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Методологічні принципи енергоменеджменту в аспекті проблем сталого розвитку підприємств деревообробної галузі

Розглянуто питання формування енергетичної стратегії деревообробного підприємства як складової частини системи енергетичного менеджменту. Визначено її роль і місце в загальній стратегії сталого розвитку підприємства, охарактеризовано основні етапи розробки енергозбереження та енергетичного менеджменту з точки зору комплексного підходу до природокористування.

Ключові слова: енергоменеджмент, сталий розвиток, відходи деревини, енергоефективність, баланс теплової енергії.

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METHOD OF CALCULATION OF DRYING TIME IN SOLAR PLANTS

Provided analytical equation calculation of the drying in the 1st and 2nd periods of drying.
Ключові слова: solar plant, grafically-criterial methods, nusselt criterion.

It is known [1, 2] that in engineering practice, to calculate the duration of drying grafically-criterial and analytical (tabular) methods are used. Thus the total duration of drying includes drying time in the periods of constant and slowing drying rates [3-7].

Note that the grafically-criterial method is based on analytical formulas that are derived from studies of the kinetics and dynamics of the drying process, as well as principles of the general theory of drying. For the analytical calculations of the drying time Initial data should be known or taken into account: species *(ρ_b)*; thickness of material *$S_1(R=S_1/2)$* which is dried, width of lumber stacks, direction of moisture flow(tangential, radial), operating conditions *(t_s, t_m, Δt, φ)* i and air circulation speed (drying agent) on stacks *v*. The sequence of calculating the duration of drying is. Depending on operating conditions, species and average humidity of wood with appropriate diagrams define the coefficients of specific heat and thermal conductivity of wood at the actual humidity of the material and define the magnitude of the coefficient of thermal diffusivity a ($a = \frac{\lambda}{\rho \cdot c}$, m^2/s).

According to the formulas given below [3] set the value of the coefficients of thermal conductivity of air (drying agent) λ and kinematic viscosity υ, that is

$$\lambda = [4{,}67-(4{,}16+2{,}45\cdot\varphi)]\ 10^{-2}+[7{,}14+4{,}46\ \varphi]\ T_1\cdot 10^{-5}, \quad (1)$$

where T_1 – absolute temperature of the dry thermometer, K; φ – relative humidity.

$$\upsilon = [0{,}113\cdot T_1-(18{,}24+7\cdot\varphi)]\ 10^{-6} m^2/s \quad (2)$$

Set mode of heat motion (drying agent) with the Reynolds criterion, that is

$$\mathrm{Re}_f = \frac{v\cdot b}{\upsilon} \text{ for air} \quad (3)$$

and several stacks of boards $\mathrm{Re}_{\text{air}} = \frac{v \cdot S_1}{\upsilon}$ (4)

Nusselt criterion, as demonstrated by our study [1], should be determined by the formula type $Nu_f = 0{,}0641 \cdot \mathrm{Re}_f^{\,0.80} \cdot \left(\frac{T_1}{T_2}\right)^2 \mathrm{Pr}_f^{\,0.33} \left(1 - \frac{1}{\mathrm{Re}_{\text{air}}} \cdot \frac{b}{S_1}\right)^4$, (5)

where $Pr_f (Pr_f = v_c/d)$ – Prandtl criterion, which for air can be taken equal Pr_f=0,72 for solar plant conditions.

Finding the value of Nusselt criterion, we can calculate the coefficient of heat transfer, that is $\alpha_к = \frac{Nu_f \cdot \lambda}{b}$, *W/(m°C).* (6)

At a given temperature regime of drying wet thermometer t_2 specific heat of vaporization will be $r = r_0(1 - 0{,}001 \cdot t_2)$ *kJ/kg.* (7)

Speed of drying in the first period, period of constant drying rate, determined by the formula [1] $N = \frac{100 \cdot \lambda_k \cdot (t_1 - t_2)}{r \cdot \rho_{\text{b}} \cdot R}$ *%/s.* (8)

As shown by our study, the value of humidity on the surface of material (drying matter) at the critical point can be determined by the formula $W_{\text{ex}} = 32{,}5 - 0{,}135 \cdot t_2$, *%.* (9)

To determine the coefficient of moisture conductivity at it is necessary to know the direction of moisture motion (radial, tangential) in wood during drying. Particularly, if solar plant chamber loaded with tangentially cut boards, the basic direction of water movement in the material should be taken radial and vice versa. When placing the boards in a mixed stack should be taken tangential direction of moisture in the material should be taken.

Mathematical treatment of our experimental studies [1] showed that the coefficient of moisture conductivity with sufficient accuracy can be calculated by the formula type $a'_m = 23{,}5 \cdot 10^{-8} \left(\frac{T_2}{273}\right)^{23} \left(\frac{\rho}{400}\right)^{-3{,}9} \left(1 + \frac{2 \cdot V_{\text{w}}}{100} + \frac{\sin\beta}{\sin 90^0}\right)$ *sm²/s,* (10)

where: V_w – the amount of volume pith, %; β – the angle formed by the tangent to the annual rings and the normal drawn to the outer layer in the middle of the board (for radial flow of water β=90°, and for tangential β=0°).

Then, the duration of wood drying in a period of constant drying rate will be

$\tau_1 = \frac{W_{\text{in}} - W_{\text{ev}}}{N}$, *s.* (11)

Duration of wood drying in the period of slowing down rate of drying can be found by the formula $\tau_2 = 2{,}31 \cdot \frac{4 \cdot R^2}{\pi \cdot d'_m} + \frac{R}{\alpha'_v} \cdot \lg \frac{W_{\text{ex}} - W_r}{W_{\text{ev}} - W_r}$, *s,* (12)

where α'_{v} – moistre-change coefficient ($\alpha'_v = \frac{N \cdot R}{0{,}25}$) *m/s;* W_r,W_{ev} – accordingly equilibrium and the fime moisture content of wood, *%.*

The intensity of evaporation of moisture in the first period is determined

$q'_m = \frac{\rho \cdot R \cdot N}{100}$, *kg / m²s.* (13)

For the second period of drying (at the beginning), when $Re > \lambda_0^5$, heat transfer coefficient is determined by the formula $\alpha_c = 0{,}032 K y_a^{0{,}80} \cdot \frac{\lambda}{b}$, *W/(m²°C).* (14)

Value of the criterion of phase transition will be $\varepsilon' = \frac{2 \cdot \lambda \cdot \Delta t}{r \cdot q'_m \cdot R}$. (15)

Thus, the total drying time will be equal to $\tau = \tau_1 + \tau_2$.

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Методика розрахунку тривалості сушіння в геліоустановці

Виведено аналітичні рівняння розрахунку часу сушіння в 1-му та 2-му періодах сушіння. Застосовано графокритеріальний метод визначення тривалості сушіння в періодах постійної та заповільнюючої швидкостей. Графокритеріальний метод базується на аналітичних формулах, які отримані в результаті досліджень кінетики та динаміки процесу сушіння, а також виразах загальної теорії сушіння. Наведено рівняння для визначення коефіцієнта вологопровідності в залежності від напряму руху вологи в матеріалі. Застосовано критерій Нусельта для розрахунку значення коефіцієнта теплообміну.

Ключові слова: геліоустановка, графокритеріальний метод, критерій Нусельта.

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WOOD INFILTRATION WITH WATER-SOLUBLE DYES

In order to obtain the necessary colour while infiltrating wood using the vacuum, we carried out an investigation to determine the optimal concentration of water-soluble dyes.

Keywords: wood, dye, infiltration, vacuum.

Applicability of the problem. With the development of industry the high cost and deficit of the valuable species of wood urge to produce their imitations from a cheaper material by way of dyeing and proper processing. The process of dyeing is carried out in different ways: by means of pneumatic spray, rollers, immersion, etc. all of them are simple to use, however, the depth of paint does not exceed 0.08 mm and that excludes any further mechanical processing.

One of the most famous methods of infiltration is using vacuum – method “vacuum – atmospheric pressure”. As the research shows, this method allows to evenly infiltrate samples of hardwood up to 10mm thick in two sets (cycles) with 5-7 minutes of duration each. The tone color is rather smooth, however the colour on the billet surface is more saturated. It should be said that homogeneity and saturation of the colour depends upon the duration of the cycle as well as on the nature and concentration of the dye. In order to find out the optimal conditions of depth infiltration of wood to obtain the necessary colour and its saturation we investigated the dependence of the nature and concentration of dye solutions, correlation of dyes in a solution, the sequence of infiltration with dyeing solutions, etc.