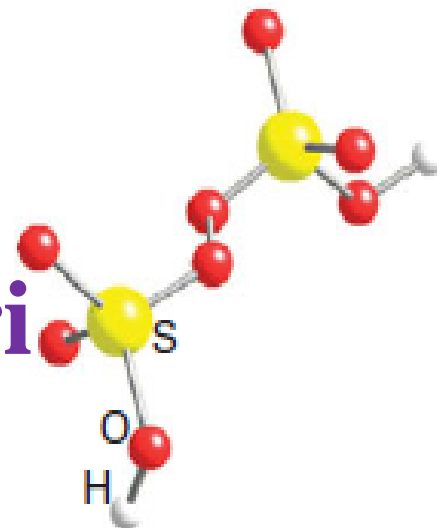
Gidroliz: $\text{HSO}_3\text{Cl} + \text{H}_2\text{O} = \text{H}_2\text{SO}_4 + \text{HCl}$

Pirosulfat kislota – $\text{H}_2\text{S}_2\text{O}_7$: $2\text{H}_2\text{SO}_4 = \text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O}$





Oltingugurtning murakkab kislotalari



$\text{HOOSO}_3\text{H} - \text{H}_2\text{SO}_5$ Monoperoksisulfat kislota

$\text{H}_2\text{O}_2 + \text{SO}_3 = \text{H}_2\text{SO}_5$ H_2SO_5 kristall ($T_s = 45^\circ\text{C}$).

Kuchli oksidlovchi: $2\text{KI} + \text{H}_2\text{SO}_5 = \text{K}_2\text{SO}_4 + \text{I}_2 + \text{H}_2\text{O}$

Biperoksisulfat kislota – $\text{HSO}_3\text{-O-O-SO}_3\text{H}$.



Kuchi oksidlovchi:

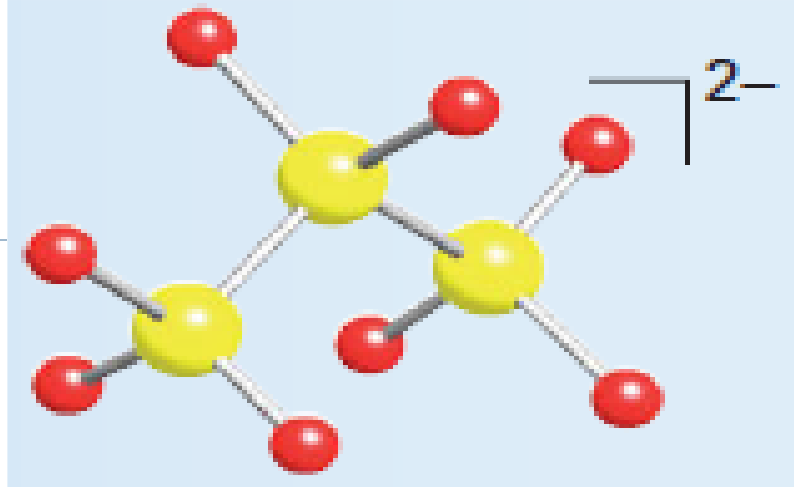
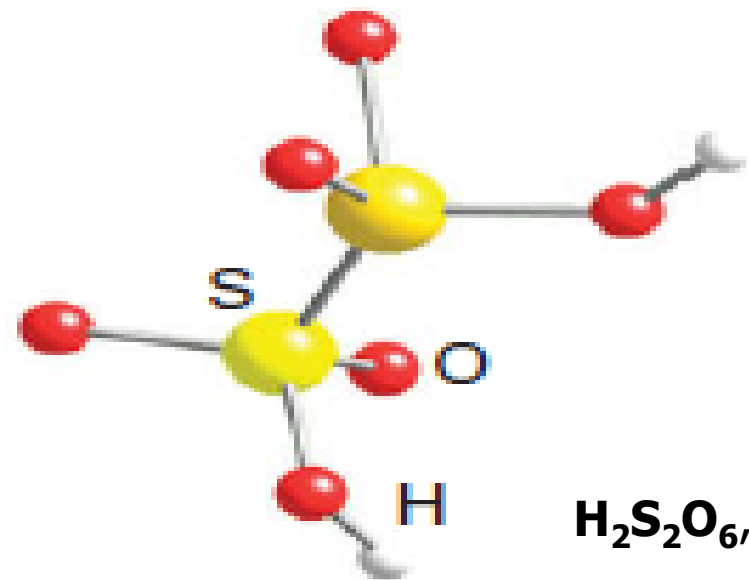


Sanoatda. 50% H_2SO_4 eritmasini elektroliz qilib olinadi:

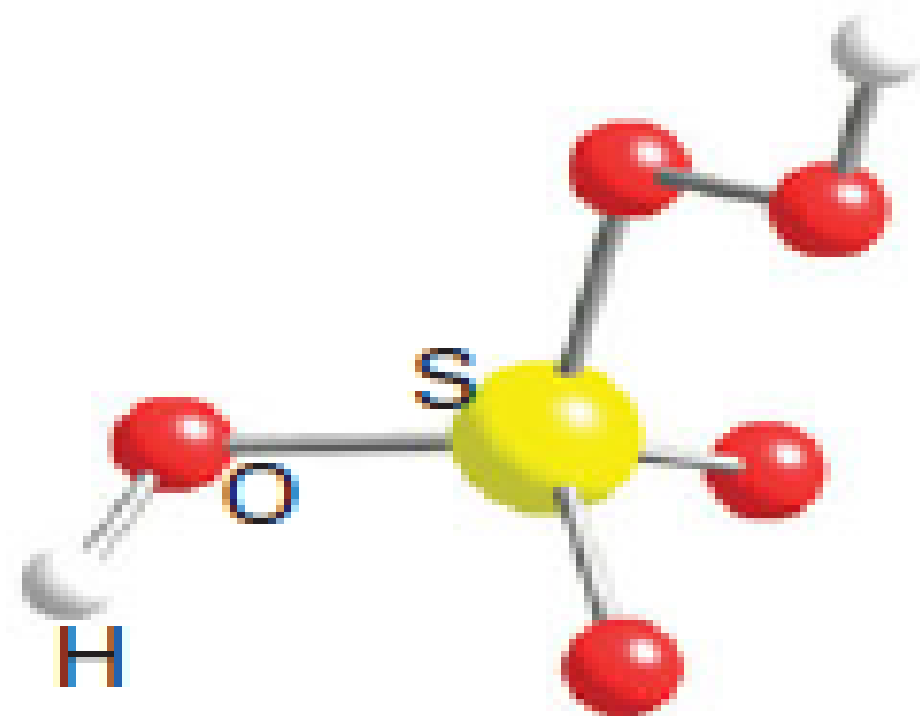


$\text{H}_2\text{S}_2\text{O}_8$ dan H_2O_2 olinadi.

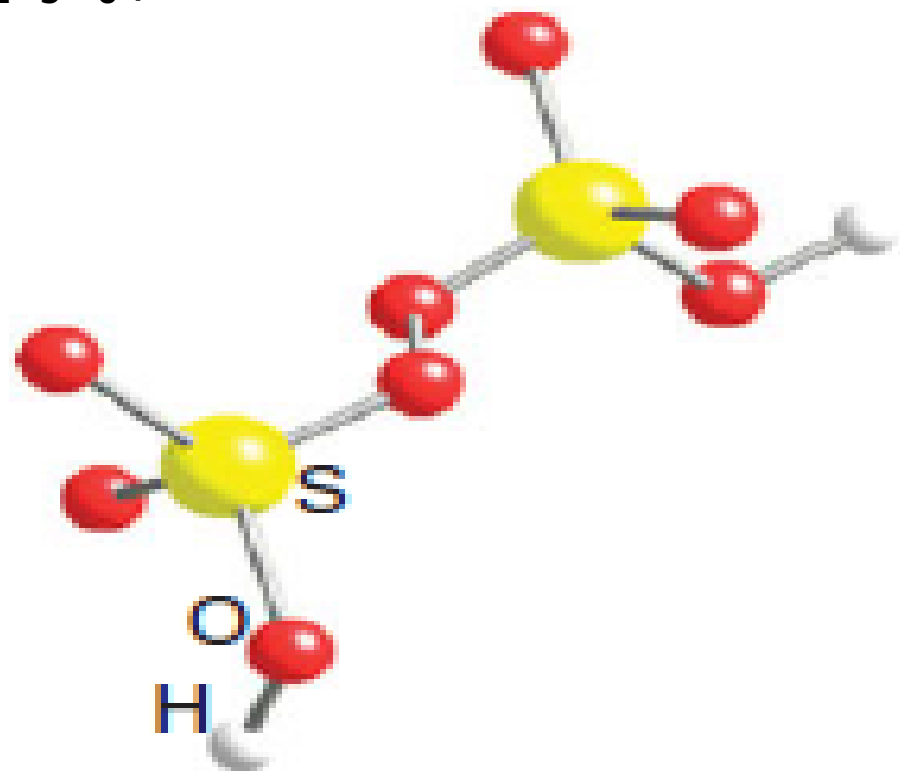




$\text{H}_2\text{S}_2\text{O}_6$, $\text{H}_2\text{S}_4\text{O}_6$, $\text{H}_2\text{S}_5\text{O}_6$ pentation



HOOSO_3H



$\text{H}_2\text{S}_2\text{O}_8$



Oltingugurtning galogenli birikmalari

Oltingugurt dixlorid - S_2Cl_2 qizil suyuqlik ($T_s = 80\text{ }^\circ\text{C}$).

Qovoq rangli, yoqimsiz hidga ega. $2S + Cl_2 \rightarrow S_2Cl_2$;

Oltingugurt tetraclorid - SCl_4 . Suyuq modda, $T_s = -30\text{ }^\circ\text{C}$.

S_2F_2 - rangsiz gaz. $T_s = -35\text{ }^\circ\text{C}$.

Oltingugurt tetraftorid - SF_4 rangsiz gaz, $T_s = -40,4\text{ }^\circ\text{C}$.

$3SCl_2 + 4NaF \rightarrow SF_4 + S_2Cl_2 + 4NaCl$;

Oltingugurt monobromidi - S_2Br_2 mavjud.

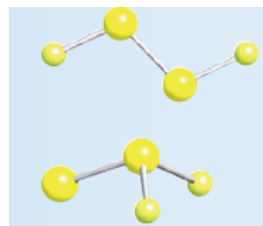
S_2Br_2 - qo'ng'ir rangli suyuqlik, $T_s = -46\text{ }^\circ\text{C}$.

S^{+6} birikmalari: SF_6 , SO_2Cl_2 .

$S + 3F_2 \rightarrow SF_6$; $SO_2 + Cl_2 \rightarrow SO_2Cl_2$;

$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$;

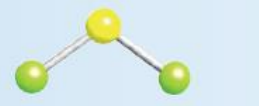
S_2F_2



S_2Cl_2



SCl_2



SF_4

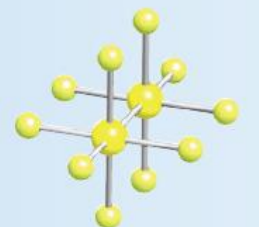
SeX_4 (X = F, Cl, Br)

TeX_4 (X = F, Cl, Br I)



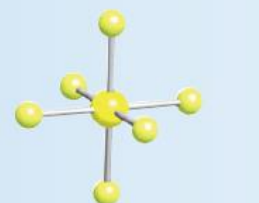
S_2F_4

Se_2F_{10}



SF_6 , SeF_6

TeF_6



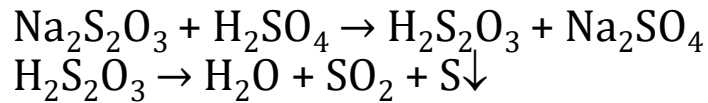
Pictures taken from Atkins, P. W. Shriver & Atkins' Inorganic Chemistry; Oxford University Press: Oxford; New York, 2010.



Oltugugurt tibbiyotda



Cho'ktirilgan oltugugurt: yuqori **tozalik** va kichik **disperslik**



$\text{Na}_2\text{S}_2\text{O}_3$ - galogenlar, CN^- , As, Pb, Hg birikmalari bilan zaharlanishda **antidot** sifatida qo'llaniladi.

$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ surgi dori sifatida.

Bundan tashqari organik birikmalari keng ishlatiladi:



Pictures taken from <https://www.dailymail.co.uk/femail/article-609405/Reddit-users-praise-sulfur-ointment-treat-cystic-acne.html>;
last accessed: 22.04.2020

Se, Te va Po

Te 60°C da TeO_2 : $\text{Te} + 2\text{H}_2\text{O} = \text{TeO}_2 + 2\text{H}_2$

Se va Te H_2EO_4 kislotalar, $\text{Po} + 8\text{HNO}_3 = \text{Po}(\text{NO}_3)_4 + 4\text{NO}_2 + 4\text{H}_2\text{O}$

H_2S , H_2Se , H_2Te , H_2Po qatorda kislota kuchi ortib boradi, biroq ularning barqarorligi kamayadi.

SeO_2 (bug'lanish.h. 315°C).



H_2SeO_3 – erkin holda olingan. H_2SeO_3 – qattiq modda.

SeCl_4 – qattiq modda (suyuql.h. 100-350°C). SeF_6 (gaz).



H_2SeO_4 – oq modda (suyuql.h. 62,4°C). ($K_1=1,2 \cdot 10^3$, $K_2=1,2 \cdot 10^{-2}$).

BaSeO_4 va PbSeO_4 erimaydi.

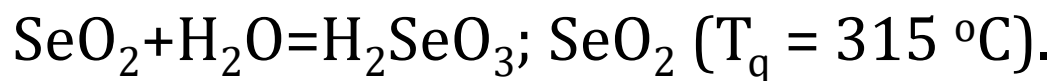
► Selen komplekslari: $\text{K}[\text{SeF}_5]$, $\text{K}_2[\text{SeF}_6]$.



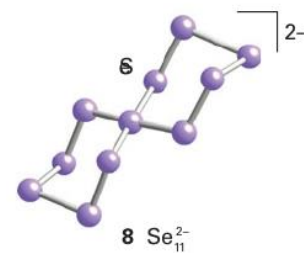
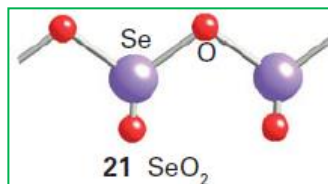
Selen kimyosi



Selenidlar va poliselenidlar hosil qiladi: Na_2Se , K_2Se_{11} ;



H_2SeO_3 ajratib olingan, qattiq modda.



SeCl_4 - qattiq modda ($T_s = 100\text{-}350 \text{ }^\circ\text{C}$) $\text{SeCl}_4 + 3\text{H}_2\text{O} = \text{H}_2\text{SeO}_3 + 4\text{HCl}$;

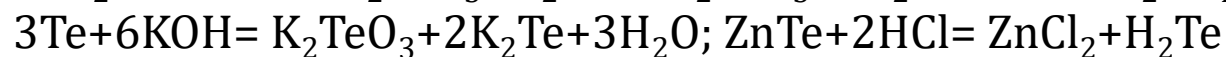
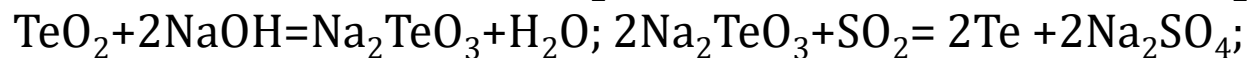
$\text{SeO}_3 + \text{H}_2\text{O} = \text{H}_2\text{SeO}_4$; H_2SeO_4 oq rangli ($T_s = 62.4 \text{ }^\circ\text{C}$), kuchli kislota:

$K_{a1} = 1.2 \cdot 10^3$, $K_{a2} = 1.2 \cdot 10^{-2}$; BaSeO_4 va PbSeO_4 erimaydi.



Tellur kimyosi

Kumush tellurid (gessit) - Ag_2Te , oltin tellurid (klaverit) - Au_2Te , silvanit - AgAuTe_4 .



H_2Te qo'llansa hidli gaz.

TeO_2 rangsiz kristall, suvda oz eriydi. H_2TeO_3 beqaror va kuchsiz kislota.

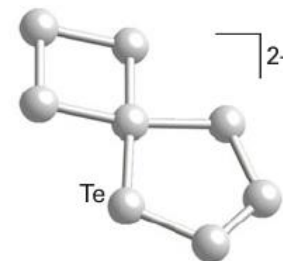
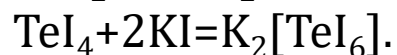
TeO_3 suvda erimaydi, ishqorlarda eriydi.

$\text{H}_2\text{TeO}_3 \cdot 2\text{H}_2\text{O}$ ortotellurat kislota H_6TeO_6 . Tuzlari Ag_6TeO_6 .

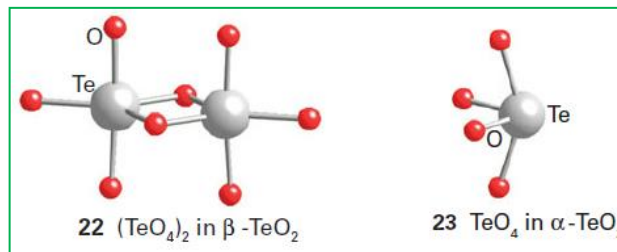
H_6TeO_6 suv yo'qotib tellurat kislota H_2TeO_4 ga aylanadi.

Kuchsiz kislota: $K_{a1} = 2 \cdot 10^{-8}$, $K_{a2} = 5 \cdot 10^{-11}$.

TeCl_2 va TeI_2 ancha barqaror. TeI_4 anionli komplekslar:



36 TeO_3^{2-}



22 $(\text{TeO}_4)_2$ in $\beta\text{-TeO}_2$

23 TeO_4 in $\alpha\text{-TeO}_2$

Pictures taken from Atkins, P. W. Shriver & Atkins' *Inorganic Chemistry*; Oxford University Press: Oxford; New York, 2010.



Poloniy kimyosi



Po oq kumushrang metal, $T_s = 254\text{ }^\circ\text{C}$. M. Kyuri kashf etgan.

Sulfidlarga o'xshash pollonidlar hosil qiladi: Na_2Po , PbPo , HgPo .

H_2S , H_2Se , H_2Te , H_2Po qatorida **barqarorlik** va **kislotalilik** kamayadi.

Kislotalar bilan metallar kabi tuzlar hosil qiladi: $\text{Po}(\text{SO}_4)_2$, $\text{Po}(\text{NO}_3)_4$, PoCl_2 .

PoO_2 kislotalik xossa kuchsiz. $\text{PoO}_2 + 2\text{H}_2\text{SO}_4 = \text{Po}(\text{SO}_4)_2 + 2\text{H}_2\text{O}$

PoCl_4 komplekslar: $2\text{KCl} + \text{PoCl}_4 = \text{K}_2[\text{PoCl}_6]$

Radiokimyoda α -zarrachalar hosil qilish uchun ishlatiladi.

Yuqori toksikligi uchun biologik ahamiyati yo'q.



Pictures taken from <https://de.wikipedia.org/wiki/Datei:Radioactive.svg>; last accessed: 23.04.2020





Xalkogenlar kimyo sanoatida

Kislород anorganik va organik kimyoda birdek muhim.

Sulfat kislota – kimyo qoni: 244.26 mln tonna (2015).

Se – shisha, quyosh panellari, fotoo'tkazgichlar, katalizda;

Te - quyosh panellari, qotishmalar, yarimo'tkazgichlarda;

Po – radiokimyoda ishlatiladi.

Source: <https://www.statista.com/statistics/961422/global-sulfuric-acid-market-volume/>; <https://en.wikipedia.org>;
<https://www.rsc.org/periodic-table/element/16/sulfur>; last accessed: 28.04.2020



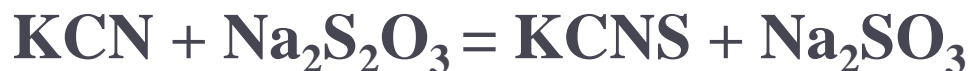
Farmatsiyada xalkogenlar

Odam organizmida O_2 – 64,4 % ni tashkil etadi. Har sekundda 0,264 litr O_2 iste'mol qilinadi. 95% O_2 va 5% CO_2 - KARBOGEN. Organizmdagi S miqdori 140 g.

Organizmning kunlik S ga bo'lgan ehtiyoji 1 g.

Oqsillar, aminokislotalar, gormonlar, vitaminlar tarkibida uchraydi.

Analitik kimyoda $Na_2S_2O_3$ – galogenlar, sianidlar bilan zaharlanganda, shu bilan birga As, Pb, Hg ni yo'qotish maqsadida ishlatiladi.



$Na_2S_2O_3$ – allergik kasalliklar va nevrozda qo'llaniladi. $Na_2S_2O_3$ при неврозе, $Na_2SO_4 \cdot 10H_2O$ (Glauber tuzi) – ichni yumshatuvchi vosita.



Xulosa

