Chapter 3
Dimension of Chemical Compounds of Atoms Metals With Atoms No Metals

ABSTRACT

The structures of compounds of a metal atom with ligands were studied by sequentially changing the groups and subgroups of the periodic system of elements in which the metal atom is located. It is shown that all metals from the first to the eighth groups form chemical compounds of a higher dimension. The formation of molecules of higher dimension occurs due to the chemical bonds of the metal atom with ligands both due to the influence of electron pairs and due to the attraction of ions. Moreover, the apparent valence of the metal atom, as a rule, exceeds the value of the valence determined by the location of the metal in the periodic table of chemical elements.

INTRODUCTION

In previous chapters, compounds of atoms of the same or different metals with each other were considered. The structures of these compounds and the dimensions of the elementary cells of a solid array of material or the dimensions of their nanoparticles (clusters of metal compounds of each other) were determined. However, in nature and in technology, the combination of metals with other chemical elements, their compounds and groups is very important. In coordination chemistry, elements or groups of elements attached

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to a metal atom are called ligands, and the compounds themselves are called complex compounds. However, there is still no exact (unambiguous) definition of the concept of a complex compound covering all possible types of such compounds (Morozov, 2008). A number of terms and definitions have been introduced that have a narrow scope (Werner, 1936; Greenberg, 1986). In particular, the concepts of the main and secondary valence of chemical elements, etc., are introduced.

In the monograph (Zhizhin, 2018), relying on the works of Gillespie (Gillespie, 1972; Gillespie & Hargittai, 1991), an analysis of almost all elements of the periodic system was carried out and it was shown that most of the molecules of the chemical compounds of these elements have a higher dimension. At the same time, it was not necessary to use special definitions of coordination chemistry, since the ball is sufficient to have ideas about divided and unshared electron pairs. There is for the purpose of determining the dimension of a molecule of a chemical compound, it is important to take into account the arrangement of the atoms of this molecule in space. A priori the equality of the dimension of space by three was not given. In addition, when determining the dimension of molecules, the nature of the chemical bond fades into the background. The result is important - the arrangement of atoms in space. In this case, there is no need to solve accurately the complex problems of determining the degree of covalence and ionization of a chemical bond. It is important that this bond is strong enough to ensure a stable configuration of the molecule. Weak bonds (for example, hydrogen bonds) are not taken into account.

To determine the dimension, the molecule is modeled by a convex figure (polyhedron or polytope), the edges of which are both chemical bonds between atoms and edges that have only a geometrical meaning. They serve to make the molecule look like a closed geometric figure. The dimension of the molecule is determined by the Euler – Poincaré formula (Poincaré, 1895), substituting the numbers of elements of different dimensions that make up the polytope. In the author's works (Zhizhin, 2016a, 2018, 2019, 2020), when considering the geometry of biomolecules, the concept of the functional dimension of biomolecules was introduced, taking complex groups of atoms attached to the central atom to be functional groups, denoting them as vertices of a polytope. In this case, the polytope is a simplified model of the molecule. The concept of functional groups and functional dimensions will also be used here when considering complex molecules.