THERMAL POLLUTION OF THE ENVIRONMENT

A.A.Bayramov, Sh.A.Alihanova, P.A.Askerova, *S.M.Bayramova

Institute of Physics National Academy Science of Azerbaijan, Baku, Azerbaijan
**Insctitute of Geology National Academy Science of Azerbaijan, Baku, Azerbaijan*

ABSTRACT

In paper the problem of thermal pollution of the environment is considered as a result of power man-caused processes. Estimation of an energy balance industrial is fulfilled PK-10 power plant used for heating.

Keywords: thermal pollution, energy balance, ecosystem, thermal radiation.

I. INTRODUCTION

The solar radiation is the fundamental power source for all processes happening in biosphere. Under action of an incident solar flow as a result of its absorption the ground surface heats and becomes a radiant of the long-wave radiation directed to an atmosphere. The atmosphere, on the other hand, also is a radiant of the long-wave radiation directed to Earth. Thus there is a cross heat exchange between a ground surface and an atmosphere. The difference between a short-wave radiation swallowed by a ground surface and effective radiation is a radiation balance of Earth [1]. Conversion of power of a short-wave radiation of sunshine at absorption by its ground surface and an atmosphere, heat exchange between them make a heat balance of Earth.

The main feature of a radiation condition of an atmosphere is the hotbed effect which consists that short-wave radiation mostly reaches a ground surface, heats its, and the long-wave radiation from Earth delays an atmosphere, diminishing thus a heat dissipation of Earth in space.

Radiation and the heat balance of Earth, their persistence plays the important role for biosphere of Earth. However the real heat balance of Earth and an atmosphere differs from considered above. Thus it is quantitatively very difficultly to estimate all components of this heat balance. It is even more difficult to estimate effect of the technogenic processes, coupled with human activity. For example, the quantitative increase of some gases and aerosols in an atmosphere as a result evolution a power industry, on the one hand, increases an incident sunshine, and deserts and sections of the cut down forest, on the other hand, more reflects an incident sunshine back in space. Thus, one technogenic processes result in to excessive heating of Earth, others - to cooling [2,3].

In addition, effect on a heat balance of Earth thermal pollution in the form of the slip heat in pools render, the rivers, in an atmosphere of a fuel and energy complex. Precise calculation of thermal pollution of an environment and its control including on the analysis of many parameters and the taking into account of many interdependent processes stipulate for technogenic human activity.

It is known, that a majority consumed by the population of electric power, it is received due to transformation of the heat energy escaped at combustion of organic fuel. At transformation of power of organic fuel approximately 30% of power of fuel turns to electric, 70% of power inputs in an environment in the form of thermal pollution and air contaminations by combustion products.

For monitoring a degree of breakdown of a heat balance level it is necessary to estimate an energy balance of processes in an environment.

II. MAIN TEXT

The energy balance of any engineering plant (the apparatus, installation, the contribution link, production) or ecological system can be description by the equations of an incoming and consumption energy. The energy balance is made on the basis of the law of conservation of energy according to which in a confined system the total of all aspects of power is fixed:

$$\Sigma E_{in} - \Sigma E_{out} = 0,$$

here E_{in} – incoming energy into the system, E_{out} – out coming energy from the system.

Most often for engineering, geotechnical and ecological systems the heat balance is calculated for continuous processes on unit a time, and for periodic one - for the period of a cycle. For a basis for calculating is the material balance with take into account thermal effects of the exothermic and endothermic chemical reactions, and also physical processes of transpiration, condensation, a sublimation, dissolution and etc.

The heat balance of ecological system can be presented according to the equation [4,5]

$$Q_{1s} + Q_{1l} + Q_{1g} + Q_{1f} + Q_{1ex} + Q_{1in} = Q_{2s} + Q_{2l} + Q_{2g} + Q_{2f} + Q_{2en} + Q_{2out}, \quad (1)$$

here Q_{1s}, Q_{1l}, Q_{1g} - a quantity of heat incoming in system, Q_{2s}, Q_{2l}, Q_{2g} - a quantity of heat, out coming solid, liquid and gases; Q_{1f} - heat of the physical processes which are flowing past with extraction (Q_{2f} - with absorption) heat; Q_{1ex} - a quantity of heat, escaping in exothermic processes; Q_{2ex} - a quantity of heat swallowed in endothermic processes; Q_{1in} - a quantity of heat made to system; Q_{2out} - a quantity of heat assigned from system.

Values Q_{1s}, Q_{1l}, Q_{1g} are calculated for each substance in view of its quantity of M, a specific heat capacity c and temperatures t:

$$Q = M \cdot c \cdot t$$

The heat capacity of a mixture of substances pays off on additively law:

$$c_M = \frac{M_1 c_1 + M_2 c_2 + ... + M_n c_n}{M_1 + M_2 + ... M_n}$$

The summarized heat of physical processes can be find from the equation:

$$Q_f = M_1 \cdot r_1 + M_2 \cdot r_2 + \ldots + M_n \cdot r_n,$$

Here $r_1, r_2..., r_n$ - heat of phase changes.

The thermal effect of a chemical reaction can be defined as the total of isobaric heats of formation of reaction particles:

$$\Delta H = \Sigma\ (DHcr)_{\text{in}} - \Sigma\ (DHcr)_{\text{pr}}.$$

The application of heat to system Q_{1in} can be considered on losses of quantity of heat by the heat transfer medium:

- by water $Q_{1in} = M_w \times c_w \times (t_1 - t_2)$;
- by steam $Q_{1in} = M \times r$;
- a heat transfer through wall $Q_{1in} = k_T \times F \times (t_1 - t_2) \times t$,

Here k_T - a heat transfer coefficient; F - a heat-exchange surface;

t_1, t_2 - temperature of the heat transfer medium on an inlet and an output accordingly;

t - a time.

At determination heat minimum of combustion of fuel in mechanic accounts it is possible to use the formula:

$$Q_{min} = 339{,}3 \times C + 1256 \times H + 109 \times (O - S) - 25{,}2 \times (9 \times H + W)$$

here C, H, O and S - a total carbon, hydrogen, oxygen and brimstone accordingly, in percentage masses; W - moisture content in working fuel, in percentage masses.

The higher heat of combustion of fuel:

$$Q_{max} = Q_{min} + 25{,}2 \times (9 \times H + W)$$

Theoretical flow of air (in kg on kg of fuel) pays off on the equation:

$$M_{teor} = 0{,}116 \times C + 0{,}348 \times H + 0{,}0135 \times (S - O)$$

The quantity of heat, moist air I_{air}, is determined by formula:

$$I_{air} = \alpha \times M_{teor} \times (1{,}02 + 1{,}95 \times x) \times t_{air},$$

Here α is a factor of excess of air:

for solid fuel $\alpha = 1{,}3 \div 1{,}7$;

for oil fuel $\alpha = 1{,}1 \div 1{,}2$;

for a gas fuel $\alpha = 1{,}0 \div 1{,}2$;

x - a moisture content of air (kg on kg dry air); t_{air} - temperature of air given to a combustor (in a furnace); 1,02 and 1,95 - a specific heat capacity of air and water vapours accordingly.

For a example, let consider operation of the industrial choke of the personal computer-10 which are heated up by a hot steam under pressure of 2 atmospheres in view of Joule heat losses in a surrounding medium. A mass of water in reactor M=5000kg, external heat loss the kg\sec, reference temperature of water in the choke t_0=15°C, final temperature t=90°C make Q_{out}=15кW, a steam rate m=0,5. We shall specify a time of heat of water in reactor t.

The hot steam condense in water, therefore during moment t quantity of water equally $M + m \times t$.

The Heat-balance equation (1) looks like

$$(M + m \times t) \times c \times t = m \times n \times t + M \times c \times t_0 + Q_{out} \times t, \quad (2)$$

Here n = 2710 kJ/kg is an enthalpy of the saturated water vapour, c = 4,19kJ/kg/deg is a heat capacity of water.

From heat-balance equation we shall specify a time of heating up of water:

$$\tau = \frac{M \cdot c \cdot (t - t_0)}{m \cdot (n - c \cdot t) + Q_{out}} = 0{,}369 \text{ hours.}$$

For an estimate of Joule heat losses in a surrounding medium we shall specify the equation of variation of temperature.

Necessary for heating up of water the quantity of a steam m^1 is equal

$$m^1 = m \times t = 665 \text{ kg.}$$

Solving heat-balance equation (2) concerning temperature, we receive

$$\text{t} = \frac{M}{M + m \cdot \tau} \cdot t_0 + \frac{(m \cdot n + Q_{out}) \cdot \tau}{M + M \cdot \tau} \cdot c$$

Substituting numerical value, we gain the equation of variation of temperature

$$t = \frac{7500}{5000 + 0{,}5\tau} + \frac{1370\tau}{2{,}095(10000 + \tau)} \quad (3)$$

III. CONCLUSION

Thus, using the gained equation (3) can be used for a loss evaluation of heat in an environment that is to evaluate thermal pollution by operation of the PK-10 industrial reactor.

Now regularity of a common increase of temperature of pools, the rivers, atmosphere in locations of power stations, and the industrial factories is founded. It result ins to variation of a thermal conditions of pools that affects a biology organisms life, to originating undesirable airflows because of an increase of temperature in an aerosphere, to variation of air moisture and a sunshine and, in the issue, to variation of a microclimate. The density of technogenic power, for example, in territory of Japan makes approximately 2 W/m^2, and in the Ruhr region of Germany - approximately 32 W/m^2. Further propagation of thermal pollution in industrial regions can lead to breakdown in common atmosphere circulation of all planet, influencing on positive stability of our ecosystem.

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