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Application, Raw Materials, Demand and Scale of Production of Nickel-Containing Catalysts

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Abstract. *The article describes the process of obtaining nickel from waste GIAP-8 and similar catalysts, which are used in the form of nickel nitrate, which is considered not only environmentally friendly, but also an economically viable solution for its production. Nickel catalysts isolated from waste were tested in laboratory conditions and used in production.*

Keywords: *industrial waste, nickel oxide, catalyst, nickel nitrate, GIAP-8, activity..*

In recent years, large-scale measures have been taken in the Republic to modernize, diversify and build new production facilities for ammonium nitrate and urea, increase volumes, expand the range of export-oriented, competitive products focused on environmental quality and the synthesis of resulting products, certain scientific and practical results have been achieved.

In the earth's crust, the nickel (Ni) content is only 0.0045 % wt. The mass of nickel in a layer of land on Earth 1 km deep is about 16 trillion. tons, when land with a land area of $149 \cdot 10^6$ km^2 and an average density of 2.5 t/m^3. To date, proven reserves of nickel ore do not exceed 54 million tons, and this is explained by its extreme dispersion with a content of 0.01 % Ni. In the earth's crust, the content of the so-called “богатой” nickel ore is 2÷4 % by mass. Although, in the 70s of the last century, the amount of nickel ore used decreased to 0.3 %. This suggests that nickel ore reserves are very rare on the globe. The European part of the Russian Federation (Krasnoyarsk Territory) has large nickel deposits, where two large metallurgical enterprises were built – “Североникель” and Norilsk Nickel. In European countries, a number of nickel deposits are located in France, Germany, Norway, Finland and England, etc. Cuba, Canada and the United States also have large reserves of metallic nickel [1; 173 p].

Nickel in nature is found in the form of such important minerals as: pentlandite - ($(FeNi)_9S_8$), nikcolite - (NiAs), annaberite - ($Ni(AsO_4)_2$), garnierite - ($Ni_4Si_4O_{10}$), revdinskite - ($(NiMg)_6Si_4(OH)_8$). The information presented in the reference book [2; 152 p.] says that world nickel production by year is (thousand tons/year): 1880 - 0.5, 1940 - 150, 1967 - 327, 1971 - 450, 1979 - 700, 1900 - 7.5. In developed countries and developing countries, since the 70s of the last century, there has been a certain gap between the volume of production and its demand. This discrepancy can be reduced to 20 % through the introduction of innovative technologies for processing raw materials and their waste.

There are two types of nickel ore in the world [3; pp. 76-79]:

1. Nickel ores ($nNiOSiO_2 \cdot MgOSiO_2$) are hydrated magnesium silicates. In them, nickel minerals occupy a small part of the ore mass in the form of bunseite (NiO), garnierite (Ni, $MgSiO_3 \cdot nH_2O$) and

revdinskite $(3NiMg)O•2SiO_2•2H_2O$. In oxidized ores, the copper content ranges from 0.01÷0.02%, nickel 0.7÷4.0 %, and cobalt - 0.04-0.16 %. they enter metallurgical processing after appropriate preparation (grinding and beneficiation process).

The largest reserves of nickel ores are found in Russia, Ukraine, Indonesia, Australia, Cuba, the USA, the Philippines, Brazil, Greece, etc. Japan can be considered the main producer of nickel, despite its territory there are no reserves of these ores.

2. The second form of ore is sulfide compounds of copper and nickel, consisting of an isomorphic mixture of Fe and Ni sulfides. Waste rock of nickel-containing ores mainly consists of Fe and Mg silicates, pyrrhotite – Fe_7S_8. Such ores contain only 0.3÷5.5 % Ni and 2.5 % Cu.

The largest reserves of copper-nickel ores are located in the areas of Norilsk, Taimyr, the Kola Peninsula (Russia), Canada and Australia. In Canada, INKO is a leading company engaged in the processing of copper-nickel ores.

In these deposits, copper-nickel ores are mainly presented in the form of pentlandite (Ni, Fe)S - an isomorphic mixture of Fe and Ni sulfides in a variable ratio.

To obtain pure nickel, its own waste is also used. In table Table 1 shows the reserves and main characteristics of waste containing the element nickel (Russia). The amounts of nickel-containing slag from ore furnaces and flotation tailings are discussed in [1; P. 173].

Table 1. Stocks and composition of nickel-containing waste

Name Waste name	Quantity (of waste Quantity of waste (orientedorientation)	Metal content, % by weight.				Resource Nickel resource, g / t
		Ni	Cu	A1	Fe	
Slag fromore-thermal furnaces	2.0-2.2 million g / t	0.07÷0.11	0.06÷0.01	5÷12	24÷30	1400÷2200
Flotation enrichment tailings	1.5-2 million g / t	0.70÷0.73	3.5÷4	0.1÷0.3	2.5÷3	6800÷14400
Spent catalysts	600 g / t	5.5÷8.0.0	-	90÷95	1.5÷2	30÷50
Electrolytic sludge	540 g / t	0.12÷0.15	0.48	-	0.5	0.6480÷0.81
Nickel plating waste	260 g / t	0.5÷0.1	--	-	0.1÷0.3	1÷2
Slags of oxidized ore	1.0÷1.5 million g / t	1.1÷1.8	0.18	6÷8	10÷16	1200÷2550

The technical characteristics of the catalysts are presented from the ammonia synthesis production of JSC “Корунд” и “Куйбышевазот”. Taking into account the bulk weight of the catalyst and the productivity of ammonia production, it is possible to determine the order of volumes and discharges of nickel-containing waste generated per year.

In Uzbekistan, nickel-containing catalysts of the brands НИАП -12-05 (48 % Ni), ГИАП -8 (6-10 % NiO), ReforMax (10-12 % Ni), НИАП -18 (11-12 % Ni) are used for methane conversion. , TO-2 (38-40 % NiO) and they are stored in warehouses of chemical enterprises. The total volume of NiO in these catalysts is 80 tons.

Methane conversion catalysts of the ГИАП -8, ГИАП -25, ГИАП -36Н brands are used to intensify the conversion process of gaseous hydrocarbons in endothermic tube furnaces - shaft converters, where the average temperature is 1030÷1050 °C. For the same purposes, they can be used for air conversion of liquefied gases (propane and propane-butane fraction). These grades are also used in the engineering industry for heat treatment of metal products and machine parts.

One of the important indicators of catalysis is the catalytic activity, expressed as the difference in the rates of one and several reactions, established without or with the participation of a catalyst. This indicator is a specific value, since it refers to a unit of mass, volume, concentration, and specific surface area of the catalyst.

Catalysts, in addition to their activity and selectivity, are characterized by stability, the feasibility of their industrial use in one or another process, which determines the service life of the catalyst. Every year, new catalysts are replaced with new ones, and they average 15-20 %. It should be noted that in many cases there is a possibility of special treatment of catalysts, the so-called regeneration process, as a result of which the catalyzers acquire their original properties. This allows them to be used repeatedly.

In the Russian Federation, catalysts are used to produce products that account for 15 % of gross domestic product. In the United States, this figure is already 30%.

To date, a catalyst for the steam conversion of hydrocarbons has been developed, including the active part, nickel, and an ammonium oxide carrier containing additional calcium oxide.

There is no production of nickel salts and nickel-based catalysts in the Republic. Due to the lack of own production, timely replacement of catalysts is not carried out, which will lead to a decrease in the performance of equipment, while the technical and economic indicators of production as a whole deteriorate.

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