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Coal Tar Market Research in the CIS

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Annotation

The report is devoted to investigation of current standing of coal tar market in CIS countries and forecast of the market development. The report consists of 5 Sections, contains 75 pages, including 20 Figures, 30 Tables and Appendix. This work is a desk study. As information sources, we used data of Rosstat, Inter-State Committee on Statistics of CIS countries, Federal Customs Service of Russia, official domestic railage statistic of JSC RZhD (former Ministry of Railway Transport of Russia), State Statistic and Customs Services of Ukraine, Statistic Agency of Kazakhstan, own InfoMine database, sectoral (industrial) and regional press, annual and quarterly reports of companies, as well as data from web-sites of company-producers of carbon black. The analyzed and summarized data were then verified and refined by the way of using selective telephone interviews of representatives of main players of the market and related experts.

The first Section of the report presents information on technology of production and processing of coal tar. The Section also analyzes standing of by-product coke production in CIS countries (Russia, Ukraine) and supplies of coking coal to Russian enterprises.

The second Section of the report is devoted to production of coal tar in CIS countries (Russia, Ukraine, Kazakhstan) in 1999-2009. The Section presents statistics of coal tar production by CIS enterprises, as well as data on quality of the manufactured products. Besides, the Section presents review of basic producers of coal tar in CIS (dynamics of the production, consumers, export activity) – for 11 enterprises.

The third Section of the report presents data on foreign trade of Russia and Ukraine in coal tar in 1997-2009, and that of Kazakhstan in 2006-2009, including data on volumes of exports and imports of the product, directions of the supplies, basic exporters and importers (Russia, Ukraine).

The fourth Section presents data on export-import prices on cola tar in Russia and Ukraine in 1999-2009, as well as some selective data on domestic prices on coal tar in Russia.

The fifth Section of the report analyses consumption of coal tar in CIS (Russia, Ukraine). The Section presents supply-demand balance of coal tar in Russia and Ukraine, pattern of consumption of coal tar in Russia (2004-2009). The Section also presents the greatest company-consumers and end-uses of coal tar in Russia and Ukraine.

The conclusion presents forecast of production and consumption of coal tar in Russia and Ukraine up to 2015.

The Appendix presents addresses and contact information for the main company-producers of coal tar in CIS.

Introduction

Coal tar is a product of the destructive distillation of bituminous coal. Coal tar can be distilled into many fractions to yield a number of useful organic products, including benzene, toluene, xylene, naphthalene, anthracene, and phenanthrene. These substances, called the coal-tar crudes, form the starting point for the synthesis of numerous products—notably dyes, drugs, explosives, flavorings, perfumes, preservatives, synthetic resins, and paints and stains. The residual pitch left from the fractional distillation is used for paving, roofing, waterproofing, and insulation.

Coal tars are by-products of the carbonization of coal to produce metallurgical coke and/or natural gas. Annual global production of 400 mln t of coke is accompanied by obtaining around 16 mln t of coal tar. Notice that some coke shops (in USA, China) apply process, which doesn't provide further processing of coal tar, which is simply burnt in the process of coke production, From estimates, only around 50% of coal tar, produced in the world, are subjected to further processing to obtain additional commodity products.

To a large degree, volume of production of coal tar depends on quantity of metallurgical coke, required for production of iron. Blast-furnace process, in spite of development of alternative technologies (for instance, DRI process) will nevertheless find application for many years in future. Notice that introducing technology of coal-dust fuel injection in the blast-furnace process allows to decrease coke consumption in iron production. Nevertheless, expanding iron output encourages demand for metallurgical coke.

Notice that demand for products of coal tar processing (for instance, pitch, used widely in aluminium industry) doesn't always coincide with demand for coking coal and metallurgical coke. At the same time, one should note a tendency of expanding potentiality of deep processing of coal tar and finding new end-uses of the processing products. That is why importance of coal tar as raw material will increase.

I. Technology of production of coal tar and resources used

1.1. Properties of coal tar

Coal tar is a brown or black liquid of high viscosity, which smells of naphthalene and aromatic hydrocarbons. Coal tar is among the by-products when coal is carbonized to make coke or gasified to make coal gas. Coal tars are complex and variable mixtures of phenols, polycyclic aromatic hydrocarbons (PAHs), and heterocyclic compounds.

Quality of coal tar is characterized by density, yield of fractions, content of phenols, naphthalene, as well as toluene-insoluble compounds, and moisture (Table 1).

Table 1: Averaged properties of coal tar

Parameter	Value
Density at 20°C, kg/m^3	1150–1177 (maximum 1200–1220)
Moisture, %	3–4
Content (% of dry coal tar):	
compounds, insoluble in toluene	8–7.1
phenols	1.84–2.10
naphthalene	7.25–10.50
anthracene (dry)	4.5–5.6
pyridine bases	1.11–1.20

Source: review of scientific and technical literature

Density of coal tar ranges 1120–1220 kg/m^3, being one of the most important properties, characterizing quality of coal tar and its fractions. Density of coal tar is determined, to a large extent, by content of compounds, insoluble in toluene or xylene – increasing share of the compounds owes raising the density and decreasing yield of oils and phenols in the course of its processing.

Coal tars are complex combinations of polycyclic aromatic hydrocarbons (PAHs), phenols, heterocyclic oxygen, sulfur, and nitrogen compounds. In chemical properties, all the components of coal tar are subdivided into 3 groups: neutral, acid and basic.

The neutral hydrocarbon compounds are mainly presented by *napthalene* $C_{10}H_8$, *anthracene* $C_{14}H_{10}$, *chrysene* $C_{18}H_{12}$, accompanied by indole, carbazole, benzo-carbazole, styrene, indene, cumarole and their derivatives.

Sulfur-containing neutral compounds of coal tar are presented by *thiophene* C_4H_4S, thionaphthene C_8H_6S (and their methylated derivatives), di-phenyl sulfide, an-benzo-thionaphthene and other. Most of the compounds occurs in washing (absorption), napthalene and anthracene fractions. However, their separation in the course of fractionation (rectification) is not possible owing to closeness of their boiling points to those of hydrocarbons. Most of the sulfur-containing neutral compounds is harmful impurity in products of coal tar processing – distillation and

so are removed from distillates (fractions, technical products) by chemical purification and other methods. The most hard-removable compound is thionaphthene.

Summarized content of the neutral compounds in coal tar reaches 42–43%. The most valuable of them are napthalene and anthracene, which are distilled from coal tar in napthalene and anthracene fractions, respectively.

Acid part of coal tar is presented by compounds, containing oxygen in side chain: *phenol* C_6H_5OH, *cresols* $C_6H_4CH_3OH$, *xylenols* $C_6H_3(CH_3)_2OH$ and polycyclic phenols, total content of which reaches 1.2–2.0%. The most valuable components are phenol and *o-, n-, м-cresols*. Most of the compounds is distilled from coal tar in phenol fraction, and the rest is spread over other fractions. Phenols from fractions are separated by their treating with alkaline solutions to obtain phenolate.

Basic properties are demonstrated by *nitrogen-containing compounds* of coal tar – *pyridine* (C_5H_5N), *xynolene* (C_5H_7N) and their derivatives, as well as high-boiling bases. Total content of bases in coal tar reaches 0.8–1.2%. In the course of distillation of coal tar the compounds are spread over fractions depending on boiling point. Separation of bases from fractions and oils is conducted by treating with sulfuric acid.

1.2. Obtaining of coal tar

Coal tar is a product of the destructive distillation of bituminous coal, when coal tar is mainly generated in the course of pyrogenetic decomposition of primary tar in coking process.

Coal is converted to coke in large coke oven batteries. The coking process consists of heating crushed coal above 900ºC in the absence of air to drive off the volatile compounds; the resulting coke is a hard, but porous carbon material that is used for reducing the iron in the blast furnace. The modern by-product coke oven recovers volatile chemicals in the form of coke oven gas, tars, and oils.

Tar is released in the course of the whole coking process: initially, primary tar is released, containing mainly aliphatic compounds. With increasing temperature, formation of aromatic hydrocarbons begins. Further heating results in formation of polycyclic compounds. For instance, maximal generation of naphthalene and anthracene is reached at 1000ºC.

Coal tar is a product of thermal breakdown of primary tar. The bulk of primary products (90-95%) raises to near-roof space of oven, where it is mixed with released gases, heated and the first stage of decomposition proceeds, with the primary products conversion into high-temperature tar, benzene and other products.

Releasing of coal tar from coking gas proceeds by several stages: the first stage – when cooling the coking gas in gas collector by over-tar water from 750˚C to 80˚C, and the second – when cooling coking gas in primary gas coolers.

Coal tar is obtained in by-product recovery shops of by-product coke enterprises. The obtained tar is mixed and goes to further processing.

Composition, yield and properties of coal tar depend on composition of charge, design of ovens and coking conditions (first of all, on temperature of near-roof space of oven and period of aging volatile components in the oven).

Yield and quality of coal tar is governed by content of volatile components in charge (the higher the content the better grade of further pitch). In this connection, charge content of coals of grades G, GZhO, GZh («gas» coals) must be maximal to obtain high-quality coal tar, whereas from viewpoint of production of metallurgical coke, the former two grades of coal refer to low-coking and their suitability is limited. That is why maximizing quality pitch yield doesn't correspond sometimes to solving problem od obtaining grade metallurgical coke.

In 1970-80s in the ex-USSR, development of by-product coke production resulted in increasing yield of coal tar and improving its quality, to a large extent in connection with increasing share of the "gas coals" in charge (especially at Ukrainian enterprises). Besides, large-tonnage ovens were introduced, and coking temperature increased. Quality of coal tar was also improved, with increasing its density, content of compounds, insoluble in toluene and quinoline, yield of pitch. Quality of coal tar was also improved at the expense of introducing a number of process design elaborations, including decreasing volume of under-roof space in coking chamber and decreasing content of dust fractions in coal charge.

However, in mid-1990, quality of coal tar in the ex-USSR slightly decreased owing to short supply of coking coal and unstable quality of coal charge.

At by-product coke enterprises of CIS, yield of coal tar in per cents of metallurgical coke ranges 4.0-4.9%.

1.3. Raw materials for coking, characteristics of by-product coke production in the CIS

In the ex-USSR, by-product coke plant capacities were developed in Russia and Ukraine.

Design capacity of enterprises on production of metallurgical coke in Russia totals currently around 38 mln t, its actual production in 2006 and 2007 was 32.7 and 33.8 mln t, respectively.

In late 2008-early 2009 the global financial-economic crisis caused considerable decline of demand for products of steelmaking companies that, in turn, owed decreasing consumption of metallurgical coke by these companies and, correspondingly, dropping the coke production. In 2008 production of metallurgical coke in Russia decreased by 5.2% compared with 2007 to 32.1 mln t. In 2009 the production of coke decreased to 27.4 mln t, by 14.5% less than in the previous year. As for individual results – by enterprise-producer – the decline of the production of coke in 2009 compared with 2007 was from 11% (JSC «Ural Steel») to 40% (JSC «NLMK»).

In Russia currently 58 coke-oven batteries are workable. Productive capacities of by-product coke shops (in structure of integrated iron&steel works) and individual by-product coke enterprises are highly worn (depreciation above 60%). Only in latest years realising of measures on reconstruction and re-equipment of the by-product coke productions began. Average age of coke-oven batteries exceeds 20 years.

The newly-built and reconstructed coke-oven batteries are equipped with modern efficient mechanization and automation systems and facilities preventing environmental pollution. In 2008-2009 several coke-oven batteries were stopped completely or for major repair. For 2008-2009 coke-oven battery №4 at JSC «CHMK», coke-oven batteries №№ 3, 4 at JSC «MMK» were reconstructed, and repair of coke-oven battery №4 JSC at JSC «Coke» and a block of coke-oven batteries №2 at JSC «MosCoke» was implemented.

Raw material base of coking industry in Russia is presented by coking coals of 6 coal basins, including Kuznetsky, Pechora, Donetsk (deposits of Rostov region), Yuzhno-Yakutian, Ulug-Khem, and Karaganda (imported coals from Kazakhstan). Volume of mining coking coals in Russia in 2006 and 2007 was 68.1 and 70.2 mln t, respectively. In the latest two years the mining volume decreased to 64.4 mln t in 2008 and 60.7 mln t in 2009.

The bulk of coking coals is mined by enterprises of Kuznetsky basin 72% of total Russian coking coal production in 2008 and 79% in 2009), the greatest of which are JSC «Yuzhkuzbassugol'» and CJSC «Raspadskaya» (Kemerovo region), which together yielded in 2008 almost 20% of total Russian mining of coking coals. Besides, large levels of coking coals mining are characteristic for JSC «Vorkutaugol'» (The Republic of Komi) and Neryungri quarry of JSC «Yakutugol'» (The Republic of Sakha-Yakutia).

Volumes of coking coals supplies to by-product coke enterprises of Russia in 2009 are presented in Table 2.

The great bulk of Russian by-product coke enterprises uses in its charge Kuznetsky coking coal (mainly of grades GZh – gas fat and Zh - fat). In latest years, at the Russian enterprises, share of supplied "gas" coals (of grades G – gas, GZh, GZhO – gas fat lean coal) increases with decreasing share of high-coking coals (coking base - OS, K, KO grades) that results in slight worsening grade of metallurgical coke. At the same time, increased yield of volatiles (30-40%) decreases yield of metallurgical coke, but yield of coal tar increases.