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FROM ENERGY-TECHNOLOGICAL TO ENERGY-ECONOMICAL COMBINING

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ABSTRACT

The necessity for changing of the model, by which the new solutions in the energetics, the industry and the way of life are submitted to the interested circles from consumers, is motivated. A critical overview of the most widespread schemes for using of the physical heat of the outgoing gases from a given furnace is made. The existing practice for energy-technological combining is analyzed and the arising of real problems in it is pointed out.

The need for moving of attention's focus from the energy, the technical and the ecological effects, on the economic one, through which also the other aspects of a determinate problem to be covered is emphasized. A new approach, called in short "energy-economical combining", is proposed. With it a preference of the valuation of all elements and processes in the different options for constructing of the systems is given, after that ways for the technical realization of the most advantageous of them are sought.

Some directions for finding of competitive schemes, which can be outlined as profit-making by perception of a leading role of the energy-economical combining, are suggested.

Keywords: energy, efficiency, technological, system, impact, synergy.

INTRODUCTION

The dynamics of the public development imposes a permanent redefinition of the ways and the means for achievement of the purposes in the contemporary economics. The periodical crises confirm the necessity for leading of a right and purposeful business policy. One of its basic trends is the achievement of a sustainable energy system in each country. This includes a number of large scale tasks, requiring a complex and concerted solution.

During the last years often is talked about the energy economics [1], which according to some researchers in a near future will be replaced by the hydrogen economics, basing on the assumed as a most perspective resource among all the renewable energy sources (RES). Their imposition is a good example for the appearance of specific difficulties from a different nature [2,3]. Along with the objective problems, a disturbing tendency for formation of negative public attitude towards the alternative energetics is observed, even before it is developed in a sufficient stage. There is a feeling for a deficit of popular explanatory measures, which to convince the people, that the subsided by the country electricity is not enforced with the aim to favor close associates of the government investors at the expense of the increase of the costs of the regular consumer. It is necessary to explain in an intelligible language, that the conventional energy will unavoidably become dearer under the influence of the ecological legislation. For that reason, instead of paying after some time the same or a higher price for growing environment pollution and insecurity because of the moral and physical old technologies, it is better to continue persistently on the way of the sensible and maximally effective using of RES.

The pointed out problems show, that a new approach to the consumers of the different energy forms is necessary, independently if it is a big plant or a modest establishment. The individual human initiative can be best activated by economic motivation. All other arguments – climate changes, health problems, interna-

tional, respectively – European legislation, sanctions, etc. are right, but they sound abstractly and furthermore (and mostly), they are adopted as imposed, and provoke both intentional, and subconscious resistance.

The present work aims to expose some ideas and proposals, which we do not claim to be orientated towards the global energetics, but they are directed to particular problems, whose successful solution would have undoubted contribution to and impact upon the achievement of the wider purposes.

USING OF THE PHYSICAL HEAT OF THE OUTGOING GAS

Before seeking ways for improvement of the existing state in many enterprises, it is necessary to present [4] and consider the possibilities for connection of the technological aggregate and the equipment following it. The physical heat of the outgoing gas is utilized in three basic ways.

Technological Scheme

It envisages the using of the physical heat of the outgoing gas for technological needs. If this happens in the same aggregate, from which it is receiving (Fig. 1), the scheme is called closed. In this way the following, widely used in practice processes, are realized:

• the preheating of the air and/or of some low-caloric gaseous fuels, implementing in recuperators and regenerators;

• the preheating of the treated in the furnace material (for example, the scrap for smelting);

• chemical-thermal conversion of some stock materials before using it in the respective process, etc.

The applying of a closed technological scheme increases the efficiency of the fuel used in the metallurgical aggregate, i. e. it reduces the outlet of thermal secondary energy resources (SER) [4,5].

If the heat of the outgoing gas from a given furnace is used in another, more low-temperature installation, as it is shown in Fig. 2, the technological scheme is an open one. In that case, the effect from the limitation of the outlet of thermal SER is realized in the metallurgical aggregate, working with a lower-potential heat, but it remains available within the bounds of the greater production unit, for example a section or a shop, where the installation is located. In the practice combinations from the displayed above schemes are also found, namely a consequent using of the heat of the outgoing gas firstly in the basic aggregate, and then – in the low-temperature one.

Energy Scheme

In this scheme, (Fig. 3) the utilization of the physical heat of the outgoing gas is implemented in installations for generation of some kind of an energy bearer (heat, electric power, artificial cold et al.).

The consequent placement of several heat using units is also possible, for example – a waste-heat boiler (WHB) and a preheater of the water from the main (wa-

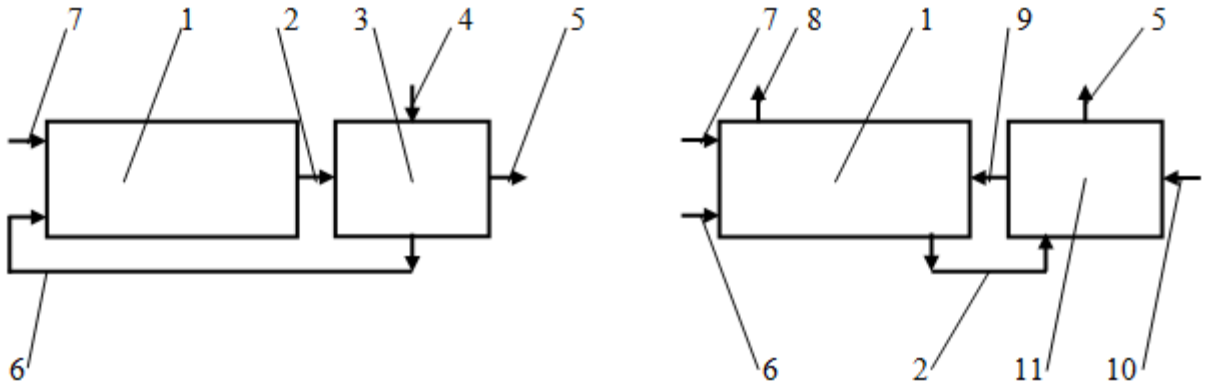

Fig. 1. Closed technological schemes for using of the physical heat of the outgoing gas: a – for preheating of air (or a gaseous fuel); b – for preheating of processed in the furnace material; 1 – furnace; 2 – taking away of the gas from the furnace; 3 – recuperator; 4 – feeding of the air toward the recuperator; 5 – taking away of the gas from the recuperator (a) or from the preheater (b); 6 – feeding of the air toward the furnace; 7 – feeding of the fuel toward the furnace; 8 – taking away of the heated material from the furnace; 9 – feeding of the partially preheated material toward the furnace; 10 – feeding of the cold material toward the preheater; 11 – preheater.

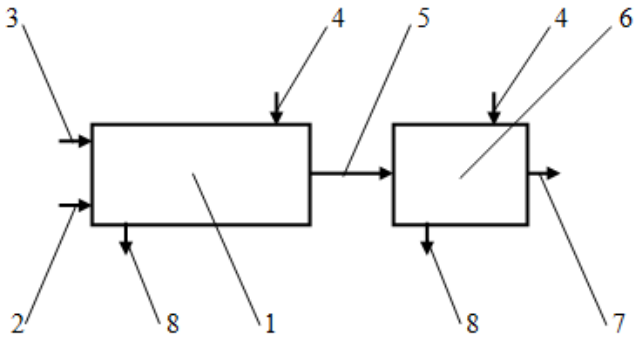

Fig. 2. Open technological schemes for using of the physical heat of the outgoing gas: 1 – furnace; 2 – feeding of the fuel toward the furnace; 3 – feeding of the air toward the furnace; 4 – feeding of the cold material toward the furnace or the second stage technological installation; 5 – taking away of the gas from the furnace; 6 – second stage technological installation (more low-temperature); 7 – taking away of the gas from the second stage technological installation; 8 – taking away of the heated material from the furnace or from the second stage technological installation.

ter economizer). From the point of view of the connection between the separate aggregates, the energy scheme represents a modification of the shown above open scheme (but it already cannot be consider a technological scheme).

The energy scheme allows for economy of fuel, which otherwise would be expended on the production in the conventional ways of heat bearers from the respective sorts and in the same quantities, at the expense the thermal SER of the technological aggregate.

Combined Scheme

The arrangement, which is shown in Fig. 4, presents a combination of the already considered technological and energy schemes. It ensures the reduction of thermal SER (due to the presence of its technological part), as well as the more effective using of these, by including them in the production process of some kind of heat bearer as a substituent of the basic fuel, which occurs in the energy zone of the combined scheme for utilization of the physical heat of the outgoing gas.

Spreading of the Separate Options

The realizing of the presented above energy and combined schemes is sought most often in the practice of the metallurgical and other big enterprises. On account of that, here underwill be paid more attention to their functioning.

It is the custom the activities for the insurance of the collaborative operation of the technological aggregate with the energy system to be designated with the term "energy-technological combining". A typical example for an energy-technological complex is the coupling of the metallurgical furnace and the WHB. Each of these aggregates works at very difficult conditions and this

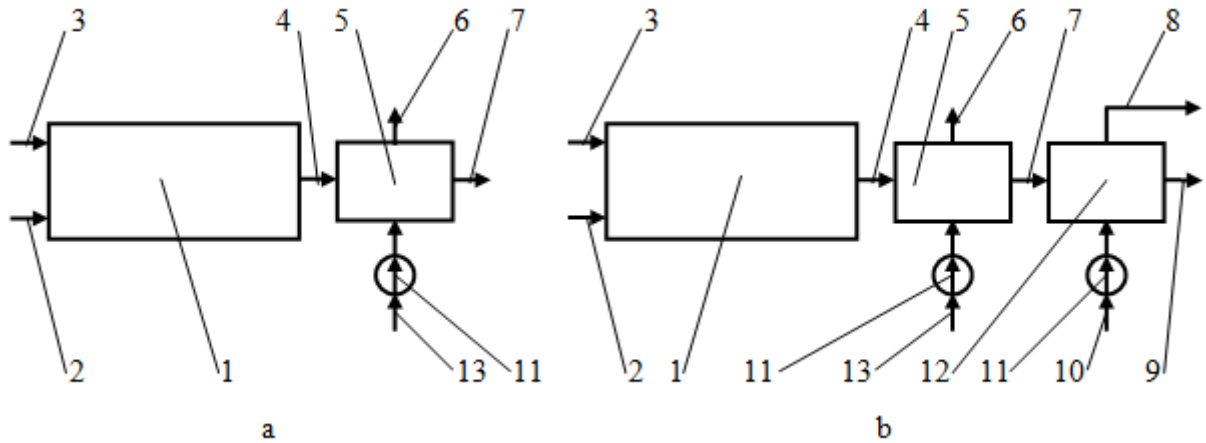

Fig. 3. Energy schemes for using of the physical heat of the outgoing gas: a – for water steam generation; b – for water steam and hot water generation; 1 – furnace; 2 – feeding of the air toward the furnace; 3 – feeding of the fuel toward the furnace; 4 – taking away of the gas from the furnace; 5 – WHB; 6 – taking away of the water steam from the WHB; 7 – taking away of the gas from the WHB; 8 – taking away of the hot water from the water economizer; 9 – taking away of the gas from the water economizer; 10 – feeding of the water toward the water economizer; 11 – water pump; 12 – water economizer; 13 – feeding of the water toward the WHB.

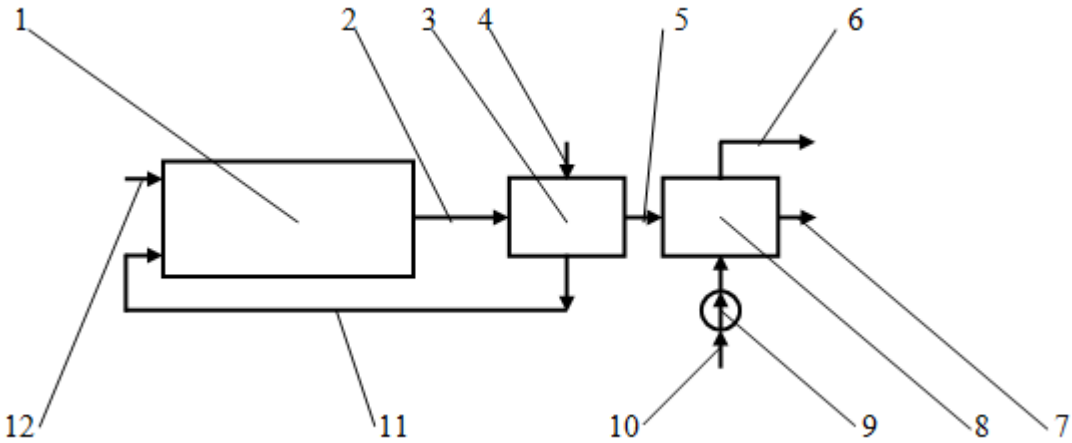

Fig. 4. Combined schemes for using of the physical heat of the outgoing gas: 1 – furnace; 2 – taking away of the gas from the furnace; 3 – recuperator; 4 – feeding of the air toward the recuperator; 5 – taking away of the gas from the recuperator; 6 – taking away of the water steam from the WHB; 7 – taking away of the gas from the WHB; 8 – WHB; 9 – water pump; 10 – feeding of the water toward the WHB; 11 – feeding of the preheated air toward the furnace; 12 – feeding of the fuel toward the furnace.

imposes a precise concordance of the separate processes in them, in order to achieve a useful reconciliation of their functions.

From that energy-technological complex the following more concrete requirements are demanded:

1) The furnace and the WHB must be in close proximity;

2) The radiation chamber of the WHB should have a large volume and be formed as a shielded horizontal uptake in order to ensure a reliable catching of the solid particles, moving with the gas outgoing from the furnace;

3) The tubes in the convective part of the boiler possibly should be placed streamwise toward the gas flux to avoid the initial strong lodgment of settlings on them in the zone, where the solid particles have highest temperatures and are most liable to sedimentation on surfaces;

4) In the same part a rectilinear movement of the smoke has to be ensured, as the presence of eddies increases the formation of settlings;

5) The pressure of the steam-water mixture should be not lower than 4 MPa, in order to use it firstly for energy needs, and then – for industrial and customer ones;

6) The heat engineering and exploitation characteristics of the WHB must be considered within the technological process;

7) The boiler has to work also as an effective dust-catching unit.

The analysis of the interaction between the two elements of the treated energy-technological complex allows to make the conclusion, that the fulfilling of the shown above requirements would be related to considerable efforts and expenses, inclusive of control and management of the processes [6]. This is not always justifiable from an economical point of view and in some cases might be difficult or even impossible. Irrespective of these problems, the idea of the energy-technological combining proceeds decades on end to form the thinking of researchers and specialists from the practice, as a peculiar tenet – where waste heat exists, it must first be used for obtaining of the possible highest-potential product and gradually to go to finding of its application in next units, producing a heat bearer with a lower temperature and pressure.

PROBLEMS IN THE ENERGY-TECHNOLOGICAL COMBINING

The practical exploitation of the WHB is often connected with serious disturbances. Some of the most typical are listed below.

- It leads to high pollution of the tubes and to an impossibility for their cleaning without interruption of the boiler's work.
- Not always the enterprise manages to utilize the steam, produced in the WHB, for power generation. There are cases, when the necessary devices for that purpose are provided and delivered, but they do not function because of additionally appearing problems.

• As a consequence of the previous demerit, the steam is directed for using it as a heat bearer towards other consumers. They, however, most often require an industrial steam with lower parameters and in larger amounts. That imposes a reduction of its pressure, which is connected with losses of mechanical and thermal energy, i. e. in that case the steam must be considered as a SER with superfluous pressure [5].

The losses from such obviously unsuitable and groundless energy-technological combining can be systematized as follows:

1) Large initial investments for installation of a boiler for generation of steam with high parameters are made.

2) Permanently increasing operational costs for its using not to the purpose are arising.

3) The amount of the produced heat bearer on account of its unnecessarily high parameters is restricting, which can lead to impossibility to fulfill all needs of the enterprise for lower-potential steam for technological and other purposes.

4) Inserting in the scheme of additional equipment for reduction of the steam pressure is imposed, leading to enlarged capital investments and operating costs, and also to an undesired outlet of SER with superfluous pressure [5].

5) The system becomes complicated by additional heat exchangers, preparing steam or heated water with the necessary lower end parameters.

DISCUSSION AND PROPOSALS FOR SOLUTION OF THE PROBLEMS

A possibility for exiting from the "trap", which sometimes can by set with good purpose, but is restricted in the technical aspect of the problems of the energy-technological combining, must be sought by turning around of the components of the technical-economic approach for assessment of the efficiency of the building complex. More specifically, it is proposed to give a priority to the economical analysis of all elements and processes in the different options for constructing of the systems, in which ways for the technical realization of the most advantageous of them to be sought.

By maintenance of the used until now terminology, this working over can be called "energy-economical combining". Its idea is grounded in following steps:

• evaluation of the whole amount of outgoing heat from the furnace;

• preliminary assessment of the options for its using, while the inserting of the WHB after the technological aggregate remains one of the options;

• taking a final decision after exhaustive analysis of the possible additional expenses and hidden factors, leading to raising of the cost of each of the options.

Logically would sound the argument that this is made up to now as well, since there is no enterpriser, which would refuse the profit from one optimal solution. Nevertheless, there are enough cases, when because of an excessive increase of some of the presented above losses or to all of them, the energy-technological complex does not work well.

An argument against the proprsed idea would be also the absence of other possible options.

Some directions for seeking of competitive schemes are proposed below. These can be considered as paying off for the adoption of the leading role of the energy-economical combining.

a. The power generation should be excluded as a way for utilization of the outgoing heat from the furnace (certainly in determinate, good reasoned cases). Instead of it, as financially and technically more profitable, the production of a lower-potential steam for technological needs might prove to be a better option, which subsequently can be used also for heating of industrial and of communal objects. This approach was already demonstrated in Fig. 2, but its repetition is justifiable from the point of view of emphasizing the refusal of power generation after it turns out to be possible in principle.

b. Immediately after the furnace one or a group of recuperators, respectively regenerators might be set, serving for preheating of the air, the fuel or both media. This means realizing of some of the closed technological schemes, displayed in Fig. 1a and b, but again with a reservation about the availability of sufficiently high-potential heat and the dropping out of the generation of electricity for economical reasons. It is worth to note as a negative tendency, which should be overcome, that notwithstanding the obvious benefit from the mentioned utilizing units and their exceptionally short amortization term [7,8], they are still treated as a subsidiary, dispensable equipment for the basic metallurgical aggregate.

c. It is even possible the economical calculations to show an advantage of the direct feeding of the heat towards the interested consumers. This would save the large capital expenditures and operating costs for the

WHB, in the place of which the investment in small and considerably cheaper, for building and maintenance, steam generators and heat water boilers is better.

d. As a natural continuation of the previous idea, measures for encouragement of the creating of small satellite enterprises at the large metallurgical plant can be sought, as the abatement from the price of the selling by it of thermal energy would be compensated with the reduced investments and losses at its transport in shorter distances or best – with the using of it practically "in situ". This can be implemented in the following three ways:

• Outsourcing of some functions, performed until now in the basic firm and considered as inessential on the background of its main production.

• Involving of enterprisers with a quite different object of activity, which can consume partially the available heat.

• Seeking of a cooperation with energy stations, based on RES, in which for preliminary or in parallel running processes, the using of thermal energy is enforced. Similar combinations are discussed in [2].

A good base for achievement of the desired synergy between the separate elements of a given energy installation is the focusing of the attention on his economic efficiency, as all other not less important problems – technical, technological, ecological and social, must find also their proper estimation by evaluation of each particular unit or measure.

CONCLUSIONS

A critical overview of the most widespread schemes for using of the physical heat of the outgoing gases from a given furnace is made.

The existing practice for energy-technological combining is analyzed and the arising real problems are pointed out.

A new approach, named in short "energy-economical combining", is proposed. With it a preference of the valuation of all elements and processes in the different options for constructing of the systems is given, after that ways for the technical realization of the most advantageous of them are sought.

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