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The thermodynamic efficiency of energy complex enterprises processing raw gas condensate

Dolotovsky I.V.[a], Larin E.A.[a], Dolotovskaya N.V.[a]*

[a]*Yuri Gagarin State Technical University of Saratov, 77 Politekhnicheskaya st., Saratov, 410054, Russian Federation*

Abstract

This paper provides analysis of thermodynamic efficiency of an energy complex of gas and gas condensate processing enterprises interrelated with primary technological facilities involved in continuous fuel, heat and electrical energy generation and consumption processes. The analysis is based on aggregate-decomposition method used for system analysis and synthesis of complex objects. Exergy balance sheets for gas condensate processing enterprise are drawn up as a Grassmann diagram. Potential of several production facilities of an enterprise involved in processing raw hydrocarbons from gas condensate is evaluated and the possibility of using their engineering design for fuel and heat production systems is discussed.

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Keywords: energy complex; thermodynamic analysis; system efficiency; gas and gas condensate processing;

1. Introduction

The energy complex of gas and gas condensate processing enterprises (GGCPC) interrelates with the main industrial processes in the continuous cycles of fuel generation and consumption, heat and electrical energy, and with external systems of raw material resources, fuel and energy resources (FER) and water resources. At the present time for their own needs of hydrocarbon processing industry consumes up to 10 % FER on the amount of composition of the processed crude hydrocarbons (CHC). However, in all significant reserves GGCPC recycled energy resources (RER), including combustible waste, the use of which does not exceed 14 % of available capacity. This is due to the low energy efficiency of separate recycling equipment, the absence of specific power plants, taking

* Corresponding author. Tel.: +7-927-224-6356.
E-mail address: dnw50@yandex.ru

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into account the specific requirements of GGCPC customers, mismatched dynamic characteristics of generation and consumption of energy and other causes. So the development strategy and improvement ways forming energy complex (EC) of each GGCPC needs its research in the interrelation with the technological system (TS) taking into account all influencing factors on the basis of the system analysis and compound objects synthesis methodology [1].

The accumulated experience of scientific and applied research based on mathematical modeling and experimental knowledge of technological processes of gas processing and power supply systems allowed to create methods and algorithms for evaluating the performance of enterprises and industrial and economic systems based on the criteria of the quality of their performance as a whole. This made structural identification of technical systems in general [2, 3] or developed economic models of objects such as the oil and gas industry as a whole [4, 5]. At the same time, GGCPC EC has some specific properties, the main of which are its structure and operating modes dependence on the technological topology of the main processing procedures (which in turn is determined by the composition of raw materials), the period of the life cycle of hydrocarbon fields, from construction of the facility, and ending its decommissioning (including the relationship with the external system to ensure FER), ecological and climatic conditions of the region the object location and economic factors.

Our own theoretical and experimental studies of large enterprises EC on processing of various heterogeneous CHC condensate fields [1, 6-10] showed that the thermodynamic analysis of such complex systems of power technology will significantly restrict the scope of the search for optimal solutions. While multivariating problem of the EC structural and parametric synthesis can be solved on the basis of the decomposing and parametric method on the first research stages with the elementwise modification generation of the only innovative and rational scheme and parametric solutions, which are effective in the changing economic conditions at all life cycle stages of the main technological processes.

2. Model of energy complex

The analysis of the FER consumption and generation in separate GGCPC elements with the potential identification of its thermodynamic effectiveness increase is completed for the object, the structure of which is in the form of the block-hierarchical model. This structure is shown in fig. 1. Each hierarchy level shows the following internal and external connections: I – external assurance systems (CHC, FER, water) and sanitation systems processing plant; II – connection ventures with external systems; communication energy complex on the fuel system; GGCPC connection with systems the energy complex and manufacture of fuel system; III – communication energy complex systems with their installations and communications facilities of the fuel system to their settings; while EC systems and TS processes include a number of facilities of level IV, which contain energy-technological units (elements of level V), simultaneously relative to two elements of the level II – to the TS and the EC; IV – communications installations with the systems, manufacture, devices; V – communication between devices and resources. Last VI hierarchy level comprises a matrix of devices matching the level of the elements V mathematical analysis of the description, the optimization of consumption and generation FER and water.

The core processes are considered as the basic elements. These processes include a number of facilities with virtually the same process structure for all GGCPC (CHC separation, drying, cleaning) and facilities typical for single objects (processes of technical carbon, sulfur, helium).

EC systems are grouped in three basic systems by type of the consumable and generated energy supplies (fuel, electro-technical and thermo-technical) and the intraproductive subsystem, which includes technological and recycling water supply, air supply, neutral gas supply, water removal.

The main EC elements have complicated internal connections and multifunctional interrelation with the TS, its separate facilities and instruments are the fuel and energy supplies producers (for example degasser, CHC column-stabilizer, energy-technological waste-heat boilers, technological pipe heaters utilizers).