LETTERS TO PROGRESS IN PHYSICS

From the Chloride of Tungsten to the Upper Limit of the Periodic Table of Elements

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Experimental study of the physical chemical properties and the technology of manufacturing chemically clean hexachloride of tungsten has led to unexpected results. It was found that each element of the Periodic Table of Elements has its own hyperbola in the graph "molecular mass — content of the element". The hyperbolas differ according to the atomic mass of the elements. Lagrange's theorem shows that the tops of the hyperbolas approach to an upper limit. This upper limit means the heaviest element, which is possible in the Table. According to the calculation, its atomic mass is 411.66, while its number is 155.

1 Introduction

In the early 1960's, I and my research group worked in the Department of Rare, Radioactive Metals and Powder Metallurgy at Moscow Institute of Steel and Alloys, Russia. We looked for a better technology of manufacturing the chemically clean hexachlorid of tungsten (WCl_6) through chlorination of ferrotungsten. Then, in the 1970's, I continued this experimental research study at the Baikov Institute of Metallurgy, Russian Academy of Sciences.

Our main task in this experimental search was to obtain a purely oxygen-free product. Because the raw material we worked with was resented as a many-component gaseous mix, we studied behaviour of the vaporous medleys during filtering them by saline method, distillation, and rectification. As a result, the percent of mass of the metal we have obtained in vaporous medley was 99.9% for W, 20.0% for Mo, 2.0% for Fe [1–3].

After cleaning the obtained condensate with the aforementioned methods, we have found a small inclusion of the chloride compound of tungsten in it. This chloride compound of tungsten differs from the hexachloride of tungsten in colour and the boiling temperature, which was 348°C for WCl_6, 286°C for WCl_5, and 224°C for $WOCl_4$ [4]. The cleaned hexachloride of tungsten recovers to the powder metallic state by hydrogen in the boiling layer, in plasma, precipitates as a thin cover on a base in use. It is used for manufacturing alloys with other metals through metalthermic method, etc. [5].

2 Results

In development of this technology, it was found that the theoretical (expected) results of the chemical analysis of the vaporous medleys do not match the experimental results for a little. This occurred due to some quantity of WO_2Cl_2 and $WOCl_4$ obtained in the process, which were used further for manufacturing a high clean WO_3 [6]. In order to keep control on the product of the chemical reactions, we have drawn dependencies of the content of tungsten, chlorine, and oxygen in the compounds (per one gram-atom of each element). This is necessary because, for example, the common quantity of the chloride of tungsten in chlorides is presented with a broken line (see Fig. 1) whose mathematical equation is impossible. As was found, after our Fig. 1, the arc of the content of tungsten is presented with an equilateral hyperbola $Y = K/X$ wherein its different compounds (in particular WO_3) are located. In analogy to this graph, the respective arcs were obtained for chlorine and oxygen, which appeared as hyperbolas as well.

Further checking for the possibility of creating similar functions for the other chemical elements manifested the fact that each element of the Periodic Table of Elements has its own hyperbola, which differs from the others according to the atomic mass of the element. As an example, Fig. 2 shows the hyperbolas created for the elements of Group 2, including the hypothetical elements No.126 and No.164. As is known, an equilateral hyperbola is symmetric with respect to the bisector of the angle XOY in the first quarter. Besides, the bisector coincides with the real axis, while the point of intersection of it with the hyperbola (the top point) is determined as the square root from $K(X_0 = Y_0)$. Respectively, for instance, the top point of the hyperbola of beryllium (atomic mass 9.0122) is located at $X_0 = Y_0 = 3.00203$.

In chemistry, it is commonly assumed to calculate the quantity of a reacted element in the parts of unit. Therefore, the hyperbola of each element begins from the mass of the element and $Y = 1$. From here, through Lagrange's theorem, we calculate the top of the hyperbola of beryllium: $X = 60.9097$, $Y = 0.14796$. Comparing the obtained coordinates, it is easy to see that $X/X_0 = 20.2895$ and $Y_0/Y = 20.2895$, which is the inverse proportionality with a respective scaling coefficient. Tangent of the angle of inclination of the real axis in the other (scaled) coordinates is $Y/X = 0.14796/60.9097 = 0.00242917$. The scaling coefficient al-

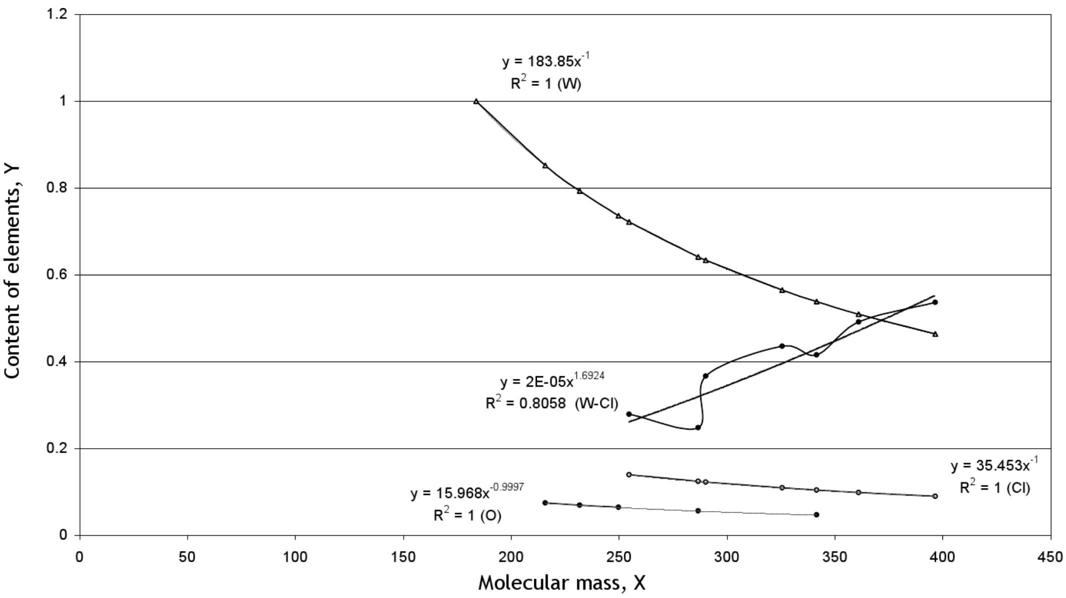

Fig. 1: The common quantity of the chloride of tungsten in chlorides.

lowed us to create a line joining the tops of the hyperbolas, located in the real axis (see Fig. 3). This is a straight crossing the line $Y = 1$, where the atomic and molecular masses of an element described by the hyperbolas are equal to each other ($K = X$). This is only possible if the origin of the hyperbola and its top meet each other at a single point where the content Y takes maximal numerical value (according to the equation $Y = K/X$). Atomic mass of this «ultimate» element, determined by the crossing point, was calculated with use of the scaling coefficient and the tangent of inclination of the real axis: $X = Y/\tan\alpha = 1/0.00242917 = 411.663243$. This calculated element is the last (heaviest of all theoretically possible elements) in the Periodic Table of Elements because Y cannot exceed 1. The second important characteristic of the element – its atomic number – was calculated through the equation of the exponent $Y = 1.6089\exp^{1.0993x}$ ($R^2 = 0.9966$). The calculated number of the last element is 155. With use of these equations, the respective parameters of all other elements of the Periodic Table can be calculated, including in the interval of super-heavy elements No.114–No.155 [7, 8].

3 Discussion

We see that on the basis of the initially experimental studies of the chloride of tungsten, a new law was found in the Periodic Table of Elements. This is the hyperbolic law, according to which the content Y of any element (per 1 gram-atom) in any chemical compound of a molecular mass X can be described by the equation of the positive branches of an equilateral hyperbola of the kind $Y = K/X$ (where $Y \leqslant 1$ and $K \leqslant X$). The hyperbolas of the respective chemical elements lie in the order of the increasing nuclear charge, and have a common real axis which meets their tops. The tops, with distance from the origin of the coordinates, approach the location $Y = 1$ and $K = X$ wherein atomic mass takes its maximally possible numerical value, which indicates the last (heaviest) element of the Periodic Table.

It should be noted that the new dependencies we pointed out here have provided not only better conditions of applied research, but also a possibility for re-considering our views on the conditions of synthesis of super-heavy elements. If already in 2003 theoretical physicists discussed properties of elements with number near 400 whose nuclei contain until 900 neutrons each [9], in February 2009, after primary publication of our studies, they discuss the elements with numbers not higher than 150–200 [10].

Submitted on November 18, 2011 / Accepted on November 22, 2011

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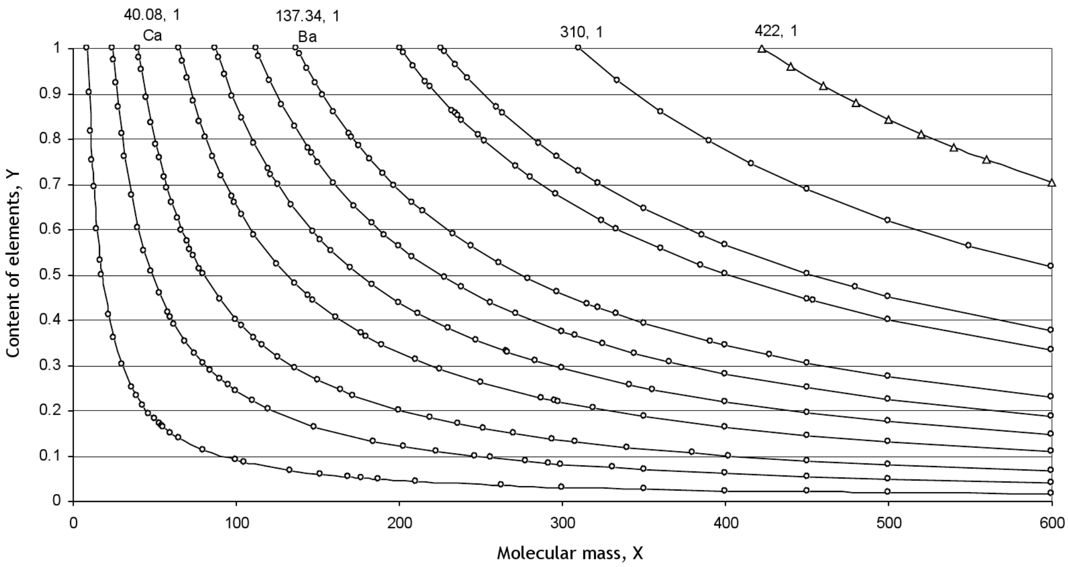

Fig. 2: The hyperbolas created for the elements of Group 2, including the hypothetical elements No.126 and No.164.

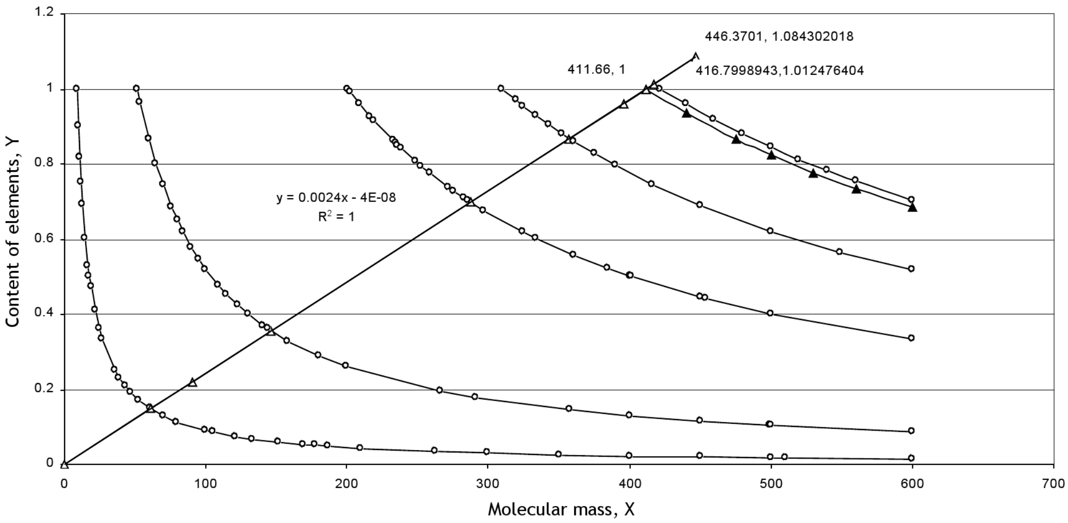

Fig. 3: The upper limit of the Periodic Table of Elements.

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