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Energy Balance of Fusion Processes of the Ozone Molecule

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Abstract. It has been disclosed that new physical chemistry of the micro world facilitates the description of the ozone molecule fusion processes within the framework of the law of conservation of energy.

Key words: nucleus, atom, molecule, electron, photon, energy of bond.

Introduction

Ozone is a gaseous substance, which consists of the three-atom molecules O_3 . In order to destroy the oxygen molecule, it is necessary to spend 5.13 eV of energy. During the fusion of two ozone molecule, 2.99 eV of energy are released. As a result, energy difference $5.13 - 2.99 = 2.15$ eV takes place. The authors of the fundamental monograph [1] devoted to ozone assert that energy of 2.15 eV is absorbed by the third unknown particle M , which takes part in this process. The oxygen atom, the molecules of oxygen, and ozone as well as any other molecules being present in the ozone molecule fusion zone can play the role of this particle. Such an assumption is made for the purpose that the law of conservation of energy will not be violated. The ozone molecule fusion reaction is written in such a way:



At any rate, it is a strange assumption. It is known that each portion of energy has its origin in the processes of fusion and dissociation of the molecules. That's why it is necessary to find a true source for the 2.15 eV of energy [1,2].

Theoretical Analysis

Prior to the analysis of the energetics of the chemical bonds of the ozone molecule, it is necessary to understand the energetics of the chemical bonds of the atom O and the oxygen molecule O_2 .

An oxygen atom is the eighth element of the periodic table and is situated in its sixth group. The structure of its nucleus is given in Figure 1 and the structure of the oxygen atom is in Figure 2 [2].

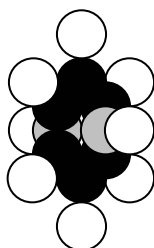


Figure 1. Diagram of oxygen atom nucleus: the protons are white and the neutrons are black and grey.

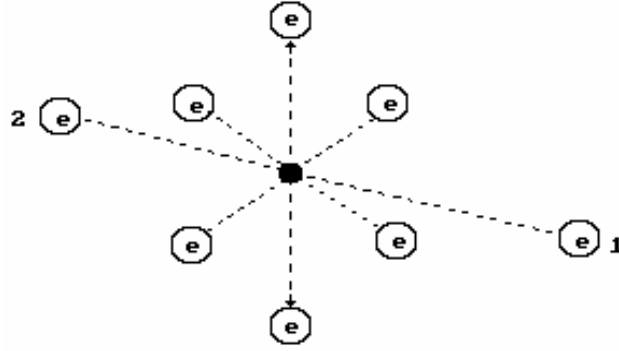


Figure 2. Diagram of the oxygen atom.

In Figure 2, a diagram of the oxygen atom originating from the structure of its nucleus is illustrated (Fig. 1). It has eight electrons and those that are situated on the axis of symmetry are the most active ones (1, 2). The other six electrons situated in the plane, which are perpendicular to an axis line (a line of symmetry), take away electrons 1 and 2 from the nucleus, at a large distance, by their total electric field which forms the conditions for their large activity during the interaction with the electrons of its neighboring atoms [2].

The least ionization energy of the electron of the oxygen atom is equal to $E_i = 13.618$ eV. The binding energy of this electron with an atomic nucleus corresponding to the first energy level that is equal to $E_1 = 13.752$ eV. Let us call this electron the first one. The calculation of energy indices of this electron, including its binding energies E_b with the atomic nucleus according to the formulas (2) and (3), gives the results seen in Table 1 [2].

$$E_{ph} = E_i - \frac{E_i}{n^2} = E_i - \frac{E_1}{n^2} \quad (2)$$

$$E_b = \frac{E_1}{n^2} \quad (3)$$

Let us pay attention to the fact that there is no energy of orbital movement of the electron in the atom in the mathematical model (2) of the formation of the spectra of the atoms and the ions. It appears from this that the electron has no orbital movement in the atom. Rotating in relation to its axis it can only precess on the atomic nucleus (Fig. 2) [2].

Table 1. Spectrum of the first electron of the oxygen atom.

Values	n	2	3	4	5	6
E_{ph} (exp.)	eV	10.18	12.09	12.76	13.07	13.24
E_{ph} (theor.)	eV	10.16	12.09	12.76	13.07	13.24
E_b (theor.)	eV	3.44	1.53	0.86	0.55	0.38

The oxygen molecule structure is given in diagram a of Figure 3. It is formed by means of a connection of unlike magnetic poles of axis electrons of two oxygen atoms [2]. As it is clear, the oxygen molecule has fourteen free electrons, which are ready for bonding. The axial electrons 1' and 2 are the most remote ones from the structure of the whole molecule and have the greatest activity, i.e. aptitude for bond with the electrons of other atoms [2].

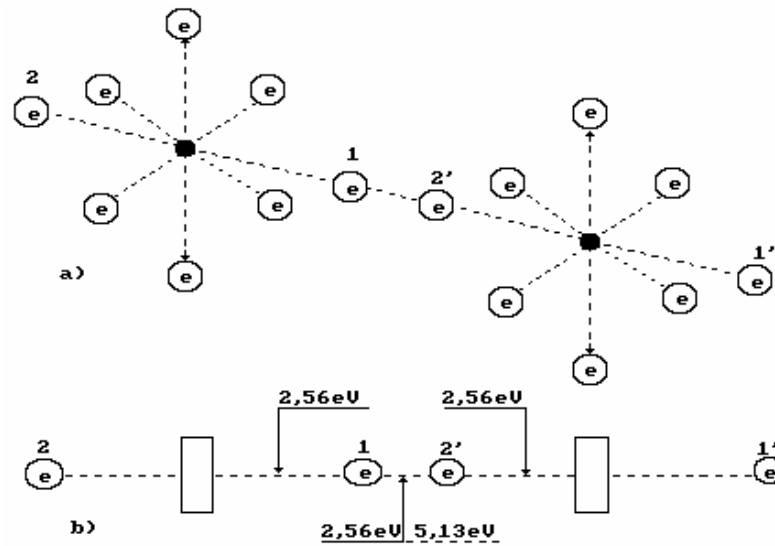


Figure 3. Diagram of binding energy distribution between the electrons in the oxygen molecule.

It is known that the fusion process of the oxygen molecules is accompanied with a release of 495 kJ/mole of energy, or in calculation for one molecule

$$E_b = \frac{495 \cdot 1000}{6.02 \cdot 10^{23} \cdot 1.602 \cdot 10^{-19}} = 5.13 \text{ eV}. \quad (4)$$

What principle does the nature go by distributing energy 5.13 eV between the oxygen molecule electrons (diagram a in Figure 3)? Energy of 5.13 eV is a thermal binding energy between the electrons 1 and 2' of two oxygen atoms (diagram a in Figure 3). When the oxygen molecule is formed, it is emitted in the form of the photons by the electrons, which enter the bond. It appears from this that it is equal to an amount of energies of two photons emitted by these electrons. Consequently, each contacting electron emits a photon with energies of $5.13/2=2.565$ eV (Figure 3). According to Table 1, in this case the valence electrons are situated between the second energy level and the third one [2].

Two oxygen atoms are connected into a molecule in an excitation state. The excitation state is the state of an atom when its valence electrons are situated at such distances from the nuclei when the binding energy between them is reduced to a fraction of a thousandths of an electron-volt. In such state, the atom can loose an electron and become an ion. Otherwise, without loosing electrons it is connected with an electron of the neighbouring atom by the valence electron, and a process of oxygen molecule formation begins. It is an exothermic process when the axis valence electrons 1 and 2' emit the photons, descend on lower energy levels and release $2.565 \times 2 = 5.13$ eV.

In order to destroy the oxygen molecule and to form the ozone molecule and spark discharge or photon flux with energies, which are somewhat larger than binding energy of $2.565 \times 2 = 5.13$ eV between the oxygen atoms in its molecule, are used (diagram b in Figure 3). It is known that ozone is formed during ultraviolet radiation with the wavelength of $\lambda = 240 \cdot 10^{-9} \text{ m}$. Photon energy, which corresponds to this wavelength, is equal to

$$E_{ph} = \frac{h \cdot C}{\lambda} = \frac{6.626 \cdot 10^{-34} \cdot 2.998 \cdot 10^8}{240 \cdot 10^{-9} \cdot 1.602 \cdot 10^{-19}} = 5.17 \text{ eV} \quad (5)$$

As ozone is formed according to equation $2O_2 + O + O \rightarrow 2O_3$, it is necessary to destroy one oxygen molecule O_2 for fusion of two molecules of O_3 . To this effect, it is necessary to excite 2 electrons having spent $2.565 \times 2 = 5.13$ eV for this purpose (Figure 4).

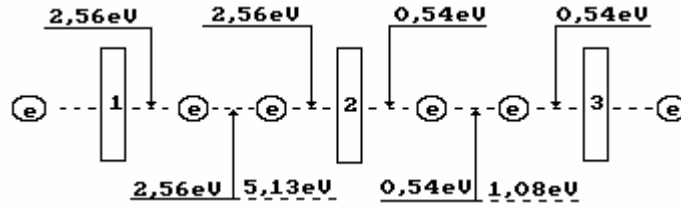


Figure 4. Diagram of binding energy distribution in the ozone molecule.

It is known that 144 kJ are released during dissociation one mole of ozone. As a result, we have per molecule:

$$E_b = \frac{144 \cdot 1000}{6.02 \cdot 10^{23} \cdot 1.6 \cdot 10^{-19}} = 1.49 \text{ eV}. \quad (6)$$

The ozone formation process begins when even the smallest temperature reduction takes place in ozone where the oxygen atoms are in excited state. Their valence electrons are connected with the valence electrons of the oxygen atoms in its molecules and emit the photons with such total energy that the remainder of energy absorbed earlier (5.13 eV) will be equal to endothermic energy of $1.49 \times 2 = 2.99$ eV of formation of two ozone molecule. Energy of the emitted photons will be equal to $5.13 - 2.99 = 2.15$ eV. This energy is spent for formation of the bonds in two ozone molecules, which have 4 valence electrons. The binding energy corresponding to one electron is equal to $2.15/4 = 0.54$ eV (Fig. 4). In this case, valence electrons are almost on the fifth energy levels (Table 1).

As it is clear that the ozone molecule is longer than the oxygen molecule (Figure 3), the binding energy (0.54 eV) to the third one, which is connected by the oxygen atom, is fivefold less than between the oxygen atoms (2.56 eV) in its molecule. As a result, the stability of the ozone molecule is less than that of the oxygen molecule, and it is destroyed easier, forming the oxygen molecules and its atoms. For this effect, availability of light photons, whose energy is changed within the range of 0.016-3.27 eV, is enough (see Table 2).

Table 2. Electromagnetic emission scale ranges.

Bands	Wave-length, m	Energy, eV
1. Low- frequency band	$\lambda \approx (10^7 \dots\dots 10^4)$	$E \approx 10^{-15} \dots 10^{-11}$
2. Broadcast band	$\lambda \approx (10^4 \dots\dots 10^{-1})$	$E \approx 10^{-11} \dots 10^{-6}$
3. Microwave band	$\lambda \approx (10^{-1} \dots\dots 10^{-4})$	$E \approx 10^{-6} \dots 10^{-3}$
4. Relic band (maximum)	$\lambda \approx 1 \cdot 10^{-3}$	$E \approx 1.2 \cdot 10^{-3}$
5. Infrared band	$\lambda \approx (10^{-4} \dots\dots 7.7 \cdot 10^{-7})$	$E \approx 10^{-3} \dots 1.6 \cdot 10^{-2}$
6. Light band	$\lambda \approx (7.7 \cdot 10^{-7} \dots 3.8 \cdot 10^{-7})$	$E \approx 1.6 \cdot 10^{-2} \dots 3.27$
7. Ultraviolet band	$\lambda \approx (3.8 \cdot 10^{-7} \dots\dots 10^{-9})$	$E \approx 3.27 \dots 1 \cdot 10^2$
8. Roentgen band	$\lambda \approx (10^{-9} \dots\dots 10^{-12})$	$E \approx 10^2 \dots 10^5$
9. Gamma band	$\lambda \approx (10^{-12} \dots\dots 10^{-18})$	$E \approx 10^5 \dots 10^9$

After destruction of two ozone molecules, the valence electrons of the separated oxygen atoms pass into excited state absorbing $0.54 \times 4 = 2.15$ eV of energy. When they reach the highest energy levels, they are separated; after the free state stage, where they form an oxygen molecule emitting the photons with a total energy equal to 5.13 eV. The difference between the emitted energy of 5.13 eV and energy of 2.15 eV absorbed by the four electrons is equal to the dissociation energy of two ozone molecules of 2.88 eV, or 1.44 kJ/mole.

Conclusion

The disclosed models of the oxygen atom and molecule as well as the empirical mathematical law of formation of the spectra of the atoms and the ions, give the possibility to make a detailed analysis of energy balance of formation of the molecules of oxygen and ozone, which corresponds to the experimental data completely.

References

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