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THE COOPERATION OF RESEARCH AND DESIGN INSTITUTIONS IN PRESENT-DAY CONDITIONS

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The article justifies the need for the importance, as well as the main directions of the joint work of research scientists and designers of the coke-chemical sub-sector nowadays. There has been shown the relevance of the creation and development of technologies that open up the possibility of integrated solutions to optimize and reduce the cost of raw materials in the context of reformatting world commodity markets, as well as reducing production costs, saving and diversifying energy resources and harmonizing environmental standards to European requirements.

Some specific examples of successful joint work of leading research and project branch institutes are given. There has also been shown the creation of an integrated technology for coking the tamped blend using heavy-duty coke ovens and advanced technology for dry coke extinguishing; a two-stage vacuum carbonate desulfurization scheme, which allows purification of coke oven gas from hydrogen sulfide to a level of $\leq 0,5 \text{ g/m}^3$; research in the field of obtaining substitutes for products based on oil and natural gas, environmental protection, standardization, etc.

In particular, it has been proved that the integrated technology for coking of the tamped blend using the dry coke extinguishing allows to solve the actual problem of metallurgical coke production in accordance with international quality standards based on coal blends with a high content of low-caking coal from 30 % (by traditional technology) to 70 %. This technology opens the possibility to reduce of natural gas consumption by 111 million m^3 per year (due to the full utilization of the physical heat of hot coke) and to reduce the harmful emissions to the environment by 15 %. The novelty of the completed development is protected by 22 patents. The actual economic effect from the introduction of this technology amounted to 224 million UAH per year.

It is shown that the joint work of SE "GIPROKOKS" and SE "UKHIN" allows to successfully carry out and introduce into production practice the developments in the field of obtaining substitutes for products based on oil and natural gas, environmental protection, standardization, etc.

Keywords: coke chemistry, scientific research, design development, coking, tamping coal blend, dry quenching of coke, vacuum carbonate desulfurization, gasification, emissions of harmful substances, collector system, emission indicators.

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THE DEVELOPMENT OF COKE OVENS WITH A STAGGERED AIR SUPPLY

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It is confirmed that the recycling of combustion products is an effective factor in slowing down the process of burning and lengthening the flame, and, consequently, reducing the amount of NO_x formation in the heating system. The decrease in the NO_x concentration during recycling is explained by a decrease in the process temperature as a result of a decrease in the rate of chain reactions in the system due to the presence of inert combustion products.

An additional factor that reduces the formation of NO_x is the staging of the fuel combustion process, provided that at the first stage fuel is combusted with a lack of oxidizing agent, and at the second stage, after-burning of gasification products at lower temperatures.

As a result of many years of research of SE "UKHIN" on hydraulic models of the heating system of horizontal coke ovens of different heights and detailed study of the dynamics of mixing heating gas with air along the height of the vertical, it became possible to develop proposals for ensuring uniform heating of the ovens. Investigations on an experimental fire vertical, simulating the conditions for gas combustion in coke oven heating channels, made it possible to determine the pattern of temperature distribution in the flare.

Modeling of various design options with different number of stages and recirculation windows showed that recycling reduces the amount of NO_x formation by at least twice, and the organization of the second stage of air supply – by an additional 10-30 % depending on the location of the second stage in height and amount supplied to it of air.

The conditions are determined to ensure uniform heating over the height of the coked load and a decrease in the formation of thermal nitrogen oxides. The calculated data on the effect of staged air supply to verticals on temperature conditions in the flame and the mechanism of formation of nitrogen oxides are obtained. Technological and constructive methods for suppressing the formation of NO_x are considered. New design solutions for refractory masonry, developed by SE "GIPROKOKS" in recent years, are given.

The complex of these conditions provides a significant improvement in the state of the air basin in the area where coke-chemical plants are located by reducing emissions of toxic nitrogen oxides.

Keywords: coke ovens, batteries, stepped air supply, heating gas combustion conditions, combustion product recirculation, formation mechanism, thermal nitrogen oxides, heating system of furnaces, reduction of nitrogen oxide formation, refractory masonry.

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THE COMPLEX OF A SEMI-INDUSTRIAL COKE OVEN FOR TESTING BULK AND TAMPED COAL CHARGES

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The article explains, why in the scientific and technical practice of the State Enterprise "GIPROKOKS", the need arose for a deeper study and prediction of patterns that affect the process of layer coking under conditions close to industrial ones.

Such studies are carried out in two directions: reproduction of industrial coking conditions in semi-industrial furnaces with a large load mass and laboratory furnaces with a small load mass, in which it is not possible to fully reproduce layer coking, which is identical to the process in industrial furnaces but they are less expensive and easier to operate.

The advantages has been described of using a semi-industrial oven at a coke-chemical plant. Such oven in particular makes it possible to select the most rational conditions for preparation of the coal blend (humidity, degree of grinding, bulk density), to find the optimal composition of the experimental blend using gas and weakly coking coal, to achieve high quality coke and to determine the effect of the composition of the blend on the value of the pressure of bursting, preparation and coking processes.

The article presents a description of a new project of a semi-industrial coke oven design of the SE "GIPROKOKS" with a mass of loading of 200-400 kg, designed to develop optimal compositions of tamped and bulk blends, as well as to determine of pressure in coke oven camera in dynamics.

In the oven it is possible to determine the expansion pressure of both bulk and tamped charges, with absolute values of pressure corresponding to industrial conditions. The developed semi-industrial complex have to be located in a separate building or block-module and, in addition to the coke oven itself, includes the area of dry and wet quenching of coke, the section of coal preparation and the node of the ramming of the coal blend. The latter provides the formation of coal mass with density from 0.8 to 1.2 t / m³ (wet weight). To eliminate the subjective factor, coal loading is carried out at the same tamping energy as in the industrial loading-pushing machine - an average of 560 kJ / kg. The data obtained allows not only to obtain the comparable research results but also to determine the quality of industrial coke.

Keywords: coal, charge, coke, bulk loading, stamping technology, layer coking, semi-industrial furnace, expansion pressure, wet and dry quenching equipment, semi-industrial complex.

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AMMONIUM SULPHATE GRANULATION BY COMPACTION METHOD

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The article briefly describes the main problems of optimizing of process of the ammonium sulfate preparation for storage, transportation and using as fertilizer in agriculture. The advantages of granular product over fine crystalline are

proved. It is shown that the efficiency of the process of obtaining molded ammonium sulfate commodity depends on the technological process of molding and equipment used.

It has been shown, that the main characteristics of the chosen method, like the shape of the granules, the specific surface, strength, the tendency to caking and the rate of decomposition in the soil, are decisive in assessing the quality of the product and its competitiveness in the markets. The advantages of a molded product also include the possibility of improving of working conditions in the working area as a result of reducing dust generation at all production sites from obtaining of the molded product to the transportation and direct use in agriculture during dosing of fertilizer and introducing it into the soil.

A new technological solution is presented that improves the quality of ammonium sulfate during transportation and application to the soil. The new technology involves granulating the product by compacting. It means the process of increasing the size of the particles of the material carried out in a dry way, in which the pulverulent product and large particles of ammonium sulfate take a uniform scaly form with a fairly narrow size range. Product compaction is achieved by mechanical compression by transporting it through a roller press. The vacuum in the bodies of main equipment reaches 20-50 Pa, that practically prevents dusting of the working area of the site. For the application of the developed method the block schemes of the installation of compaction of crystalline ammonium sulfate, flow chart and equipment layout plan has been proposed.

The compaction method is one of the most promising ways to produce ammonium sulfate as a marketable product. The method is recommended for use in coke production or in a specially organized complex, where ammonium sulfate from several coke-chemical enterprises or enterprises producing this fertilizer may be received for preparation.

Keywords: ammonium sulfate, compaction unit, packaging, warehouse, granulation, molding, grinding, dusting, product quality, cost-effectiveness.

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POSSIBLE MANUFACTURED EMERGENCY SITUATIONS ON COKE CHEMICAL PRODUCTION

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The paper provides a brief description and analysis of coke-chemical production facilities in order to determine the potential emergencies and accidents at the enterprise, as well as their impact on the environment. The definitions of the concepts "emergency" and "accident" have been given. The relevance of potential emergencies and their impact on the environment and human health is assessed.

Causes of emergency situations are divided into the following groups: technical (technological parameters exceeding critical values, power supply interruption, corrosion, erosion and physical deterioration of equipment, etc.), organizational (non-compliance of the technological regulations, labor protection standards and other instructions and regulatory documents) and external factors (natural disasters, abnormal natural phenomena, terrorism, etc.).

The scenarios of the development of accidents with the assessment of their consequences have been studied. The considered emergency situations are ordered according to the technological processes carried out at the coke plants. The characteristic of pollutants entering the environment in different emergency situations at coke plants have been shown. The probability and conditions under which emergencies and accidents are possible are identified, based on the characteristics of operation of both individual equipment and technological installations as a whole, taking into account the explosion and fire hazard properties of substances that occur during the production process. An algorithm for the phased implementation of the assessment of the impact of accidental emissions on the environment, taking into account the features of equipment and technological installations, is presented. All measures for the elimination or minimization of emergencies are carried out taking into account the materials developed at the enterprise "Plan of measures for localization and liquidation of consequences of accidents".

The description has been given of the methodology developed by the SE "GIPROKROKS" for the assessment of air pollution in emergency situations. The methodology allows the calculation method to determine the qualitative and quantitative composition of emissions of pollutants.

Keywords: coke production, emergency situations, accidents, emissions, pollutants, air, environment, equipment, technology.

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NEW EDITION OF THE “RULES OF TECHNICAL OPERATION OF COKE-CHEMICAL ENTERPRISES” - 2017

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Until the beginning of 2018, the “Rules for the Technical Operation of Coke-Chemical Enterprises”, approved by order No. 305 of July 5, 2002 of the Ministry of Industrial Policy of Ukraine, were in force in Ukraine. Over the previous 15 years, there have been active attempts to bring the “Rules for the Technical Operation of Coke-Chemical Enterprises” in line with the emerging new regulations.

In connection with the issuance of a new edition of the Labor Law (“On Labor”) and a number of other regulatory acts, it became necessary to update the “Rules for the Technical Operation of Coke-Chemical Enterprises”, which became the basis for the decision of the Board of Directors of the Ukrainian Scientific and Industrial Association “UKRKOKS” (UNPA “UKRKOKS”) on revision of the “Rules for the Technical Operation of Coke-Chemical Enterprises”. The task for the development of a new version of the “Rules for the Technical Operation of Coke-Chemical Enterprises” was approved by the Ministry of Industrial Policy of Ukraine and UNPA "UKRKOKS".

The new version of “Rules for the Technical Operation of Coke-Chemical Enterprises” was developed, reviewed at a meeting of the Scientific and Technical Council and approved by Order No. 20 of December 29, 2017 of the Ukrainian Scientific and Industrial Association “UKRKOKS” and put into effect on January 2, 2017.

The new edition of PTE for coke batteries extends only to the traditional technology for the production of coke in horizontal narrow-chamber coke ovens with bulk loading of the charge. For other technological processes of coke production (with tamping, heat treatment, partial briquetting, etc.), coke batteries are operated in accordance with the technological regulations developed directly by the company. “Rules for the Technical Operation of Coke-Chemical Enterprises” 2017 is a regulatory document for all coke-chemical enterprises and industries, regardless of ownership.

The article describes the process of approval of the document “Rules for the technical operation of coke-chemical enterprises”, and also contains the main changes introduced in the new edition.

At the same time, it was considered expedient to streamline the structure of the document: the list of regulatory documents was highlighted in a separate chapter, expanded and moved to the beginning of the text of the Terms and Definitions and Notations and Abbreviations section, the section on the rules for the acceptance of coke chemical plants into operation was eliminated (as inappropriate for the purpose of the document).), a number of other editorial additions have been made

Keywords: coke production, emergency situations, accidents, emissions, pollutants, air, environment, equipment, technology.

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IMPROVEMENT OF THE ENERGY EFFICIENCY AT COKE PRODUCTION

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The article presents the new technological solutions used in the projects of the State Enterprise "GIPROKOKS" to improve the energy efficiency of coke production facilities as an effective way to increase the competitiveness of coke by reducing the cost of its production.

One of the factors determining the effective dry quenching of coke is the temperature of the circulating gases supplied to the quenching chamber. The studies of the State Enterprise "GIPROKOKS" in the field of reconstruction of the waste-heat boiler with the installation of additional heating surfaces confirmed the possibility of reducing the temperature of the circulating gases at the outlet of the boiler. It has been shown that the optimal solution is to install a sub-economizer with a coil heating surface and a water-to-water plate heat exchanger in front of it to protect against sulfuric acid corrosion.

Compared with other methods of cooling of circulating gases, the sub-economizer has a number of advantages, confirmed by a technological and economic analysis of its possible structures. It has been shown that working with a sub-economizer provides high-quality quenching of coke at a 10 % increase in the capacity of the coke dry quenching unit without increasing the coke temperature as well as the specific consumption of blast.

To provide facilities for coke-chemical production with steam for technological and heating needs, it is proposed to use a steam supply scheme that includes a turbine generator room, which will generate electricity for the needs of the boiler room at the expense of the high-pressure steam potential.

The use of a centralized source of steam of low parameters will allow to reduce the number (or abandon the use) of

inefficient reduction and cooling units.

Recommended use of condensing turbines as a way to optimize steam supply, soft gas holders instead of traditional low-pressure, developed transmission systems for near and far consumers of excess coke oven gas for own and the third-party consumption, which makes it possible to effectively use its surpluses regardless of the relative position of consumers.

Keywords: dry extinguishing of coke, subeconometer, steam-turbine, gasholder, steam supply, gas transmission, energy efficiency.

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