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# RESEARCH OF THE TECHNOLOGY OF OBTAINING COBALT POWDER FROM COBALT OXIDE

**Sharipov Kongratbay Avezimbetovich**
Professor, Minister of Higher Education, Science and Innovation
**Parmonov Sarvar Toshpulatovich**
Associate professor, Head of Department
of Chemical Technology, Almalyk branch of *TSTU*

**Annotation.** This article presents the research results on obtaining cobalt powders in two stages in a hydrogen atmosphere from cobalt oxide, purchased today as an imported product. Conducted scientific and practical research shows that the chemical composition of initial cobalt oxide, when analyzed using Energy Dispersive X-ray Fluorescence (EDXRF) equipment, additional metals such as Mo, Ni, Cu, As, Ag, Sn, Sb, Te. It was found that the cobalt powder obtained from the recovery process contains additional metals such as Al, Si, S, Ca, Mn, Fe, Ag, Sn, Sb, W, Te, Ni, and Mo It was carried out at the laboratory base of National University of Uzbekistan named after Mirzo Ulugbek and Almalyk branch of Tashkent State Technical University named after Islam Karimov.
**Keywords:** cobalt oxide, cobalt powder, restoration, Energy Dispersive X-ray Fluorescence, additional metals, electric furnace, binder metal, solid alloy.

**Introduction.** One of the factors affecting the hardness, brittleness, density, bending strength, annealing temperature, and corrosion resistance of the hard alloys during the annealing process of tungsten carbide-cobalt-based hard alloys is the properties of the binder. The binder must be strong enough to bend, tough and resistant to corrosion under operational conditions. At the same time, in the process of annealing, the binder should soak well and partially dissolve the carbide phase. The above requirements are fully satisfied by iron group metals Co, Ni, and Fe. Today, nickel and iron powders are used as binders in powder metallurgy instead of relatively high-cost cobalt.

The fact that nickel is more common than cobalt, the formation temperature of the system eutectic is at a relatively low temperature, and that it is more resistant to oxidation than iron and cobalt at high temperatures is the reason why it has been widely used as a binder in the production of tungsten and tungsten-free hard alloys in recent years. is happening [1].

The reason why nickel reacts with tungsten carbide during the annealing process and the degree of densification continues much faster than in the tungsten carbide-cobalt system is due to the formation of eutectic nickel at relatively lower temperatures. In solid tungsten carbide-cobalt and tungsten carbide-nickel alloys, the growth of carbide particles begins at a temperature of 1400 °C, but the optimal annealing procedure for the tungsten carbide-nickel system is a much wider range than for the tungsten carbide-cobalt system. However, as a result of insufficient dissolution of tungsten carbide particles in the nickel binder, tungsten carbide-nickel-based hard alloys show lower strength and corrosion resistance than tungsten carbide-cobalt-based hard alloys, and conglomerates of carbide particles are formed [2]. The resulting conglomerates additionally increase the brittleness of the hard alloy [3]. At the same time as

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the brittleness decreases, the hardness of the surface layer of hard alloy particles decreases slightly due to the defective transformation of carbon in the outer layers of tungsten carbide particles [4].

**Literature review**

Recent advancements have focused on making cobalt extraction more sustainable and efficient:

Bioleaching: Bioleaching uses bacteria to extract metals from ores. This environmentally friendly method reduces the need for harsh chemicals and high temperatures. Research has shown that specific strains of bacteria can be highly effective in extracting cobalt from low-grade ores, making it a viable option for more sustainable mining operations [5].

Hydrometallurgical Processes: Innovations in hydrometallurgy, particularly the use of advanced solvents and reagents, have improved the efficiency and selectivity of cobalt extraction. Ion exchange and solvent extraction techniques are being refined to minimize waste and enhance the recovery rates of cobalt from mixed-metal ores [6-7].

Selective Leaching: Selective leaching techniques target cobalt more precisely within ore bodies, reducing the extraction of unwanted metals and minimizing environmental impact. This method is particularly useful in polymetallic ore deposits, where cobalt is present alongside other valuable metals like copper and nickel [8-9].

**Analysis and Results**

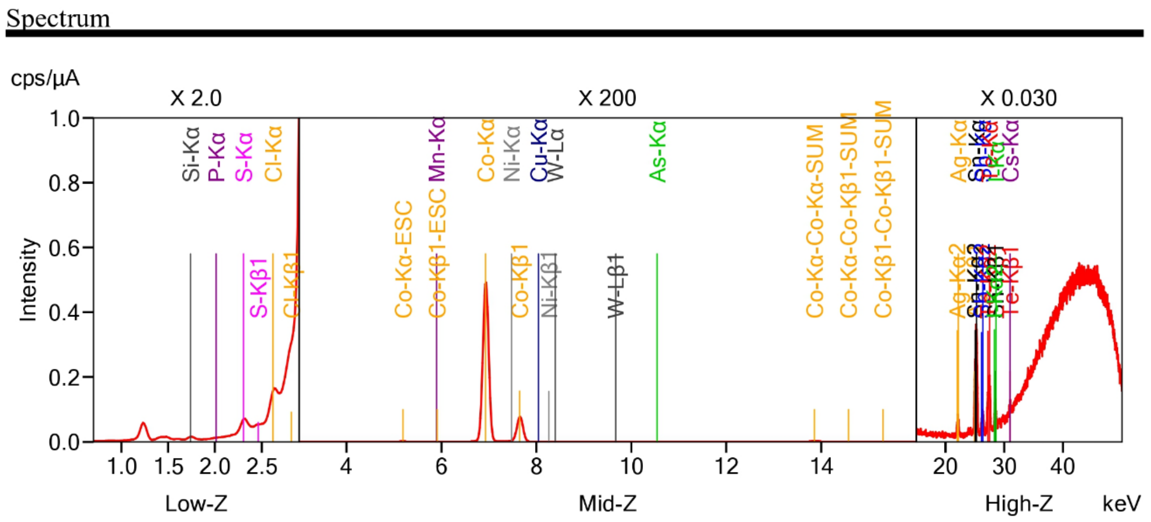
The conducted literature analysis and scientific and practical experiments showed that the use of cobalt as a binder compared to nickel and iron showed better mechanical properties of the obtained samples. Therefore, cobalt powders were used in all experiments.

Cobalt powders used in the production of corrosion-resistant hard alloys are imported products in the form of cobalt (III) oxide to RMHAP SPA under AMMK JSC. Extraction of cobalt powder from cobalt (III) oxide (see Table 1 and Figure 1) was carried out in two stages in a hydrogen atmosphere in STN-2.35 electric furnaces.

1 – table

**Chemical composition of $Co_2O_3$**

| Elements being identified, % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *M* | Co | Mo | Ni | Cu | As | Ag | Sn | Sb | Te |
| % | 99.7 | 0.0236 | 0.184 | 0.0107 | 0.0023 | 0.0046 | 0.0356 | 0.0041 | 0.0158 |



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**1 - picture. Chemical composition of $Co_2O_3$**

The recovery process takes place in the following reaction:

$$Co_2O_3 + 3H_2 = 2Co + 3H_2O \quad (1)$$

The production of cobalt powder from cobalt (III) oxide was carried out in the following sequence: first, cobalt oxide was loaded into boats until they were full, and then boats filled with cobalt oxide powder were successively loaded into the electric furnace. The speed of movement of the boats in the oven was determined to be in the range of 12-20 mm/min. 6-12 m3 of hydrogen per hour was supplied along the length of the furnace from the back, and the boats were moved towards the flow of hydrogen with the help of the furnace's mechanical thruster. The furnace consists of 2 zones: in zone 1, the temperature is 500-600 ℃, in zone 2, the temperature is 600-750 ℃ (the temperature in the furnace zones, the speed of movement of boats in the furnace, and the amount of hydrogen may change depending on the density of cobalt oxide). After the 2-stage powder was completely cooled in the cooling stage, it was removed from the oven. Taking the powders out of the oven before they have cooled completely can cause the cobalt to oxidize again:

$$4Co + 3O_2 = 2Co_2O_3 \quad (2)$$

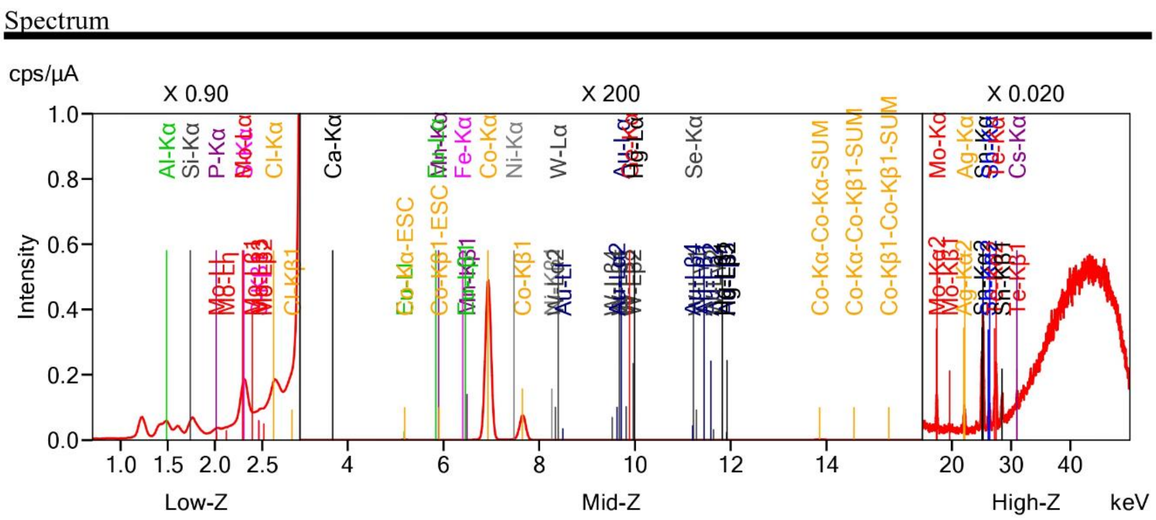
$$2Co + O_2 = 2CoO \quad (3)$$

After complete cooling, the cobalt powder removed from the oven is ground in a ball mill at a speed of 30-40 rpm for 30 to 120 minutes, depending on the particle size, to ensure granularity.

2 – table

**Chemical composition of Co**

| Elements being identified, % | | | | | | | |
|---|---|---|---|---|---|---|---|
| *M* | Co | Al | Si | S | Ca | Mn | Fe |
| *%* | 97.4 | 1.37 | 0.306 | 0.0728 | 0.0722 | 0.0454 | 0.0526 |
| *M* | Ag | Sn | Sb | W | Te | Ni | Mo |
| *%* | 0.0045 | 0.0248 | 0.0029 | 0.410 | 0.0106 | 0.221 | 0.0097 |




**1 - picture. Chemical composition of Co**

**Conclusions**

Based on the conducted research, when the chemical composition of the original cobalt oxide was analyzed in the process of obtaining cobalt powder from cobalt oxide, the presence

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of additional metals such as Mo, Ni, Cu, As, Ag, Sn, Sb, Te was found in the composition of the cobalt powder obtained from cobalt oxide that underwent the recovery process. and it was found that there are additional metals such as Al, Si, S, Ca, Mn, Fe, Ag, Sn, Sb, W, Te, Ni, Mo. Therefore, metals such as Al, Si, S, Ca, Mn, Fe, and W may have been caused by incorrectly performed processes during the recovery process.

In the process of restoration of Kobat, it is carried out in 2 zones at temperatures of 500-600 ℃ and 600-750 ℃. Depending on the initial density of cobalt oxide, the temperature in the furnace zones, the speed of movement of the boats in the furnace, and the amount of hydrogen change.

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