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Modernization of thermal power plants in Uzbekistan

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I. INTRODUCTION

The analysis of the world electric power industry development shows that even in the XXI century, despite significant financial investments in the development of renewable energy, the dominant role of fossil fuels in the production of electricity will remain. Thermal power plants based on organic fuel form the basis of the modern world electric power industry.

At the same time, environmental requirements for energy sources have become much stricter over the past decade. These circumstances stimulate research and development of innovative technologies in the field of solid fuel use, primarily of low-grade types, which reserves are significant, and according to statistics, Uzbekistan in recent years fully satisfies its needs in solid fuel through its own production. Coal reserves on the territory of the republic are concentrated at Angren, Baisun and Shargun deposits. Angren field is the largest in the country and fully covers the needs of the electric power industry. Lignite brown coal of the Angrenskoye field belongs to the class of low-grade energy fuels (LEF). Direct burning of LEF in the furnaces of existing TPP boilers does not fully ensure the efficiency of thermal engineering processes, reliability of equipment operation and cleanliness of the environment [1]. In order to maintain combustion stability, it is necessary to mix natural gas or liquid fuel - scarce fuel oil - with LEF. High ash content in flue gases leads to abrasive abrasion of metal heating surfaces and equipment, as a consequence - frequent repairs of power units. The specified circumstances lead to a decrease in reliability of operation, increase in specific fuel consumption for electricity generation, reduction of the overhaul period, as a consequence, an increase in overhead costs.

At present, there are various innovative technical solutions for modernization of existing coal-fired thermal power plants to increase their economic efficiency with simultaneous reduction of pollutant emissions [2,3]. The accumulated world experience of the carried out TPP modernization indicates that there are two approaches to solving this problem.

The first variant assumes re-equipment of outdated plants with installation on them of the devices providing reduction of harmful emissions and satisfaction of ecological standards. At the same time, the plant can be re-equipped independently or in parallel in the following stages: fuel preparation, combustion and cleaning of combustion products.

The equipment installed for coal preparation provides coal enrichment by means of both traditional methods and advanced methods of physical, chemical and microbiological purification. Preliminary preparation of coal before burning (washing, preparation of suspensions) leads to a small increase in efficiency of the plant itself by reducing the amount of processed mineral part in the cycle. However, the cost of burnt fuel increases. Modernization of coal preparation is mainly aimed at expanding the range of quality of used coals. in the case of modernization of the flue gas treatment stage, there are certain additional costs, as a consequence of the reduction of net efficiency of the plant (from 3 to 10%). This is particularly true for the installation of a wet gas flushing system to remove sulphur oxides. In general, conversion methods that do not require large production areas, as in the case of the installation of lime scrubber desulphurization, are common [3].

The second option pursues the purpose of essential improvement of technical-economic and ecological characteristics of the station and assumes radical reconstruction of the station with replacement of a considerable part of the old equipment on more perfect and effective technologies among which the greatest prospects are connected with CSGSs GU (the combined steam-gas cycle with coal gasification), CSGSs GU (the chamber of combustion of the raised pressure) and furnaces KSA (the chamber of combustion of an atmospheric pressure), KSAC (a circulating boiling layer), and also KSD and KSDC.All these technologies, for The 265 MW CFB boiler was successfully used to

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convert one unit of the Northside power plant in Florida at the beginning of 2003. The total cost of modernization of the boiler amounted to 310 million dollars.

During the reconstruction of the existing coal station, the existing boiler is replaced by a new coal gasifier or combustion chamber with a CS. If a high pressure combustion chamber is used in front of a gas turbine, gas cleaning and heat recovery systems must also be installed. It is desirable that the rest of the equipment (coal feeders, steam turbine, power generators) be also upgraded.

The experience of upgrading one of the old units at the WabashRiver coal-fired power plant in Indiana deserves attention. A conventional steam unit has been converted to a combined steam and gas cycle for coal gasification products. A Destec process was used as a gasifier. The unit was put into operation in 2000, its capacity - 250 MW [4]. The experience of modernization of the unit was used to develop the project of a new 1155 MW KPGTs GU. It is estimated that the unit capital cost of the 1,500 MW plant under consideration will be $10,066 per kilowatt of electrical capacity, almost $500 less than the prototype. At the same time, the plant will meet all environmental requirements, moreover, it will significantly exceed the existing prototype in terms of specific emissions.

In general, it can be argued that the reconstruction of the existing coal units of the plant in configuration with a steam-gas cycle and coal gasification (gasifier - gas turbine) will require additional investment from 1100 to 1300 U.S. dollars for each kilowatt of electrical capacity. However, the reconstruction with the introduction of the combined cycle with gasification may increase the efficiency of the coal-fired power plant from 35% to more than 40% and increase its capacity by 50-150%. Therefore, due to the increased productivity and efficiency of the upgraded plant compared to the old one, the price of electricity will increase by no more than 0.2 cents per kWh. Additionally, these spent funds will allow to reduce emissions of sulphur oxides by almost 99%, as well as significantly reduce emissions of nitrogen oxides.

Table 1. Approximate technical, economic and environmental characteristics
Modernization of traditional coal-fired power plants

Technology	UEF	Sox/Noxemissions, %	Output power	Service life	Additional costs, $/Kw	Power/energy cost increase $/MWh
Traditional Solution						
Coal enrichment	Small increase	>30; Doesn't affect	The same	Small increase	Additional fuel price	2-3
Scrubber desulfurization	Decrease	90-95; Doesn't affect	Moderate reduction	Doesn't affect	180-200	9-11
Innovative solution						
Fluegas cleaning	Decrease	**>90;** High	Small increase	Doesn't affect	175-190	10-12

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Multistage combustion with limestone	Decrease	50-60; Medium.	Small increase	Doesn't affect	80-110	5-8
Pre-combustion furnace with bottom ash removal	Small increase	50-90; Moderate	Small increase	Small increase	50-60	1-2
С дожиганием газа	The same	Doesn't affect,Moderate	Doesn't affect	Small increase	10-20	Depends on the gas price
Water-coal suspension	Small increase	10-60; Doesn't affect	Small increase	Doesn't affect	20-50	11-23
Combined gas and steam cycle with gasification	Moderate increase	95-99; Moderate	50-150% Increase	Moderate increase	1100-1300	1-2
Circulating fluidized bed under pressure	Doesn't affect	90-95; 60	50-70% Increase	Moderate increase	800-1000	2-4
Atmospheric (circulating) fluidized bed	Doesn't affect	90-95; 60	10-15% Increase	Moderate increase	700-900	6-8

If we apply technology with increased pressure in the CW furnace, we can expect an increase in efficiency from 35 to 38% and an increase in power by 50%. Capital costs are slightly lower (800-1000 dollars per kW), but due to the fact that the productivity increases to a lesser extent than in the combined cycle with gasification, electricity costs slightly more - by about 0.4-0.6 cents per kWh.

Reconstruction with the use of fluidized bed combustion at atmospheric pressure does not lead to a significant increase in the plant's efficiency, but a 10-15% increase in power is achieved. Capital costs are not higher than 700-900 dollars per kWh, but due to relatively small increase in capacity, the increase in electricity price is 0.6-0.8 cents per kWh[4].

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A promising direction is the multistage combustion of high-sulphur ash fuels in power plants, which is realized in the form of intracycle gasification with the use of combined cycle gas turbines, allowing increasing the coefficient of fuel potential energy use and generating electricity without harmful emissions into the environment [5]. It assumes rational inclusion of gasification and purification of generated gas into the energy cycle. The most important part of this approach is the development of an efficient gasification reactor - gasifier. The choice of its specific type depends on many circumstances, including the nature of the final use of the resulting gas, the physical and chemical properties of coal, the required gasifier capacity and the methods of heat and by-products utilization.

On the basis of the conducted analysis it is possible to draw a conclusion that the technology of the combined combinedcombined steam-gas cycle with gasification is a perspective direction of use of LEF fuel. Complex energy and technological use of brown coal of the Angren deposit can be implemented by including it in the heat cycle - the process of pyro-gasification, taking into account its physical features and chemical composition.

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