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ANALYSIS OF THE CURRENT STATE AND PROMISING DEVELOPMENTS IN THE FIELD OF FERROUS METALLURGY**Poletskov P.,***DrSc (Eng.), Director of the Engineering Center, Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia.***Emaleeva D.,***PhD (Eng.), Junior Researcher, Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia.***Gulin A.,***PhD (Eng.), Junior Researcher, Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia.***Kuznetsova A.,***Junior Researcher, Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia.***Alekseev D.***Research Engineer, Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia.***DOI: 10.24412/3453-9875-2021-71-68-73****Abstract**

The paper presents the results of the analysis of the current state of the world ferrous metallurgy. Topical problems in the area under consideration are identified, including: a general decline in production and a decrease in demand for metal products in the world market, an excess of production capacity in the metallurgical industry, as well as an increase in protectionism. Special attention is paid to the developments of Russian scientists in the field of creating promising materials for extreme operating conditions.

Keywords: ferrous metallurgy, steel, state of the art, promising developments.

Metallurgy is one of the leading sectors of the world economy, an instrument for ensuring national security, a source of employment and income for a significant part of the population. This is confirmed by the

information of the international metallurgical association World Steel Association (Worldsteel) on the contribution of metallurgy to the world economy (table 1).

Table 1

Information on the contribution of metallurgy to the world economy

№ п/п	Index	Value
1	Share of metallurgy in GDP, including related areas, %	3,8
2	The number of jobs in related fields due to the creation of 1 job in metallurgy, pcs	14,7
3	How much \$ 1 GDP in metallurgy creates in related industries, \$	4,8
4	The share of metallurgy in the total number of employees, including related industries,%	2,9

One of the main indicators of the affective activity of ferrous metallurgy is the amount of smelted steel. Figure 1 shows the results of the analysis of global steel production in the period from 1950 to 2020.

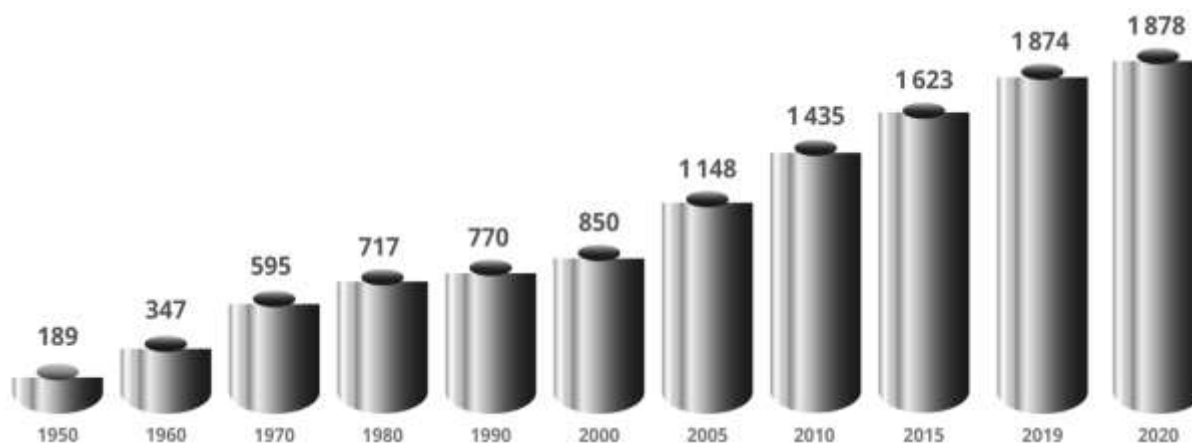


Figure 1 - World crude steel production 1950 to 2020 (million tons)

(source: Worldsteel)

As shown in Figure 1, in the period since 1950 there has been a steady trend towards an increase in the volume of steel production on a global scale. At the same time, at the end of 2020, the world leaders in steel smelting were China, India and Japan, the USA and Russia (Table 1).

Table 1

Top 10 steel-producing countries 2020

№	Country	Annual production, million tons
1	China	1064,8
2	India	100,3
3	Japan	83,2
4	USA	72,7
5	Russia	71,6
6	South Korea	67,1
7	Turkey	35,8
8	Germany	35,7
9	Brazil	31,0
10	Iran	29,0

As follows from table 1 and the statistics of the Worldsteel association, over the past decade, China remains the world leader in steel production (Figure 2).

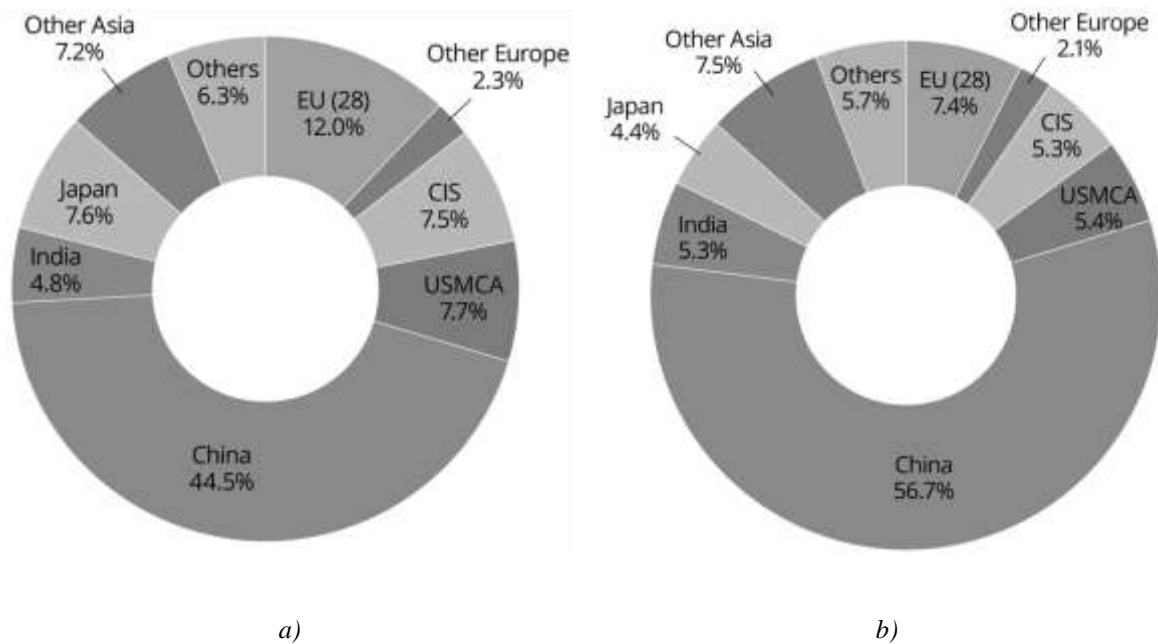


Figure 2 – Crude steel production and use: geographical distribution in 2010 & 2020
a – 2010 z.; b – 2020 z.

(source: Worldsteel)

The Worldsteel Association has prepared a rating of the largest metallurgical companies that smelted more than 3 million tons of steel in 2020. The indicated rating includes 107 manufacturers from 21 countries of the world. In terms of the number of representatives, the leaders of the rating are Chinese companies, which

took 64 places in it. In addition to representatives from China, the rating includes two companies from Japan and South Korea and one from Luxembourg, India, the United States and Iran. Information on the Top 10 global steel producers in 2020 is shown in Table 2.

Table 2

Top 10 Global Steel Producers in 2020

No	Manufacturer	Country	Annual production, million tons
1	China Baowu Group	China	115,29
2	Arcelor Mittal	Luxembourg	78,46
3	HBIS Group	China	43,76
4	Shagang Group	China	41,59
5	Nippon Steel Corporation	Japan	41,58
6	Posco	Korea	40,58
7	Ansteel	China	38,19
8	Jianlong	China	36,47
9	Shougang	China	34,00
10	Shandong Steel Group	China	31,11

In the course of analyzing the current situation, special attention should be paid to the problems in the field of the world ferrous metallurgy. As an example, the following should be noted:

1. General decline in production and decrease in demand for metal products in the world market. This is one of the consequences of the COVID-19 pandemic and the unprecedented crisis in the global economy. In 2020, in the largest developed countries of the world, the decline in GDP was much more significant than during the global financial crisis of 2008–2009, and in a number of countries it became a record for the entire post-war history [1].

2. Excess production capacity in the metallurgical industry. In world practice, there is an excess of pro-

duction capacity in all major segments of steel and metallurgical production. In particular, the world's steelmaking capacity is designed to produce 2.3 billion tons of steel, and the annual steel output is about 1.7 billion tons [2].

3. Strengthening protectionism, including in the metallurgical industry. In recent years, the metals industry has faced a number of trade restriction measures. More and more countries are using various measures to combat unfair competition that restrict the import of metal products. This leads to a distortion of competitive advantages, volatility in prices for metal products, increased competition in barrier-free markets, as well as a decrease in global economic growth [3].

As for Russia, the metallurgical industry is the basic industry that determines the development of

many industries. In terms of iron ore reserves, Russia ranks third in the world, behind only Australia and Brazil. The amount of proven reserves of iron ore reaches 25 billion tons, which in terms of pure iron is 14 billion tons [4]. At the end of 2020, the contribution of metallurgy to Russia's GDP amounted to 4.9%.

According to the data of the Federal State Statistics Service, metallurgical production in Russia has experienced an upsurge over the course of 5 years (Figure 3). An exception is the insignificant drawdown in 2017 [2].

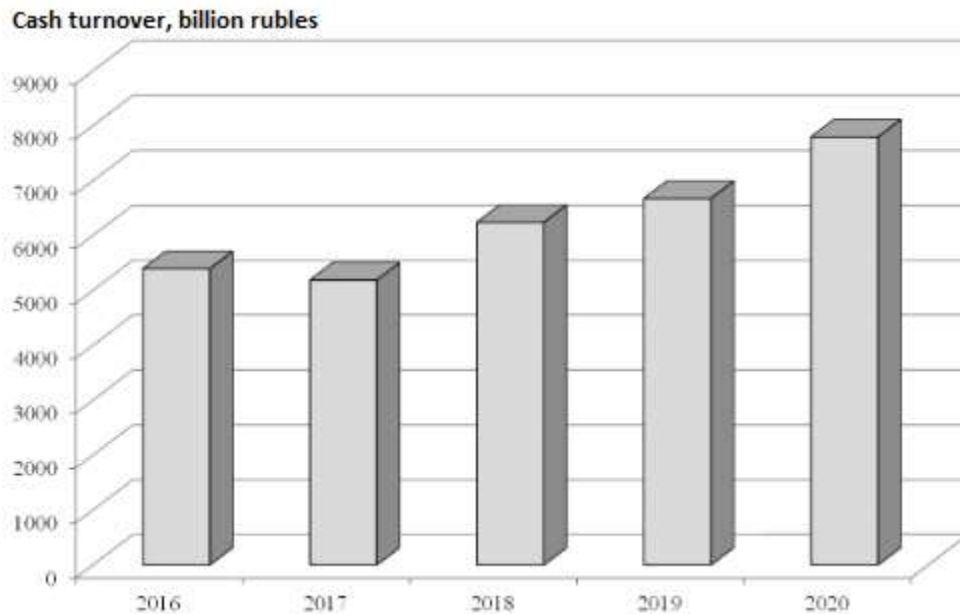


Figure 3 - Turnover of metallurgical production in Russia

At the end of 2020, the volume of steel production in Russia amounted to more than 70 million tons. This corresponds to the 5th place in the ranking of world leaders in steelmaking. At the same time, the leading companies were (Figures 4, 5) [6 - 11]:

- Group of companies PJSC "Novolipetsk Metallurgical Plant" (PJSC "NLMK" - 22nd place in the world in terms of steel production;
- Holding "EVRAZ" - 30th in the world in terms of steel production;

- PJSC Magnitogorsk Iron and Steel Works (PJSC MMK) - 37th in the world in terms of steel production;
- PJSC Severstal - 40th in the world in terms of steel production;
- LLC UK Metalloinvest - 72nd place in the world in terms of steel production);
- PJSC Mechel - 96th place in the world in terms of steel production). PJSC Mechel Group of Companies.

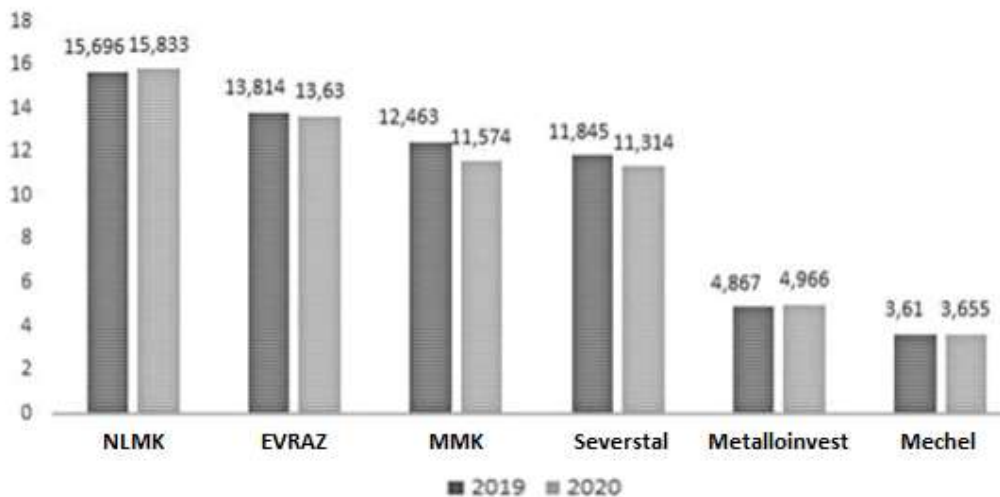


Figure 4

Dynamics of steel production by companies - leaders of the Russian ferrous metallurgy (in million tons)

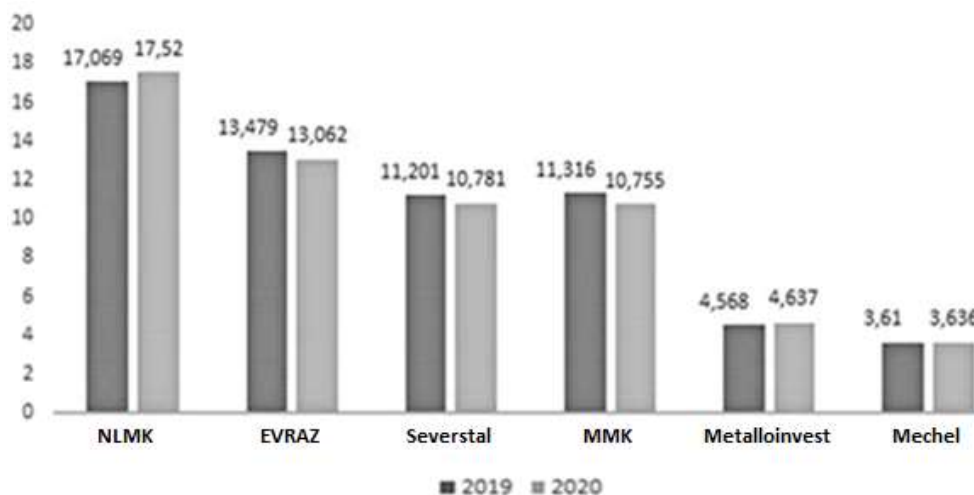


Figure 5 - Dynamics of sales volumes
companies - leaders of the Russian ferrous metallurgy (in million tons)

As it follows from Figures 4 and 5, despite the global economic crisis and the unprecedented recession in the global economy caused by the COVID 19 pandemic, the Russian metallurgical industry performed well.

Currently, the largest share of ferrous metallurgy products falls on [3]:

- finished rolled products (60.5 million tons),
- unalloyed steel (58 thousand tons)
- pig iron (52.1 thousand tons).

Examples of priority products of ferrous metallurgy, planned for production in the future, are shown in Table 3 [12].

Table 3

Target values of production volumes of priority products of the ferrous metallurgy in Russia by 2035

№	Product type	Target values, thousand tons
1	Steel smelting by type	92690,1
2	Sheet metal	40609,5
3	Long products	34133,3
4	Cold rolled sheet products	18395,2
5	Coated sheet products	9633,3
6	Steel tubes	18150

According to the materials of the meeting of the Presidium of the Russian Academy of Sciences, Russian scientists make a significant contribution to the development of the metallurgical industry and to the development of new materials and products from them [4]. At the same time, one of the priority tasks is to provide conditions for the development and sustainable development of the Arctic zone of the Russian Federation - an object of territorial, resource and strategic interests of a number of states, influencing the development of the world economy and energy in the coming decades. The peculiarities of the Arctic climate consist in the long-term impact on the material of low temperatures,

significant wind loads, high humidity, etc. The combination of the above factors gives particular severity to the Arctic climate [13].

An example of a promising development of Russian scientists in this direction is rolled metal made of multifunctional materials with a unique combination of high strength, ductility, and wear and cold resistance at temperatures down to minus 70 ° C. At present, a set of works on the organization of high-tech production of the metal products in question is being carried out by scientists of the FSBEI HE NMSTU on the initiative of PJSC "Magnitogorsk Iron and Steel Works" [14]. The main characteristics of the products being developed are shown in Table 4.

Table 4

Main characteristics of the developed types of products

Main characteristics	Rolled metal products from multifunctional materials				
	Type 1	Type 2	Type 3	Type 4	Type 5*
Tensile strength, MPa	580-950	950-1200	1200-1500	≥ 1500	≥ 750
Yield strength, MPa	≥ 500	≥ 800	≥ 950	≥ 1100	≥ 700
Relative extension, A ₅ , %	≥ 20	≥ 14	≥ 13	≥ 10	≥ 12
Relative extension, A ₅₀ , %	≥ 22	≥ 15	≥ 14	≥ 12	≥ 14
Hardness, HBW	160-280	280-350	350-450	450-570	230-320
Impact energy, KV, Дж	≥ 80	≥ 40	≥ 30	≥ 20	≥ 40
at a temperature, t, °C	- 70	- 70	- 70	- 70	- 40

* Material resistant to atmospheric corrosion

Materials with the specified characteristics can be simultaneously used for the manufacture of the following objects, operated, including in the conditions of the Far North and the Arctic:

- load-bearing welded frame structures;
- details of assemblies, frame and hull elements of a wide range of equipment;
- units subject to intense wear.

It should be noted that, in the opinion of experts in the area under consideration, in the future, the following factors will contribute to an increase in the competitiveness of metallurgical production [3]:

- growth in the volume of production with an increase in the depth of processing;
- increasing the efficiency of using raw materials and energy resources;
- increasing labor productivity;
- improving the quality of products, including through the development of new technologies.

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