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DYNAMIC ANALYSIS AND MODELING OF SOLAR RADIATION IN A CLOSED ENVIRONMENT

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ABSTRACT
This paper analyzes the solar thermal energy in a closed air environment which serves as heat accumulation. Within the power equation of thermal equilibrium that appears in the closed environment is taken into account the construction environment and the level of air movement and air temperature in the environment. So within this enclosed environment also performed a kind of ventilation which means the transport of heated air in a particular destination environment. The closed environment has entry channel for air and exit channel of air from the environment. So air accumulated heat in the closed environment through the capacity created by solar radiation can be used in various practical applications. Through analysis and charts will be represent the data of amount thermal energy and the temperature in function of the construction of the wall, in function of the surface, and in the function of flow.
Keywords: Solar, radiation, thermal, energy, environment.

1. INTRODUCTION
Good insulation enclosed space can be achieved including: reducing the thermal conductivity of the walls, increasing the number of transparent layers (instead of only one, double glass windows), setting fixed thermal curtains in northern facades and roofs, setting the curtains - thermal protectors in southern facades and roof, or in the growing plant area (night work), right orientation space heating with solar energy, using cheaper sources of energy (waste heat, solar energy, etc.), better organization of heating and ventilation systems, etc. Additional system for receiving and transforming the energy of solar radiation into heat (receiver), determined by the structure of space, and preferably closer objects which dedicates their energy in order to reduce the cost of investment and heat loss in transportation.

2. EQUATION OF THERMAL POWER BALANCE AND DYNAMIC ANALYSIS OF SOLAR RADIATION
Energy which is delivered to the inside environment in unit of time can be expressed through the heat balance [1]:

$$\frac{dQ_b}{d\tau_s} = \frac{dQ_k}{d\tau_s} + \frac{dQ_k}{d\tau_s} \quad \ldots (1)$$

Heat which is delivered to the enclosed space by the system with conventional fuel combustion, and is determined by the equation:

$$Q_k = \dot{m}_a \cdot c_{pa} \cdot \Delta t_a \cdot \tau_s \quad \text{… (2)}$$

Heat which is achieved in the closed area by the action of the sun's radiation is expressed by the equation:

$$Q_s = (\tau \cdot \alpha) \cdot P \cdot S_{bm} \cdot \tau_s \quad \text{… (4),}$$

Thermal losses more pronounced are those with thermal conductive, convection and radiation through the roof and walls, and other losses are neglected. Thus, thermal losses are presented in the general form:

$$Q_h = k \cdot \Delta t_s \cdot S_m \cdot \tau_s \quad \text{… (5)}$$

In the alleged limits and preconditions, achieved total dependence of the energy balance:

$$k \cdot \Delta t_s \cdot S_m \cdot \tau_s = \dot{m}_a \cdot c_{pa} \cdot \Delta t_a \cdot \tau_s + (\tau \cdot \alpha) \cdot P \cdot S_{bm} \cdot \tau_s \quad \text{… (6)}$$

By insulation and better climatic conditions, changing of the power solar radiation directly affects the change of t_b. Heat which is lost by ventilation is [2]:

$$Q_a = Q_{af} + Q_{ar} \quad \text{… (7)}$$

Air temperature depending on the seasons is 30÷50 °C.

Assuming that $Q_s=0$, from equation (6), the difference $t_{ng}=t_h$ (air temperature at the exit of the heating system) from t_0 determine for certain features of space and working space parameters according to equation:

$$t_{ng} = t_h = \frac{S_m \cdot (t_b - t_0)}{\dot{m}_a \cdot c_{pa}} + t_b \quad \text{… (8)}$$

From this expression determined dependence of inside heat Q_b of t_{ng} (fig. 1). In fig. 2 is given the dependence of Q_s from P for one glass with certain constructive characteristics, and for different values of ($\tau\alpha$). Dependence of air temperature increase of global solar radiation is determined by the expression (fig. 3):

$$\Delta t_a = \frac{P \cdot (\tau\alpha) \cdot S_{bm}}{\dot{m}_a \cdot c_{pa} + k \cdot S_m} \quad \text{… (9)}$$

Dependence of air temperature increase of t_b of t_o and P for one glass with certain constructive characteristics ($\tau\alpha$)=0,73; ($\tau\alpha$)=0,55 and k=5,8 W/(m^{2}K), is given in fig. 4. In fig. 5 is given to the change of the amount of heat depending on the temperature of the air and constructive characteristics ($\tau\alpha$) and k.

Dependence of change $\dot{m}_a$ from t_b and P, is given in fig. 6. For constant values of $\dot{m}_a$, air temperature increase t_b for glass with certain characteristics is given by the expression [3]:

$$\dot{m}_a = \frac{P \cdot (\tau\alpha) \cdot S_{bm}}{c_{pa} t_b} - \frac{k \cdot S_m}{c_{pa}} \quad \text{… (10)}$$

Where: $\dot{m}_a$, kg/h – mass flow rate of air which is heated in the closed environment of the warm period, which is sent from the closed environment into certain environments without heated; c_{pa}, kJ/(kgK) – specific heat of air, and $\Delta t_a = t_h - t_d$, ^{0}C – change of the inlet (t_h) and output (t_d) air temperature of enclosed space, τ_s, s – time duration of the energetic effect. Q_b, W – heat which is delivered in closed area; ($\tau\alpha$) - walls transmission - absorbing properties of enclosed space; P, W – thermal power of global solar radiation; S_{bm}, m^2 – base surface of the closed space; k, W/(m^{2}K) – the overall coefficient of heat transmission; $t_s = t_b - t_o$, ^{0}C – the temperature change in the inside environment (t_b) and of the air surrounding temperature (t_o); S_m, m^2 – surface of the space wall and roof. Q_{af}, W - component of the heat lost from "air processing, which removed as the need for fresh air; Q_{ar}, W - component of the heat lost from the air, due to the necessity of lowering the temperature of the air from the effect of solar radiation heat.

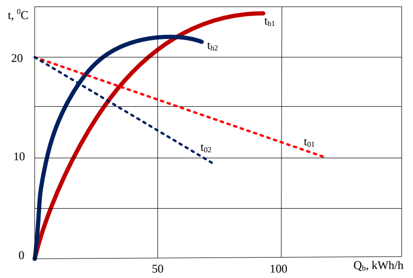


Fig. 1. Dependence Q_b from t_h and t_o for the glass with constructive certain features, with one glass (1) and double glass (2), k_1 =5,8 W/(m^2K), k_2=3,6 W/(m^2K), t_b=20°C, $\dot{m}_a$ =6,25 m^3/s, S_m=1950 m^2

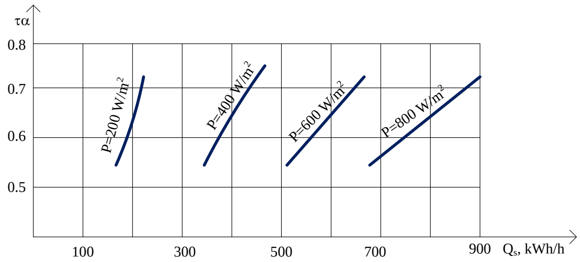


Fig. 2. Dependence of change Q_s from (τα) for different values of P, and for S_{bm}=1540 m^2

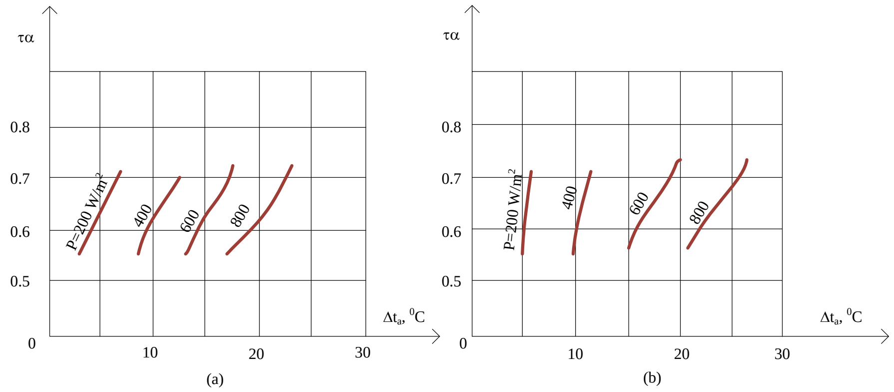


Fig. 3. Dependence of change Δt_a from P and (τα) for (a) k=5,8 W/(m^2K) and (b) k=3,6 W/(m^2K), and glass with certain characteristics.

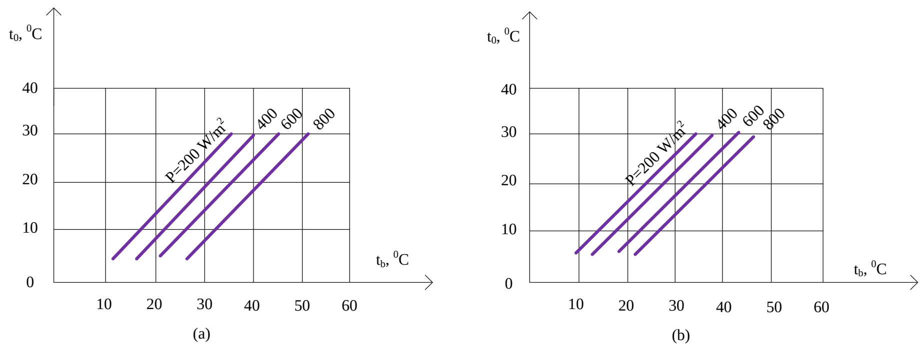


Fig. 4. Dependence of change t_{vs} from t_o and P for k=5,8 W/(m^2K); (a): (τα)=0.73, and(b): (τα)=0.55

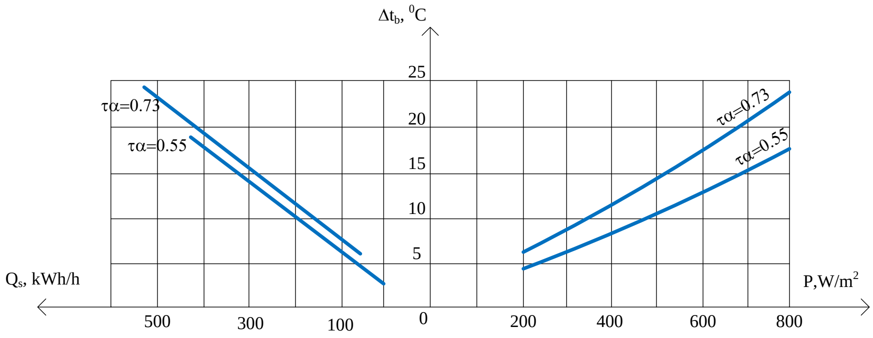
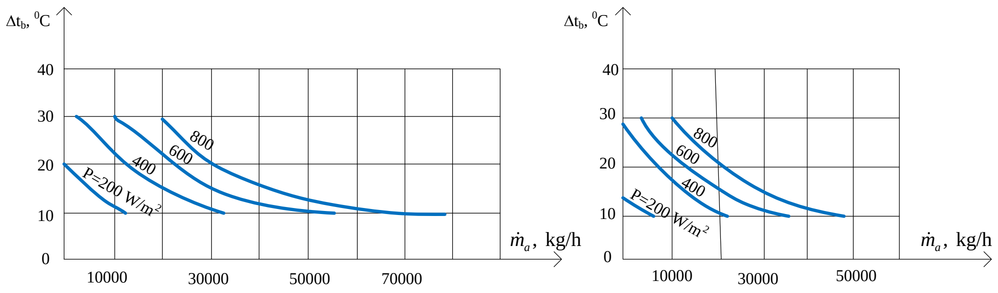


Fig. 5. Dependence of change Q_s from P and Δt_b for glass with k=5,8 W/(m^2K), $\dot{m}_a$ =6,25 m^3/s and t_o=20°C.



(a) (b)

Fig. 6. Dependence of change $\dot{m}_a$ from Δt_b for $k=5,8$ W/(m^2K) and (a): $(\tau\alpha)=0,73$ and (b): $(\tau\alpha)=0,55$

3. CONCLUSION

By means of heat exchanger type air-water heat or applying the heat pump, enable the air inside potential radiated energy used for heating needs to sanitary and technological water, drying of various products etc., which significantly affects the economic growth of their work. With such analysis and results can be provided conditions which include: improved thermal insulation area which limits the closed area, the intensive use of solar energy in space heating process, and the proper management of the available solar energy, or "production" and sending heat to other customers.

4. REFERENCES

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