Question #61746, Chemistry / Inorganic chemistry

Discuss the formation, reactions and structures of oxides of sulphur and selenium.

Answer

Both sulfur and selenium can form oxides with formula EO_2 and EO_3.

Sulfur (IV) oxide can be easily obtained from the reaction between simple elements, burning of the sulfides, by the reduction of S(VI) compounds or by the replacement reaction between sulfides with strong acids:

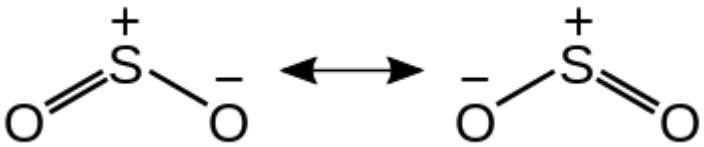
$S + O_2 = SO_2$

$4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2$

$2CaSO_4 + C = 2CaO + 2SO_2 + CO_2$

$Na_2SO_3 + H_2SO_4 = Na_2SO_4 + SO_2 + H_2O$

SO_2 is a bent molecule with C_{2v} symmetry point group. In terms of electron-counting formalism, the sulfur atom has an oxidation state of +4 and a formal charge of +1. A valence bond theory approach considering just s and p orbitals would describe the bonding in terms of resonance between two resonance structures.



Sulfur (IV) oxide shows classical properties of the acidic oxide. It forms weak acid – H_2SO_3 and reacts with bases forming sulfite and hydrosulfite salts.

$SO_2 + NaOH = NaHSO_3$

$SO_2 + 2NaOH = Na_2SO_3 + H_2O$

It is strong reducing agent and weak oxidizing agent.

$2SO_2 + O_2 = 2SO_3$

$SO_2 + C = S + CO_2$

Sulfur (VI) oxide is usually obtained by oxidizing sulfur (IV) oxide, what was shown above.

Gaseous SO_3 is a trigonal planar molecule of D_{3h} symmetry. In terms of electron-counting formalism, the sulfur atom has an oxidation state of +6 and a formal charge of +2. The Lewis structure consists of an S=O double bond and two S–O dative bonds without utilizing d-orbitals. The electrical dipole moment of gaseous sulfur trioxide is zero. This is a consequence of the 120° angle between the S-O bonds.

It is classical acidic oxide, reacts with vases forming sulfates and hydrosulfates< anhydride to the sulfuric acid. Can react with sulfuric acid with formation of $H_2S_2O_7$, with hydro halides.

$SO_3 + NaOH = NaHSO_4$

$SO_3 + NaOH = Na_2SO_4 + H_2O$

$SO_3 + HF = HSO_3F$

Selenium (IV) oxide is obtained similar to the SO_2, main method is the reaction of simple elements.

$Se + O_2 = SeO_2$

In contrast to the SO_2, SeO_2 is solid one-dimensional polymer, the chain consisting of alternating selenium and oxygen atoms. SeO2 is considered an acidic oxide, with corresponding selenous acid, but it is weaker in comparison to the SO_2. Due to the +4 oxidation it can react as strong reducing agent and weak oxidizing agent.

$SeO_2 + NaOH = NaHSeO_3$

$SeO_2 + 2NaOH = Na_2SeO_3 + H_2O$

$SeO_2 + H_2O_2 = H_2SeO_4$

$SeO_2 + N_2H_4*H_2O = Se + N_2 + 3H_2O$

Selenium (VI) oxide, in contrast to the SO_3, can`t be obtained by directed oxidation of the selenium. So it`s obtained from its salts

$SO_3 + K_2SeO_4 = K_2SO_4 + SeO_3$

Structure of the SeO_3 is similar to the SO_3. It is solid, which can be easily sublimated. SeO_3 is acidic oxide, with corresponding selenic acids and its salts. It easily decomposes on heating to the SeO_2, is strong oxidizing agents.

$2SeO_3 = 2SeO_2 + O_2$

$SeO_3 + H_2O = H_2SeO_4$

$SeO_3 + 2HCl = SeO_2 + Cl_2 + H_2O$

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