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Research paper

Current State and Perspectives of Ferrous Metallurgy Development in Russia

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Abstract

The current state of ferrous metals' market is characterized by intensive development; the metallurgical production in several Asian countries has taken the leading position in the world; and metallurgy in the USA, Germany and Russia faces strong pressure from manufacturers of metals in Asian countries. The metallurgical complex in Russia is experiencing the period of its reconstruction: the time-consuming open-hearth steelmaking has been virtually deleted in the country, electrometallurgy is developing slowly, especially production of steel in induction furnaces, the amount of rejects in rolling is significant, and production of rolled products is still insufficient.
The key changes in metallurgy are observed in rolling production. High quality finishing of metal allows to reduce the overall amount of rejects in metallurgical production, improve the interest of the market in the produced metal, and increase the export potential of the Russian metallurgy.
The reduced production in the engineering industry after 1990 had the most negative impact on the development of Russian ferrous metallurgy. An important element that contributes to improving the economic efficiency through the activity of the metallurgical complex is more uniform placement of production across the country, particularly development of metallurgy in the Far East Federal District.

Keywords: *ferrous metals' market, manufacturers of ferrous metals, production of certain kinds of rolling, blast furnace production in Russia, coke oven production in Russia, powder metallurgy, development of the machine building complex in Russia.*

1. Introduction

Ferrous metallurgy companies in most industrial countries are rapidly developing, the utmost attention is paid to development of rolling production, the technology of secondary steel making, powder metallurgy, and introduction of petroleum coke. New technologies are also mastered by Russian metal producers. However, in our country the technological reequipment is developing at a slower pace than in China, South Korea, or Japan. An important task of the economical science is disclosing the reasons for the backlog in introduction of technical reconstruction and studying the optimal ways of optimizing the activities of enterprises in the metallurgical complex. This article is focused on achieving these goals.

2. Methods

The research was based on the following methods of economic analysis – the method of comparative analysis, the method of averages, the tabular method, and the method of typological grouping.

3. Results

The market of ferrous metals in the world is continually developing [10, 17, 20, 21]. Powerful invasion of Asian economies has changed the geography, but has not influenced the direction of its development, the market still needs sheet metal with surface hardening, stainless steel rolled material, and structural steel [2, 15, 17, 19]. The main consumers of rolled materials are still construction industry and car-making industry [2, 17, 21, 22].
Steel production in the world in 2010–2016 is shown in Table 1.

Table 1: Steel production in the leading producing countries [26, 27] (million tons)

No.	Country	2010	2015	2016
	All world countries	1,413.6	1,620.4	1,628.0
1	China	626.7	803.8	808.4
2	Japan	109.6	105.2	104.8
3	India	68.3	89.6	95.6
4	USA	80.6	78.9	78.6
5	Russia	66.9	71.1	70.8
6	South Korea	58.5	69.7	68.6
7	Germany	43.8	42.7	42.1
8	Ukraine	33.6	22.9	24.2
9	Brazil	32.8	33.3	30.2
10	Turkey	29.0	31.5	33.2

Dominating in the world market of ferrous metals, China, South Korea, India, and Turkey are increasing their production. Japan, although it somewhat reduced production of steel, remains a sure leader in high-quality steel production, and is modernizing its blast-furnace and steelmaking production in parallel [10, 22, 29]. The US market also retains its positions.
The position of Russia in the world's metallurgical market has also remained stable, moreover, modernization of steel making has been undertaken in our country, the open hearth furnaces have

been virtually removed from production, and electrometallurgy is developing [17, 19, 24, 32].

Let us look at the structure of steel production in Russia (Table 2).

Table 2: Steel production by types [26, 27] (million tons)

No.	Steel type	2010	2014	2015
1	Steel (total)	66.8	70.5	69.4
	including cast slabs and cast sections, produced:			
2	- in open-hearth furnaces	4.6	1.9	1.7
3	- in converters	42.4	46.8	47.2
4	- in electric furnaces	19.1	21.2	19.9
	cast slabs and cast section produced			
5	- in vacuum-induction furnaces	0.005	0.006	0.004
6	- in plasma-arc furnaces	0.7	0.8	0.6

Converter steelmaking remains the main technology [12, 17, 28, 33]. Production of electric furnace steel [17, 19, 24, 29] amounts to 1/5 of the total production and, which is especially important, production of metal in vacuum-arc furnaces [15, 19, 29, 32] that provides the most pure metal is almost not growing. With these technologies, growing importance is attached to secondary steelmaking [17, 19, 29] and continuous casting. Speaking of steel production, one can note that reconstruction of steel making production had been undertaken in the past decade [1, 7, 16, 24], but later, this process stalled, and today the Achilles' heel of Russian metallurgy is rolling production.

The structure of the manufactured rolled products (Table 3) [2, 8, 17, 24, 28, 35], with insignificant changes, retains old birthmarks of the Soviet metallurgy, when total production, production of bar products and high level of rejects fully characterized domestic ferrous metallurgy [2, 7, 16, 17, 19].

Table 3: Production of certain types of metallurgic products [26, 27] (thousand tons)

No.	Product name	2010	2015	2016
1	Cast slabs and cast sections produced in inverters	42,407	47,194	46,454
2	Cast slabs and cast sections produced in electric furnaces	19,122	19,920	21,548
3	Stainless steel flat-rolled and hot rolled products	39.9	22.6	33.6
4	Stainless steel flat-rolled products and wide cold-rolled band with the width not less than 600 mm	21.2	4.8	4.6
5	Hot rolled hot-drawn bars	36.9	29.0	28.1
6	Rails made of ferrous metals, including current-carrying rails	954	855	1259
7	Flat cold rolled coated steel with the width not less than 600 mm	3,622	5,445	5,244
8	Angles, metal profiles	189	100	113.8
9	Cold drawn stainless steel bars	32.4	6.7	11.6
10	Shaped angles and construction iron or stainless steel	837	1,369	1,334
11	Corners, shaped and special profiles made of stainless steel	14.4	45.4	64.4
12	Cold drawn bars made of iron or stainless steel (other)	140	91.4	103
13	Flat-rolled steel, with the width less than 600 mm, uncoated	660	583	494
14	High-strength drill pipes	30.6	39.4	45.1
15	High-strength casing pipes	281	401	542
16	High-strength bumping and compression pipes	168	167	185

Production of valuable products like flat rolled steel and wide cold-rolled stainless steel band with the width of not less than 600 mm, cold drawn stainless steel bars, hot-rolled bars, hot-drawn bars has been significantly reduced [2, 11, 21, 28, 29, 35]. The production of flat-rolled products, hot-rolled stainless steel products, angles and profiles shapes, cold rolled bars made of iron and stainless steel, flat-rolled steel with the width of less than 600 mm, uncoated high-strength drill pipes remains stable. Thus, production of rolled steel shows its stability, while the world today requires intensive changes [8, 24, 34, 35].

4. Discussion

Let us have a look at the qualitative characteristic and the technical and economic indicators of metallurgy (Table 4).

Table 4: Qualitative characteristic, and the technical and economic indicators in metallurgy [26, 27]

No.	Indicator name	2010	2015	2016
1	Specific weight of cast bars and cast sections produced in converters and electric furnaces, in the total amount of produced steel (percent)	92.0	96.7	97.4
2	Finished steel to produced steel ratio (percent)	82.3	87.1	86.6
3	Specific weight of rolled steel (uncoated) in the total amount of finished steel production (percent)	44.4	45.9	45.6
4	Specific weight of cold rolled steel in the total amount of rolled steel production (percent)	26.9	29.8	29.1
1	Specific power consumption for coal production (kilowatts per ton)	26.8	14.9	14.7
2	Specific power consumption for production of electric steel (kilowatts per ton)	714.1	561.7	-
3	Specific power consumption for production of finished ferrous roll material (kilowatts per ton)	151.7	137.2	128.8
1	Specific consumption of conditional fuel for production of cast iron (kg/ton)	578.0	544.4	545.1
2	Specific consumption of conditional fuel for production of finished ferrous rolled products (kg/ton)	136.4	74.9	73.5

The data in Table 4 show that qualitative improvement of metallurgical production in our country is slow. Blast furnace production still remains the main method of production [16, 20, 32, 35]. The main material for steel production is cast iron, scrap metal takes a relatively modest place in the resource base of steel making [1, 3, 11, 12]. Finished steel production grows, but slowly. It is accompanied by high level of rejects [16, 17, 19, 21]; during the production of rolled steel, the share of rejects in some cases reaches 50% of the total amount, while in the metallurgy of Germany and the USA this indicator has decreased to 3%. Low level of secondary steel making also affects the quality of metal. Petroleum coke [11, 14, 24] is still not widely enough used in metallurgical production; its consumption should be increased three times; the quality of coal coke is also inferior to that of foreign analogs.

Specific energy consumption in steel and cast steel production has been gradually decreasing, which indicates technological progress in the industry [3, 12, 15, 17], however, the problem is mostly expanding production of electric steel in induction furnaces.

Significant reduction in fuel production by 46.2% over 6 years in rolled ferrous metals' production [17, 19, 24, 28] is an undoubted evidence of the technological progress in rolling production.

Assessing functioning of the ferrous metallurgy in Russia in 2010–2016, one can draw a conclusion that, despite the "inertia of bulk production" accumulated in the 30ies of the XXth century, when booming engineering and capital construction required as much metal as possible, and machine-building enterprises operating in three shifts could allow labor-consuming stripping works in blank production, modern metallurgy in our country slowly turns to quality metallurgy [2, 8, 22, 27, 35], rolled sheet metallurgy, production of exact structural metal with minimum clearances, and powder metallurgy.

Let us have a look at the spatial changes that characterize recovery of metallurgic complex enterprises in our country (Tables 5, 6) [2, 12, 17, 24]

Table 5: Production of steel, rolled metal steel, and pipes by federal districts [26, 27] (million tons)

Federal district	Steel production in 2010	Steel production in 2014	Steel production in 2015	Production of finished rolled steel in 2010	Production of finished rolled steel in 2014	Production of finished rolled steel in 2015	Production of steel pipes in 2010	Production of steel pipes in 2014	Production of steel pipes in 2015
Russian Federation	66.8	70.5	69.4	55.0	61.2	60.4	9.2	11.3	11.4
Central Federal district	12.9	17.2	17.7	12.1	15.7	16.2	0.6	0.7	0.7
North-Western Federal district	11.4	11.1	11.2	9.7	10.1	10.2	0.9	1.2	1.4
Southern Federal district	3.2	3.9	3.7	0.4	1.9	1.6	2.2	2.5	2.4
North Caucasian Federal district	0.8	0.8	1.2	-	0.03	0.02	0.001	0.05	0.009
Volga Federal district	5.2	3.5	3.6	4.8	4.4	4.8	2.4	2.3	2.7
Urals Federal district	24.9	26.4	25.4	19.6	21.6	20.5	3.1	4.1	4.0
Siberian Federal district	8.5	7.7	7.3	7.7	6.9	6.6	0.1	0.3	0.2
Far-Eastern Federal district	0.7	0.6	0.5	0.7	0.6	0.5	-	0.0	0.0

Table 6: Shares of federal districts in the production of steel, rolled steel, and steel pipes [26, 27] (percent)

Federal district	Steel production in 2010	Steel production in 2014	Steel production in 2015	Production of finished rolled steel in 2010	Production of finished rolled steel in 2014	Production of finished rolled steel in 2015	Production of steel pipes in 2010	Production of steel pipes in 2014	Production of steel pipes in 2015
Russian Federation	100	100	100	100	100	100	100	100	100
Central Federal district	19.30	24.39	25.50	22.00	25.65	26.82	6.52	6.19	6.14
North-Western Federal district	17.07	15.74	16.14	17.64	16.50	16.88	23.90	10.62	12.28
Southern Federal district	4.79	5.53	5.33	0.72	3.10	2.65	23.91	22.12	21.05
North Caucasian Federal district	1.19	1.13	1.73	-	0.05	0.03	0.01	0.44	0.08
Volga Federal district	7.78	4.96	5.19	8.73	7.19	7.95	26.09	20.35	23.60
Urals Federal district	37.27	37.45	36.59	35.64	35.29	33.94	33.69	36.28	35.09
Siberian Federal district	12.72	10.92	10.52	14.00	11.27	10.93	1.09	2.65	1.75
Far-Eastern Federal district	1.05	0.85	0.72	1.27	0.98	0.83	0.0	0.0	0.0

Production is dominated by enterprises in the Central, Urals, North-Western, and Siberian federal districts, which together provide 88.75% of the total production; rolled steel production [88.57%] is also concentrated in these districts. It should be noted that enterprises in the Volga District produce about 1/4 of steel pipes. This geography is the evidence of the fact that metal is to be imported into the southern and eastern regions of the country [2, 4, 8, 27, 35]. Since the main share of Siberian steel and rolled steel is produced in Western Siberia, one can easily access the amount of transportation costs. It is necessary to develop the metallurgical industry in the Far East and Eastern Siberia; as to the Northern Caucasus, it is necessary to develop engineering, instrument manufacturing, and electronic industry in the region, given the high level of unemployment. Therefore, the amount of metal produced in the region should also be increased.

In recent years, metallurgy has been developing, and the production capacities have been growing, though slowly [2, 6, 13, 22, 27]. Let us illustrate this process with the indicators in Table 7.

Table 7: Commissioning of production capacities [26, 27] (in physical terms)

No.	Commissioned production capacities	Unit of measurement	2010	2013	2014
1	Steel production capacities	million tons	0.31	2.11	1.46
2	Rolled ferrous metals' production capacities	million tons	0.6	0.3	1.3
3	Steel pipes' production capacities	million tons	0.64	-	0.06
4	Continuous casting capacities	million tons	1.70	-	1.40

It should be noted that in 2013 and 2014, steel production capacity continuously increased [2, 7, 9, 22, 24, 31]. The introduction of continuous casting facility in 2010 and in 2014, and the increasing rate of capacities' growth in rolled metal production have also been important for the technical progress in the industry. These events indicate the fact that recovery of the industry continues, though it has been slowed down.

Let us look at the influence of the mechanical engineering complex on metallurgy development. Mechanical engineering is the second most important industrial consumer of steel products after civil construction [2, 5, 10, 20, 22, 23, 30, 33].

Heavy and transport mechanical engineering, automotive industry and agricultural mechanical engineering are the largest consumers of metal. However, in today's Russia, mechanical engineering enterprises are in a deep crisis [2, 18, 22, 25, 33]. Table 8 shows the data about operation of the mechanical engineering industry in 1990–2016.

Table 8: Production of main types of machinery and equipment [26, 27]

No.	Name of equipment	Unit of measurement	1990	2010	2016
1	Power turbines	million kW	12.5	9.2	3.6
2	Tunneling machines	pcs	406	54	33
3	Metal-cutting machines	thousand pcs	74.2	2.0	3.4
4	Forging press machines	thousand pcs	27.3	2.2	3.2
5	Passenger cars	thousand pcs	1103	1210	1215
6	Trucks	thousand pcs	665	156	128
7	Locomotives (diesel locos)	sections	46	33	167
8	Locomotives (electric locos)	pcs	-	19	-
9	Long-distance freight cars	thousand pcs	25.1	50.5	28.7
10	Wheel tractors	thousand pcs	92.6	6.9	5.5
11	Combine harvesters	thousand pcs	65.7	4.3	4.4

Table 8 shows that the production of most types of mechanical engineering products decreased 5 to 10 times [2, 26, 27]. Metal consumption decreased correspondingly. It can be said that the stabilization and the export orientation of the Russian metallurgical complex are largely due to the decline of domestic engineering.

5. Conclusion

The research has shown that today the world's metallurgy is experiencing hard times, and increased costs in the metallurgy of China had negative impact on the development of the market of ferrous metals. Ferrous metallurgy in Russia is in the state of stagnation due to both external and domestic factors. The retrofitting undertaken in the early 2000s had positive effect, but today its potential is exhausted, and new significant investments (first and foremost) are required into the rolled steel production; the amount of rejects in it being still very high. Stagnation in Russian mechanical engineering has the most negative effect on the development of ferrous metallurgy, since the amount of orders from mechanical engineering companies keeps reducing, which inevitably results in curtailment of ferrous metals' production in the country.

Competition with Chinese, Korean, Indian, Turkish, and Brazilian metallurgy increased sharply, along with remaining competition with the metallurgy in the USA and Japan. The production of sheet rolled metal, precisely calibrated billets, rolled metal with surface hardening and secondary steelmaking technologies develop slowly.

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