Issues related to energy saving in petrochemical sector and methods for their solution

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Abstract. The paper describes the case study of energy saving problems in the petrochemical sector and discusses methods of recovery of low-grade renewable energy resources and approaches to assessing their potential use.

The coordinated action of the power facilities within the industrial undertakings (distinguished below in three main parts) make it possible to efficiently consume fuel and energy resources in the required amounts. These are [1]:

1. Sources of energy resources, i.e. dedicated companies or in-house systems that produce the required types of energy.
2. Systems of transportation and distribution of energy resources between consumers.
3. Consumers of energy resources.

Each of the party in the energy resources producer–consumer system has its own hardware and is characterized by certain indicators of energy and thermodynamic efficiency. This may result in a situation when high efficiency indicators of some of the system participants are leveled by other participants, so that the total efficiency of the heat and power system turns out to be low [5,9,10].

The most problematic in this regard is the stage of consumption of energy resources. Inspection of some petrochemical companies shows that the actual energy resource consumption 1.7–2.6 times exceeds the theoretically required one [1], i.e. targeted use of energy resources is about 43% of the actual necessary costs of production technologies. The main causes for this situation to happen in the domestic industry are:

1) failure to select correct machinery, which in real conditions of operation can not facilitate the power usage effectiveness that correspond to the actual level of technical development;
2) inadequately arranged coordination between heat and power systems and heat engineering systems;
3) insufficient or inefficient use of secondary medium- and high-grade energy resources;
4) low-grade secondary energy resources, which include heat flows having a temperature [2]:
   t < 90° C for liquids;
   t < 150°C for gases;

are almost never used in industry and energy systems. However, the temperature level of consumption of heat resources in processes, as a rule, is low (see Table 1), and therefore the output of low-grade secondary energy resources used by the petrochemical undertakings makes up almost 90% of their total secondary energy resources.
Table 1 Heat consumption by a petrochemical undertaking [2]

| Consumers          | Total consumption of steam and hot water,% | Temperature level of heat absorption |
|--------------------|--------------------------------------------|-------------------------------------|
|                    |                                            | Up to 150 °C | Over 150 °C |
| Process            | 65                                         | 55          | 10          |
| Heating and ventilation | 25                                       | 25          | -           |
| Hot water supply   | 10                                         | 10          | -           |
| Total:             | 100                                        | 90          | 10          |

The linking chart of power production and distribution systems typical applied in petrochemical undertakings is shown in Fig. 1.

In the conventional approach, the heat and power systems of industrial consumers are solely considered as a sufficient power source adequate in quality as required by the process regulations [3]. The mode of operation of heat and power systems is subject to the conditions dictated by the consumer. Such an approach often leads to miscalculations while setting up heat engineering systems and heat and power systems, i.e. to the latent or apparent overspending of fuel and power resources, which naturally affects the cost of products.

Fig. 1 The linking chart of power production and distribution systems typical applied in petrochemical undertakings
CHS stands for centralized heating system;
HWS stands for hot water supply;
HS and VS stands for heating and ventilation systems;
PHSS stands for production heat supply systems;
CC and RS stands for condensate collection and return systems;
ACS stands for air conditioning systems;
CSS stands for cold supply systems;
CWS stands for cooling water system;
ASS stands for air supply systems.

In particular, the seasonal fluctuation [1, 3] has a rather strong influence on the overall indicators of the energy efficiency of industrial undertakings. In summer time, the secondary energy resources are usually supplied in excess, and at the same time the people face problems associated with insufficient amount and quality of cooling fluids due to an increase in the temperature of the cooling water. At the stable lowest outside temperatures, on the contrary, the heat energy is consumed to excess because of an increase in heat losses through cladding taking much time to identify and requiring substantial economic costs [8].

The key challenges to be addressed include:
1) ensuring the balance of energy resources of the required characteristics in any period of time for reliable and cost-effective operation of individual units and the entire production association;
2) optimal selection of utilities according to thermophysical and thermodynamic parameters;
3) definition, nomenclature and modes of operation of reserve and accumulating utility sources, as well as alternative consumers of secondary energy resources in the period of their excess supply [4];
4) identification of space for the energy efficiency of a production to grow at the current level of technical development and in the distant future.

Closed heat supply systems are one of the main components of waste-free production systems. The recovery of low-grade heat and its transformation to the required temperature level may return a considerable part of the energy resources, which is usually discharged into the atmosphere back to the process [6-7].

Cold supply systems of an industrial undertaking do not have a significant impact on the supply of secondary energy sources, but can be regarded as consumers of heat when developing recovery measures. In particular, one of the effective solutions for smoothing seasonal fluctuations in the power consumption system in the course of the year is the inclusion of absorption heat transformers in recovery systems.

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