The strategy of developing of resources of brown coal. Energy. Ecology

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Abstract. Brown coal, lignite of Siberia and the East of Russia, are able to provide the country's energy and markets of the surrounding developing countries with affordable and cheap energy. But this will require to overcome the factors of large distances from the main consumers, update the generating capacities and introduce new technologies, solve environmental problems. The work contains assessments of how this can be effectively implemented.

Introduction
Russia has huge fossil fuel reserves, of which the most valuable oil and gas constitute the basis for our exports. Coal is also in demand, and its best energetic grades, along with metallurgical ones, are actively used both in our country and exported. But coal mining is carried out labor-intensive mine way, and for this reason is not expanded rapidly. Among developed countries with rich reserves of hard coal its share in the energy sector of Russia half less than in neighboring countries. This provision could, and probably soon change dramatically in connection with upcoming changes in energy markets Asian, Pacific, South-East regions. The burgeoning energy needs of developing countries in these regions can be met at the expense of little used Brown coal (lignite) Siberia and East of our country. But this would require adjustment technology and energy development strategy based on lignite.

What are the quality of brown coal (lignite) as compare the hard coal. The shallow bedding, open methods of mining is a huge advantage of lignite. But it is realized, if it is not necessary to carry fuel to the remote user, take care of preventing spraying and inflaming of fuel. The second factor is the high moisture lignite, often up to 40 percent or more of their weight. Hence the low efficiency of combustion, the inflated dimensions of the equipment, especially of the boiler, and complicated purification of an atmospheric exhaust. In mining areas there are no large consumers of electricity. There is no well-developed road network and complex delivery of equipment. Also severe natural and climatic conditions. List of troubles completed by a fine dust of ash in the exhaust almost every power plant, whereas brown coal in almost the most affordable and the only fuel. Dust this permanently hangs in the atmosphere, causing respiratory illness population and the high percentage of complications. Its presence in the atmosphere with displeasure watching as the "red dawn". So is there any affordable technical solution of the above problems on the way to mastering this most cheap but dirty fuels. In the recent past, such a solution could be expected from the US or Germany, which are trying to create lignite thermal power plant with drying and gasification in the combined steam and gas cycle. But, apparently, it stumbled on drying as a key point of the new technology. Our proposals for drying wet organic material, applicable to lignite, were published in the form of applications under the Patent Cooperation Treaty (PCT), and in articles in science journals Thermal Engineering and High Temperature [1–4]. Below we look at how they solve famous problems.
Drying

Studies [5] show how much the drying of dispersed materials in the fluidized bed is more effective than in the best of industrial technologies and apparatus, for example, in a drum dryer, with energy costs exceeding the specific heat of the phase transition in terms of kilograms of moisture removed. Less could be only in technology [6], in which, however, the temperature gradient between the heating medium and the particle material should be small, which excludes the intensification of the process, so necessary in industrial power devices. The decisive intensification of drying can be achieved by increasing the temperature of the heating medium, and by choosing superheated steam as a drying agent. Such drying can be carried out in a circular steam flow in an airtight device, with the secondary heating of cooled steam and diverting additional steam of evaporated moisture (after separation of the particles) into a heat engine. This can be a screw turbine [7], or a steam turbine in a clean steam circuit with heat input in the separation heat exchanger. This way part of the drying energy will be returned as a mechanical work. The residence time of the particles on drying is determined by drying the largest particles, it will be up to 1 - 2 min for particles of diameter up to 1 mm in superheated steam. At a flow rate slightly higher than the winding speed, for example, 1 m/s, the flow part should be of the order of 100 m, and therefore a vortex-type apparatus was used, but its volume correspond to the residence time, i.e. aging until complete drying. Finally, such a device under pressure above atmospheric operates even more efficiently, and its dimensions are correspondingly smaller. This is the most compact and fastest drying device, which was not enough for the developers of Germany and the United States. Having made a negative decision to assess the state of work, they can not continue it.

Gasification

In the concept of the PP modernization on brown coal (lignite) the drying is only the first stage, previously often used to some improve the characteristics of the used fuel. Drying, which can remove almost all the ballast moisture of the fuel, leads to a drastic change in the entire scheme of the power plant. In this completed version, the dry organic mass of brown coal should be efficiently gasified with removal of acid gases in a single process when dusts of absorbents – calcium and magnesium carbonates, or lime – are introduced. Then, the dusty synthesis gas stream is cooled and the dust is removed using a cyclone, bag filters, and a wet flusher, after which the synthesis gas directed into the gas turbine. What this gives in the energy aspect for PP was calculated on the model of using peat as a fuel in a combined-cycle PP scheme with energy-saving drying and gasification, when Q-T diagrams of interacting (interrelated) elements of the scheme are coordinated [8]. Here, the efficiency get at the level of 50%, whereas the "usual" PP on the lignite gives no more than 37%. Carrying out such modernization, we simultaneously reliably protect the atmosphere from undesirable, but inevitable at the “usual” technology with the "red dawn" emissions. An expert view may notice that the modernization uses extremely simple drying equipment - a hollow device for modest pressure (of the order of 1 MPa) at a temperature of 350–450 °C (or about 200° in a modest form). The steam generator of the PP must provide steam drying at these parameters in the volume of the evaporated moisture of the fuel. A gas turbine can not be installed at all, if it is envisaged to transport synthesis gas to a remote power plant with a gas turbine, through a pipeline.

Additionally

When working on synthesis gas, as a convenient, high-caloric fuel, the traditional steam power equipment should provide significantly more performance and reliability. In this case, synthesis gas is not supposed to be purified from ballast gas impurities – water vapor, CO₂, nitrogen, if they do not significantly reduce the efficiency of the turbine. When gasifying brown coal, the problem may be to choose the optimal mode for it. In order to reduce the inevitable losses, it is customary to limit the gasification temperature by ash softening conditions. In other cases, not only the process is disrupted, but there is also an emergency destruction/ reflow of the gasifier structure. Therefore, the higher the reflow temperature of ash, the more efficient are the conversion of fuel, the more reliable the operation
of the device and the separation of the gas from impurities. These considerations are dominate at the use of wet organic materials as a fuel for drying and gasification in green energy.

However, in brown coals, the carbon part of the fuel composition prevails on the hydrogen one, and since in the gasification reaction CO is formed during the oxidation of carbon by oxygen, or in the reaction with water C + H₂O = CO + H₂, an interesting observation appeared in [8]: when drying fuel before gasification, is it reasonable to remove all water?

But in this case, it is supposed to consider the technology of modernization of PP on brown coal with a high degree of carbonizations, and, without leaving additional moisture to the fuel, introduce air as an oxidant. This circumstance contributes to an increase in the gasification temperature, so the regime to be known with ash fusion, 1300 °C and liquid-phase removal of ash. Omitting as secondary components of gasification that are not essential for the energy balance, based on the calculation technology and the IVTANTHERMO database (the development of the JIWT of the RAS), we obtain for ND lignite (Germany) as having an increased ratio of the number of moles of C to H₂ (weight), enthalpy of moisture = –2416 kJ; H₂O = 17.91 (moles); C = 37.18; H₂ = 14.7; O₂ (self). To this composition, atmospheric air is added as an oxidant (oxygen and nitrogen). The preferred use of water or air can be established only as a result of technical and economic calculations. Here, drying and air are used. At a gas outlet temperature of 1300 °C in the gas phase (C = 0), the chemical energy of CO and H₂ is 12976 kJ(total), which is more than half the calorific value of the dry weight of this brown coal. The heat of the reaction products is sufficient to meet all the technological needs of the cycle of such modernization of the brown coal thermal power plant.

Used machines
For drying, gasification and separators, it is proposed to use cavity vortex apparatus, including cyclones. For the drying, steel welded structures can be used. For the walls of the gasification reactor in high-temperature zone, it is necessary to use concrete structures at 1300 °C (MgO, Al₂O₃).

Protection of the environment and population health
If the improvement of the thermodynamic cycle of the use of brown coals in Russia, at the cheapness of such fuel, and temporary regional energy abundance can be regarded as insufficiently motivated, then this can not be said about the threat of serious air pollution. Gasification allows to "wash" the dust fraction in the exhausts of power plants and decisively improve the atmosphere of the region. Moreover, regardless of the type – high-temperature or conventional gasification of brown coal, if it is followed by a wet scrubbing of the used synthesis gas.

Let's notice, in this decision the main thing is a reduction of the volumes of gas to be cleaned by an order of magnitude and excellent possibilities for wet cleaning. These two factors are capable of replacing the necessary sophisticated exhaust gas purification systems for traditional PP, the costs of which would certainly exceed the proposed modernization.

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