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Pitch Coke Market Research in the CIS

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Summary

This report contains research of current condition in pitch coke market of the CIS countries and forecast of its development. The report consists of six parts, contains 67 pages, including 25 figures, 37 tables and 2 appendices. This work is a desk research. As information sources we used data of the Federal state statistics service of the Russian Federation (FSSS of the Russian Federation), the State statistics committee on the CIS countries, Federal customs service of the Russian Federation (FCS of the Russian Federation), the official statistics of railroad transportation of the Russian Federation, the trade and regional press, annual and quarterly accounts of emitters of securities, and also Internet sites of manufacturers and consumers.

The Report's **First Chapter** presents features of raw materials required for manufacture of pitch coke, their characteristics. In addition, this chapter reviews methods and peculiarities of pitch coke production.

The **Second chapter** of the report is devoted to manufacture of pitch coke in the CIS countries (Russia, Ukraine). In this section of the report cites data on process flow of this production in 1994-2009 at the enterprises of the CIS. In addition, a part of chapter is devoted to description of current condition of the main manufacturers of pitch coke in the CIS where, inter alia, the information about their deliveries is cited.

The **Third chapter** of the report deals with pitch coke foreign trade operations in Russia (1994-2009) and in Ukraine (1999-2009).

The **Fourth chapter** analyses data on changes of the export-import prices on pitch coke in Russia (1994-2009) and in Ukraine (2001-2009), and gives level of current domestic pitch coke prices.

The **Fifth chapter** of the report considers consumption of pitch coke in Russia. This section examines balance of manufacture and consumption of pitch coke (1994-2009) as well as industrial structure of consumption; gives main Russian consumers (with consumption volumes in 2003-2009): examines status and prospects of development for the largest enterprises-consumers (aluminium and electrode factories).

The **sixth** final chapter of the report results pitch coke manufacture outlook in Russia and in Ukraine, and pitch coke consumption forecast in Russia until 2015.

Contact information on manufacturers and consumers of pitch coke in the CIS could be found in appendices.

Introduction

Target issue of this study is the market of coal tar pitch. It comprises big enough number of participating enterprises, which belong to various branches of industry (coal-mining, ferrous- and non-ferrous metallurgy).

As is known, the processing of coking coal is carried out by the coke plants, which belong to ferrous metallurgy branch. They obtain coking coal from the coal-mining industry enterprises.

Coal tar pitch that is produced on chemical-recovery enterprises is the raw material for production of pitch, part of which is used for production of pitch coke. It is the principal raw material for production of anodic paste, graphitized electrodes, various carbonic engineering materials, which are produced at the enterprises of non-ferrous metallurgy (electrode and aluminium works).

The scale of production of pitch and pitch coke principally depends on the output of pitch and coal tar while their volume, in its turn, depends on the supply of metallurgical coke consumed in pig-iron production.

Thus, the volume of production of coal tar, pitch and pitch coke makes the by-product coke plants to play the leading part in supplying carbonic raw materials for non-ferrous metallurgy enterprises, without which supply no commodity output can be obtained. However, the production of tar coal, pitch and pitch coke is a by-product process, and depends on the volume of production of metallurgical coke.

According to the analysis of trends in ferrous metallurgy, blast-furnace process will be keeping its importance in spite of the development of alternative technologies (e.g. direct reduction of iron) for quite a long period. This, in its turn, will make for keeping the demand for metallurgical coke, at the least, which can only partially be substituted by other fuel in the blast-furnace process.

On the other hand, a rise in consumption of pitch is observed, especially taking into consideration the fact that there is no possible substitute for pitch. The need to match pitch demand restrains its production. The role of pitch coke is lower, in its turn, since it could be substituted by petroleum coke. That is why the growth rate of metallurgical coke production may not correspond to the possible growth of consumption of pitch and pitch coke.

1. Raw Materials and Quality Requirements for Pitch Coke Production

1.1 Raw materials for pitch coke production

Pitch is raw material for pitch coke fabrication. Pitch itself is the main product from treatment of coal tar obtained at by-product coke plants. Pitch is obtained in the process of treatment of coal tar at tar-processing shops. There is 17 such kind of shops in the territory of the CIS.

Pitch coke production needs high-temperature pitch (softening temperature over 100 C^0). Medium-temperature pitch is subjected to thermal treatment in still-reactors (their number at operating ventures varies from five to eight units) to obtain pitch coke. Domestic by-product coke industry boasts prevalence of bubbling still-reactors of vertical tar-still design. Thereby yield of high-temperature pitch nears 85-87%.

Quality of high-temperature pitch for production of pitch coke is regulated by GOST 1038-75 demanding softening point of 135 – $150C^o$, yield of volatiles below 51%, ash content below 0.2 points.

By-product coke plants in the CIS manufacture high volume of high-temperature pitch while just as intermediate product in pitch coke production. Characteristics of high-temperature pitch from some the CIS enterprises are presented in Table 1.

Table 1: Characteristics of High-Temperature Pitch Produced in the CIS

Enterprise	Softening temperature, C^o	Fraction content, %		Yield of volatiles, %	Cake residue, %
		α1	α 2		
“Zaporozhe Coke”	140	29.6	17.2	50.5	64.2
“Sever Steel”	142	30.3	18.4	48.8	66.3
“Mittal Steel Temirtau”	140	30.5	14.0	54.6	60.8

Source: analysis of articles published in the “Coke and Chemistry” journal

1.2 Technology of Pitch Coke Production

The basic technology for pitch coke production in the former USSR belongs to carbonization of high-temperature pitch in special silica furnaces. These furnaces enjoy some design differences against coal carbonization kilns due to better sealing of coking boxes masonry, larger dimensions of gas-outlet holes in box bridging etc. From the coke side, the temperature is maintained at the level of 1,260-1,340 C^0. Pitch loading (18.5-19 tons) is carried out through either one or two feeding openings.

Table 2 presents production parameters of pitch coke.

Table 2: Process-dependent parameters for Pitch Coke Production in the CIS
(averaged among enterprises)

Parameter	Box carbonization
Yield of medium-temperature pitch from coal tar, %	59
Yield of raw pitch coke from medium-temperature pitch, %	78.1
Yield of raw pitch coke from coal tar, %	46.1
Tare of volatiles in raw pitch coke, %	0.6
Yield of coke crumb at raw pitch coke unloading, %	
< 6 mm	-
< 10 mm	2
Yield of commodity raw pitch coke from medium-temperature pitch, %	76.9
Yield of burnt pitch coke from raw pitch coke at dry-quenching unit, %	76.8
Yield of roasted pitch coke from coal tar, %	45.3
Yield of commodity roasted pitch coke from coal tar, %	44.6
Design parameters of pitch coke production (per 1 ton of primary material)	
Vapor, MJ	1.26
Electric power	25
Water, m^3	2

Source: analysis of articles published in the "Coke and Chemistry" journal

Pitch coke output from coke-pitch oven is usually cooled by means of wet quenching method and than is delivered to the consumer, where it is roasted at a temperature of 1,300 C^o in special ovens, which leads to considerable loss of pitch coke.

Experts at "Giprokoks" institute have developed and introduced a method of pitch coke roasting followed by dry quenching. Such a unit for dry quenching of pitch coke (USTPK) is used at the by-product coke shop of OJSC "Sever Steel". The experience of operating the unit showed its effectiveness and brought to light the following advantages: low coke loss level at baking (2-3%), lowering air pollution, excluding the necessity of sizing the pitch coke, and using heat from hot coke for baking.

In spite of the found USTPK advantages and high quality of baked pitch coke produced at the enterprise, the method of dry quenching of pitch coke does not have further expansion and the rest of enterprises as usual keep producing raw pitch coke.

At present, there are seven pitch-coke shops in the CIS with capacity from 80,000 to 140,000 tpa of pitch coke. All these shops are equipped with typical process outlay, which includes the following stages:

- secondary preparation – producing high-temperature pitch from medium-temperature one, heavy pitch distillates and pitch tar;
- carbonization of the high-temperature pitch to produce pitch coke, pitch-coke gas and pitch tar;
- cooling of pitch coke gas and condensing vaporous products of carbonization along with isolating of pitch coke tar.

Loading of liquid pitch into pitch-coke ovens has become specific feature of production at the CIS enterprises in recent years.

Tables 3 and 4 present quality characteristics of pitch coke produced at the CIS enterprises.

Table 3: Characteristics of Pitch Coke Produced at Russian Enterprises

Characteristic	NTMK	ChMK	Sever Steel	NLMK
Density, g/cm^3	2.0	1.99	2.01	2
Ashes, %	0.27	0.27	0.28	0.3
Total sulfur, %	0.26	0.26	0.27	0.27
Yield of volatiles, %	0.8	0.7	0.8	0.7
p of original coke, mcOm.m	515	780	540	635
p of baked coke, mcOm.m	400	440	415	435
Structural strength, J/m^2	1310	1300	1280	1410
Wearability, %	2.5	2.9	2.2	1.4
Microstructure, number	2.2	2.2	2.5	2.4
Graphitization degree, %	62	64	63	60
Volume change (in the range of 1300-2400 degree)	2.72	2.75	2.67	2.94

Source: data from OJSC "Uglerodprom"

Table 4: Characteristics of Pitch Coke Produced at Ukrainian Enterprises (average readings)

Characteristic	OJSC “Avdeyevka Coke Chemical Plant”	OJSC “Zaporozhe Coke”
Density, g/cm^3	1.953	1.997
Yield of volatiles, %	0.63	0.35
Chemical composition		
C	97.95	98.04
H	0.43	0.33
S	0.65	0.63

Source: analysis of articles published in the “Coke and Chemistry” journal

Standard technology of pitch box carbonization in assembled silica ovens designed as analogue to layered coal charge carbonization, during the previous half century was subject to significant but not principal improvement. In particular, silica refractory materials replaced chamotte leading to two-fold expediting coking process.

Nevertheless, this technology, used in the CIS, has some weak points that are difficult (or practically impossible) to eliminate. First, we should mention short lifetime of pitch coke ovens (from 2 to 10 years). Such low performance could be explained with several reasons: carbonization of refractory materials with subsequent failure of oven camera geometry and its separate zones; low level of operation due to difficulties in maintenance of processing equipment; low level of equipment automation.

Another essential drawback of the box-coking process is large emission of harmful substances.

In other countries, box-coking technology for pitch coke fabrication is extremely rare.

Studies by Coal Chemical institute (UKhIN) showed that the CIS countries’ method of pitch electrode coke manufacture was realized at non-optimal conditions, as carbonization process is carried out in non-isothermal environment and at high speed of temperature changing. The composition of raw material for box coking (high-temperature pitch with high content of quinoline insoluble substances) restricts acquisition of coke with high anisotropy degree (acicular).

That is why the experts of UKhIN in late 1980-ies – early 1990-ies developed a technology for production of burnt electrode pitch coke by means of delayed carbonization similar to petrochemical process. Flow sheet of delayed carbonization matches perfectly separation technology of tar distillation because material in this process is soft pitch obtained in the process of tar flash vaporization at temperature of 310C^o-330C^o.

According to UKhIN, this technology helps in perfection of technological process due to optimal temperature range (480C^o - 520C^o), decrease emission of harmful substances and obtain burnt pitch coke (including coke with non-isotropic structure by means of coal tar deep purification).

According to some other specialists, the existing box technology most rationally realizes coke-forming potential of the coal tar (increases yield of raw coke and burnt commodity coke from tar). The technology of slowed carbonization appears to be more efficient for manufacturing of coke with acicular structure.

The process of delayed carbonization until now has not yet received commercial application in the CIS (they just designed and tested pilot mounts - at Bashkir Petroleum Industry Research Institute).

1.3 Quality Parameters of the CIS Manufactured Pitch Coke

Pitch coke versus petroleum coke boasts several significant advantages: lower ash impurity, reduced sulfur content, higher mechanic features and lower reactivity (in anodic mass production it helps to reduce binder consumption). Therefore, nevertheless, pitch coke (isotropic) is hard to graphitize (due to high rate of quinoline insoluble substances - α_1 fraction) that is why it goes to manufacture of anodic paste.

Quality parameters of pitch coke in the former USSR are regulated under the GOST 3213-71 standard. Under it, there are three brands of pitch coke, namely KPE-1, KPE-2, and KPE-3 (see table 5).

Table 5: Quality Parameters of Electrode Pitch Coke of brands KPE-1, KPE-2, KPE-3

Parameters	KPE-1	KPE-2	KPE-3
Ash content, %	0.30	0.30	0.50
Total sulfur content, %	0.30	0.70	0.70
Moisture, %	3.0	3.0	3.0
Yield of volatiles, %	0.8	0.8	0.8
Fragments size, mm	10.0	10.0	10.0
Content of class 10-25 mm fragments, %	8.0	8.0	8.0
Content of fines (< 10 mm), %	2.0	2.0	2.0
Specific electric resistance, 10^{-6} Ohm/m	600	600	600