THE INTEGRATED CRITERION OF ECOLOGICAL SAFETY OF INTRODUCTION OF HELIOENERGETIC SYSTEMS

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Perfection of estimation system of an ecological efficiency when introducing helioenergetic systems for producing heat in comparison with the thermal boiler-houses working while burning traditional fuel, through the system of integrated criterial factors is offered in the given work.

The criteria of a condition of an ecosystem should answer a number of general requirements from which it's expediently to allocate the followings:

a) sufficient sensitivity in relation to parameters $e_i(\varepsilon_{\text{птг}})$ of ecosystems, answering to the given criterion;

b) necessary constructability allowing rather simply to define numerical value of criterion;

c) sufficient universality from the point of view of possibility of comparison of efficiency of the nature protection functions realized in an ecosystem.

Formalizing requirements to integrated criterion of a condition of an ecosystem, it can be presented as a functionary:

$$J[\varepsilon_{\text{птг}}] = \Phi\left[\varepsilon_{\text{а}}\left(\sum_{i=1}^{n} e_i\right); \varepsilon_{\text{в}}\left(\sum_{i=1}^{n} e_i\right)\right], \tag{1}$$

where $\varepsilon_{\text{а}}\left(\sum_{i=1}^{n} e_i\right)$, $\varepsilon_{\text{в}}\left(\sum_{i=1}^{n} e_i\right)$ - a vector, accordingly, characterizing parameters of an ecosystem which are given in to management and not influencing on integrated criterion of a condition.

For an ecological estimation of a heat power boiler-house we will consider the integrated factors consisting of criteria of an estimation of pollution of air, water environment and soil which will consist of criteria with controllable and uncontrollable parameters.

$$J_k\,[\varepsilon] = \Sigma W(\varepsilon_{\text{атм}}) \cdot \Sigma W(\varepsilon_{\text{вода}}) \cdot \Sigma W(\varepsilon_{\text{почва}}) \cdot W(\varepsilon_{\text{метеор}}) \cdot W(S) \cdot W(Ч) \tag{2}$$

where $\Sigma W(\varepsilon_{\text{атм}}) = \left(\frac{C_{1\,атм}}{ПДК_{1\,атм}} + \frac{C_{2\,атм}}{ПДК_{2\,атм}} + \ldots + \frac{C_{i\,атм}}{ПДК_{i\,атм}}\right)$ - the criterion of an ecological safety of atmosphere;

$\Sigma W(\varepsilon_{воды}) = \left(\frac{C_{1\,воды}}{ПДК_{1\,воды}} + \frac{C_{2\,воды}}{ПДК_{2\,воды}} + \ldots + \frac{C_{i\,воды}}{ПДК_{i\,воды}}\right)$ - the criterion of ecological safety of the water environment;

$\Sigma W(\varepsilon_{\text{почвы}}) = \left(\frac{C^*_{1\,почвы}}{ПДК_{1\,почвы}} \right)$ - the criterion of ecological safety of soil;

$W(\varepsilon_{\text{метеор}}) = \frac{\vartheta_{ск}}{\vartheta_{\max}} \cdot \frac{\beta_{влаж}}{\beta_{\max}} \cdot \frac{T}{T_{\max}} \cdot \frac{Z_c}{Z}$ - the criteria of influence of weather conditions (a wind, rain, snow temperature) on environment reaction;

$C_{i\,атм}$, $C_{i\,воды}$, $C_{i\,почвы}$ - accordingly (g/m^3), concentration of the harmful substances inherent in emissions at combustion of fuel, thrown out in atmosphere, in water objects together with technical water from boiler-houses, ground concentration of corresponding harmful substances, falling in soil; $ПДК_{i\,\text{атм}}$, $ПДК_{i\,воды}$, $ПДК_{i\,почвы}$ - accordingly (g/m^3), maximum permissible concentration of harmful substances in atmosphere, in technical dumped water, in soil; $\vartheta_{ск}$, $\vartheta_{\max}$ - speeds of a wind accordingly average (on a wind rose) during the operation of installation and maximum in the given region; $\beta_{влаж}$, $\beta_{\max}$ - relative humidity accordingly average during the operation of installation and maximum in the given region; T, $T_{\max}$ - temperatures according to a season of operation of installation and maximum in the given region; Z_c, Z - quantity of sunny days and quantity of days for a season of operation of installation.

We will consider the criterion of alienation of the territory of earth occupied under installations (thermal boiler-houses and helioenergetic). First of all, the territory of heliosystem considerably exceeds the territory of location of a boiler-house, as the area of solar systems depends on the capacity of installations. The alienation territory leaves a crop rotation, loses direct sunlight and is exposed to less fall of rain, snow, there is a poor vegetation on it and it is used a little by fauna. For definition of efficiency of ecological safety we will carry the area of considered installation of individual capacity to the area of a solar power plant of the same capacity and we will receive the criterion of alienation of territory

$$\Sigma W(S) = \frac{S_{уст}}{S_{гел.уст}} \cdot \frac{C_{ст}}{C_{ст\,рег}} \qquad (3)$$

$S_{уст}$ – the area of corresponding installation (a boiler-house or a solar power plant); $S_{гел.уст}$ – the area of alienation of the territory occupied with a solar power plant, i.e. occupied helioenergetic modules of a simple design; $C_{ст}$ – cost of the land in installation site, tenge; $C_{ст\,рег}$ – average cost of the land in region, tenge;

$$S_{гел.уст} = [(l \cdot H \cdot \cos\alpha) \cdot m + M] \cdot n \cdot 1{,}2 \qquad (4)$$

where: l and H– width and height of the module of passive action, m; cos$a$ – a module angle of slope to horizon, hailstones; m– number of modules in line; n– number of lines; M– pass factor between numbers of modules, M=1,2; 20 % for the general non registered expenses of territory, factor – 1,2;

The area of the helioenergetic installation with modules of a simple design can be chosen as the equivalent to the capacity of a thermal boiler-house. If the capacity of boiler $1\cdot10^6$ Vt, then capacity corresponding the heliosystem with modules of a simple design will be:

$$N_{гел.сист} = N_{котел} = 1\cdot10^6 = G\cdot Q_p^H \cdot\rho\cdot\eta_{котел} = S_{гел.уст}\cdot Q_{пад}\cdot\cos i\cdot\gamma\cdot\nu\cdot\xi\cdot\eta_{КПД} \quad (5)$$

where G–the fuel consumption burnt in a boiler-house (for gas); Q_p^H – the lowest warmth of combustion of fuel; ρ – density of submitted fuel (gas); $\eta_{котел}$ – EFFICIENCY of boiler installation; $Q_{пад}$ – the maximum capacity of the solar radiation falling on a horizontal surface of the earth, $Q_{пад}$ =750 Vt/m^2 (for Aktau in June); $\cos i$ – a corner considering the position of solar modules; γ – the factor considering degree of overcast of a firmament during the day; ν – the factor considering daily changes of the falling solar energy; ξ – dust content factor of lightpassing coverings of helioreceivers (ξ =0,85); $\eta_{КПД}$ – EFFICIENCY of the module of a simple design, $\eta_{КПД}$ =0,3. Then

$$S_{гел.уст} = \frac{1\cdot10^6\cdot}{Q_{пад}\cdot\cos i\cdot\gamma\cdot\nu\cdot\xi\cdot\eta_{КПД}} \quad (6)$$

$S_{уст}$ - the territory (for example, a boiler-house), including the building of a thermal boiler-house, a platform under warehousing of materials, container, reserve fuel for the station with the capacity 1 MВт, it is possible to accept equal 20×30 $м$, $S^*_{уст}$ – the area of an effective helioenergetic installations depending on degree of perfection of modules and the established capacity it is possible to calculate as:

$$S^*_{уст} = S_{гел.уст}\cdot\eta_{C_{о.э.}}\cdot\eta_{эфф}^{сел}\cdot\eta_{аккум.системы} \quad (7)$$

where $\eta_{C_{о.э.}}$ – factor of degree of concentration of sun rays on installation of an adapting surface of the flat module of a type «a hot box»; at unitary refraction of rays in concentration $\eta_{C_{о.э.}} = \frac{1}{C_{о.э.}} = 0{,}52$, at double $\eta_{C_{о.э.}} = \frac{1}{C''_{о.э.}} = 0{,}37$

where $C_{o.e}$– the optiko-power factor depending on an overall performance of a solar collector, for unitary, $C_{о.э.} = 1{,}9$, for double $C''_{о.э.} = 2{,}7$; $\eta_{эфф}^{сел}$ – the factor considering applications of selective coverings of the adapting surface, accepted 0,9; $\eta_{аккум.системы}$ – the factor considering application in the system of the thermal accumulator of a solar energy, accepted 0,85.

Calculations on the areas of alienation of the territory by the resulted technique are carried out and following values factors of alienation are received $W(S)$:

for a gas boiler-house: $W(S) = 0{,}06 \cdot \frac{C_{cm}}{C_{cm\ pez}}$;

for a boiler-house working on black oil: $W(S) = 0{,}1 \cdot \frac{C_{cm}}{C_{cm\ pez}}$;

for a boiler-house working on coal: $W(S) = 0{,}25 \cdot \frac{C_{cm}}{C_{cm\ pez}}$;

for effective helioenergetic installations: $W(S) = 0{,}35 \cdot \frac{C_{cm}}{C_{cm\ pez}}$.

Integrated factor analysis of ecological safety of introducing installations shows that the most ecologically adverse are the application of the thermal boiler-house working on coal, containing a considerable quantity of firm particles and slags, oxides of sulfurs, carbon, nitrogen etc. and having smaller in comparison with black oil and natural gas the lowest warmth of combustion of fuel. A considerable share of loss of heat from incompleteness of combustion of fuel. Coal boiler-houses occupy rather large territory for storage of firm fuel and recycling wastes, and also uses technical water.

The boiler-houses working on highsulphide black oil, have higher indicators on the lowest warmth of combustion of fuel (almost in 2 times) that affects capacity and an installation overall performance, the exit of slags decreases, the quantity of harmful substances with smoke gases in atmosphere decreases. Consumption of technical water is lowered, and it is absent in some designs of boiler-houses at all. The area under capacities for black oil storage is much less than the territories, given for technological needs of the boiler-houses working on coal. In the boiler-houses working on gas, harmful ecological loads are considerably lowered in comparison with other kinds of fuel, but wastes of products of combustion in atmosphere remain. Block boilers have appeared recently which are much more compact than stationeries. However there is an important factor that boiler-houses are adhered to a gas highway and cannot work in the independent mode isolated from external relations. Therefore the first three criteria in an integrated indicator are inherent only in boiler-houses and are absent in helioenergetic systems. It is necessary to accept the criterion of ecological safety and labour input for boiler-houses is higher, for example, for a coal boiler-house $W(Ч)$=1, a black oil boiler-house $W(Ч)$=0,8, gas $W(Ч)$=0,6, and for helioenergetic installations $W(Ч)$=0,1. The danger of manufacture, preparation and personnel training, appointment of round-the-clock watch and manual work share should be also taken into consideration while appointing this factor. The analysis and the above-stated reasonings lead to the following indexes:

$$J_k\,[\varepsilon] = \Sigma W(\varepsilon_{атм}) \cdot \Sigma W(\varepsilon_{вода}) \cdot \Sigma W(\varepsilon_{почва}) \cdot W(\varepsilon_{метеор}) \cdot W(S) \cdot W(Ч) \le 1 \quad (8)$$

$\Sigma W(\varepsilon_{атм}), \Sigma W(\varepsilon_{вода}), \Sigma W(\varepsilon_{почва}), W(Ч)$ for boiler-houses are the defining in a substantiation of ecological compatibility of the project when introducing installations.

Reliability of heliosystem work in the season of prospective operation is connected with uncontrollable parameters, basically with the energy of solar radiation. However we can already say that reliability and stability of work is shown by the technics of advanced world Powers. It is improved by introduction of more effective sun heating modules, accumulators and settles down on the aloof areas (roofs of houses), it does not demand the man's constant control , its operation is simple. The architecture of modern town-planning provides for making special roofs with the built-in heating modules. This the technology of future.

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ИНТЕГРАЛЬНЫЙ КРИТЕРИЙ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ ВНЕДРЕНИЯ ГЕЛИОЭНЕРГЕТИЧЕСКИХ СИСТЕМ

Б.Ж.ТУРКПЕНБАЕВА, Т.ОМАРБЕКУЛЫ

Предлагается совершенствование системы оценки экологической эффективности внедрения гелиоэнергетических систем для выработки тепла по сравнению с тепловыми котельными, работающими при сжигании традиционного топлива, через систему интегральных коэффициентов.