THE METALLURGY OF CANADIAN COBALT ORES

I. METHOD OF TREATMENT AT THE COBALT PLANT OF THE CANADIAN COPPER CO.

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The Cobalt plant of the Canadian Copper Company was situated at Copper Cliff, Ontario, about one half mile south of the large copper nickel smelter. The works were remodelled and designed to smelt and treat ores and concentrates from the Cobalt silver district. The plant was in operation from December, 1905, to February, 1913, during which time more than 40,000,000 ounces of silver, 2,200,000 pounds of cobalt, 1,500 000 pounds of nickel, and 4,500,000 pounds of pure arsenic were produced. Some idea of the richness of the ores treated can be obtained from Table 1. The low grade Crown Reserve ore included in this table was used as a flux.

Treatment:—If the ore was in large lumps it was crushed and then ground in a Krupp ball mill to pass 30 mesh. For sampling about 6% was cut out by a Snider sampler. Sampling was completed by coning and quartering. The first quartering divided the sample into four parts, which were worked down as two independent samples known as No. 1 and No. 2. These samples were reduced by quartering until the final quarters separated by a Jones sampler gave two samples of about 18 pounds, one of which was ground and the other held for reserve. The samples were ground to pass 100 mesh, or until nothing but silver scales remained which were weighed and assayed separately. The sampling work and moisture determination for the 8 cars of ore received in May, 1910, is shown in Table No. 2.

The ore was charged with suitable fluxes into 32″ x 72″ blast furnaces, having a capacity of 25 to 30 tons per 24 hours. Limestone from Michigan was used as a basic flux and low grade Crown Reserve ore was used as the acid flux.

The products of the blast furnaces were:—1. Flue dust and crude arsenic; 2. Slag; 3. Silver Bullion: and 4. Speiss.

The crude arsenic and flue dust from the blast furnaces and roasting furnaces were collected in suitable condensing chambers. The flue dust was recharged to the blast furnaces and the crude arsenic was sublimed from an arsenic refining furnace which made it ready for packing. Pure white arsenic assayed 99.98% arsenic oxide with about 0.03 ounces of silver per ton.

The slag from the blast furnaces during ore runs was rejected except when it was found to carry more than 10 ounces of silver per ton in which case it was used as revert to the blast furnaces. The slag produced while smelting speiss to remove the iron was all used as revert on ore runs because of its high silver and high cobalt content. Complete assays of the two slags were as follows:—

	Ore Slag	Speiss Slag
Silver	8.8 oz.	32.8 oz.
Arsenic	.13	.47
Cobalt	.44	13.97
Nickel	.29	1.28
Iron-oxide	11.63	28.54
Aluminum-oxide	14.15	9.75
Calcium-oxide	22.78	6.50
Magnesium-oxide	8.67	4.68
Silica	41.13	34.03
	99.35	99.22

The silver: About 75% of the Silver in the ore charged was obtained as buttons which were easily separated from the speiss and charged into an oil-fired cupelling furnace with a capacity of 30,000 ounces. The assay of this crude silver was as follows:—

Lot	Weight oz.	Assay	Fine Silver
668	16128.80	85.88	13851.41
669	14524.67	84.91	12332.90
670	15982.97	86.71	13858.83
673	15939.22	85.99	13706.14
674	14758.00	86.11	12708.11

After about 24 hours in the cupelling furnace the silver was ladelled out and cast into bars and shipped to the Balbach Smelting and Refining Company of Newark N.J. A few lots of this silver assayed as follows:—

Lot	Weight oz.	Assay	Fine Silver
637	46320.40	99.44	46065.17
645	37893.25	99.54	37721.97
649	34339.70	99.43	34147.05
652	50230.10	99.34	49900.59
659	52646.70	99.21	51238.68

The speiss was quite brittle as a rule and easily broken with a hammer. After being run through a crusher it was ground in the ball mill to pass 30 mesh, 20% of salt being added as the speiss was charged to the mill. This speiss, known in the smelter process as high iron speiss, was roasted in 8 Edwards reverberatory furnaces fitted with mechanical rabbles and having a capacity of 2400 pounds per 24 hours. The composition of high iron speiss is shown in Table No. 3.

The product of the roasting was a chloridized speiss which was transferred from the smelter to the hypo-leaching building. Here it was treated in a large agitation cylinder, first with cold water which dissolved out the undecomposed salt and the soluble salts of cobalt, nickel and copper. This water solution was decanted onto scrap iron to precipitate the copper and was then pumped to another tank where the cobalt and nickel were precipitated as hydrates by caustic soda. This precipitate was dried, calcined to oxides, ground and barrelled for shipment. The average assay of this material was:—Silver, 15.0 oz; Arsenic 0.3%; Cobalt 40.00 %; Nickel 3.00%. Nickel is lower than the usual proportion of nickel to cobalt for the reason that it is less easily converted to a soluble salt in the chloridizing roast.

After the wash with water the treatment of speiss is continued with four covers of sodium hyposulphite solution which takes all the silver chloride into solution and gives the "First Hypo Residue" which contains 20 to 30 oz. of silver. The silver was precipitated from the hypo-solution as silver sulphide which was collected in a filter-press, dried and mixed with sodium nitrate and carbonate. This mixture was roasted in an oil-fired furnace and then leached in hot water. The residue was a sponge-like mass of metallic silver which was charged to the silver refining furnace.

The "First Hypo Residue" resulting from the leaching process was returned to the smelter where it was mixed with quartz and run through the blast furnaces for the purpose of removing the iron. This was made necessary because of the contract under which the "Crude Cobalt Material" was sold, which required that the iron content be below 5%. This smelting operation resulted in a new green speiss called "Low Iron Speiss" of a composition shown in Table No. 4.

This speiss was milled with salt and roasted just the same as the "High Iron Speiss", and then washed with water and treated with hypo. The residue in this case was called "Second Hypo Residue". It was dried and