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MODELING A MATHEMATICAL MODEL OF CIRCULATING WATER COOLING PROCESSES IN THE MATLAB SIMULINK PACKAGE

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Abstract
To learn how to cool water by supplying air to the operating area of the cooling tower, a mathematical model of the processes of cooling circulating water in the thermal supply system of the thermal power plant was modeled in the matlab simulink package.

Keyword: energy, temperature, circulation, condenser, steam turbine, steam condensation, fuel, technical water.

Introduction

It is known that the main purpose of calculating heat exchange apparatus is to determine the surface of water cooling, the parameters of heat carriers, the most appropriate consumption of heat carriers and their speed, as well as the optimal dimensions of the apparatus. The heat balance equation and heat transfer equation are fundamental in the calculation of heat exchange apparatus.[1-2]

Heat transfer equation:

$$\mathrm{Q} = kF(t_1 - t_2) \tag{1.1}$$

Where Q - is the heat flux, Vt; k - is the heat transfer coefficient, $\frac{Vt}{m^2 \cdot K}$; F-water cooling surface m^2; t_1 and t_2 are hot and cold heat carrier temperatures, respectively.

Heat balance equation:

$$\mathrm{Q} = m_1 \Delta h_1 = m_2 \Delta h_2 \tag{1.2}$$

or:

$$Q = V_1 p_1 c_{p1}(t_1' - t_1'') = V_2 p_2 c_{p2}(t_2' - t_2'') \tag{1.3}$$

where $\mathrm{V}_1\rho_1$ and $V_2\rho_2$ are the mass consumption of heat carriersbu $\frac{kg}{s}$; c_{p1} and c_{p2} are the average heat capacity of a liquid in the temperature range from t' to t''; t_1' and t_2' temperature of the liquid at the entrance to the apparatus: t_1'' and t_2'' temperature of the liquid at the exit from the apparatus. $V_p \cdot c_p = W$ the magnitude is said to be the water equivalent.[3-4]

Considering the last equation (1.3), the equation can be written as follows.

$$(t_1' - t_1'')/(t_2' - t_2') = W_2/W_1 \qquad (1.4)$$

where W_1 and W_2 are the water equivalents of hot and cold liquids. So, it turns out that the change in the temperatures of hot and cold heat carriers in heat exchange apparatus will be inversely proportional to the water equivalents.[5-6].

$$dt_1/dt_2 = W_2/W_1 \qquad (1.5)$$

In inducing the heat transfer equation (1.1), it was believed that the temperature of heat carriers does not change in the apparatus. As can be seen from figure 1.1, the final temperature of the cold heat carrier at the right current is always lower than the temperature of the boiling heat carrier.

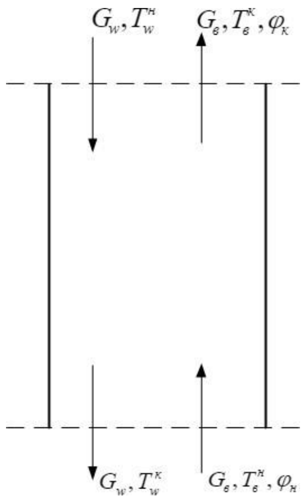

Figure 1.1. Calculation scheme

In reality, however, the temperature changes of heat carriers during their passage through the apparatus, in addition, the change in temperature is greatly influenced by the movement scheme of the fluid and the water equivalents.[7-8]

Based on the above algorithm, the process was modeled using the matlab program.

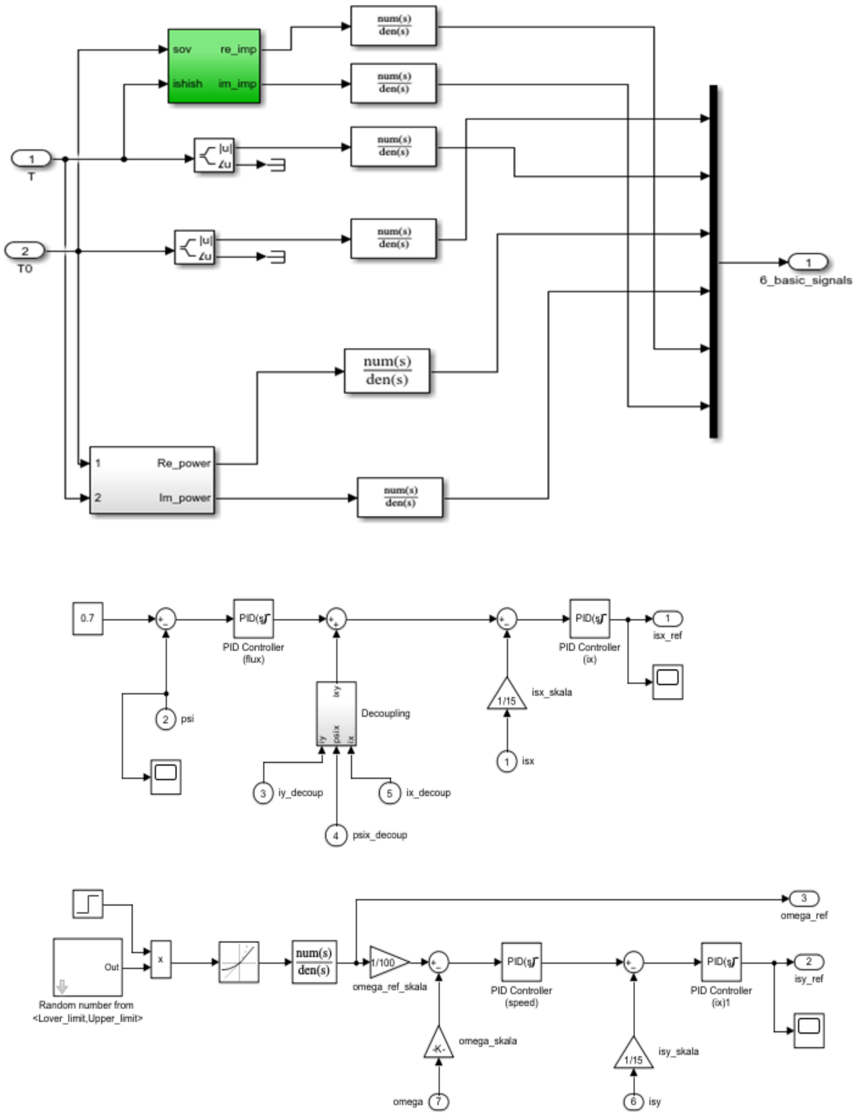

Figure 1.2. MATLAB program-based cooling processinig model

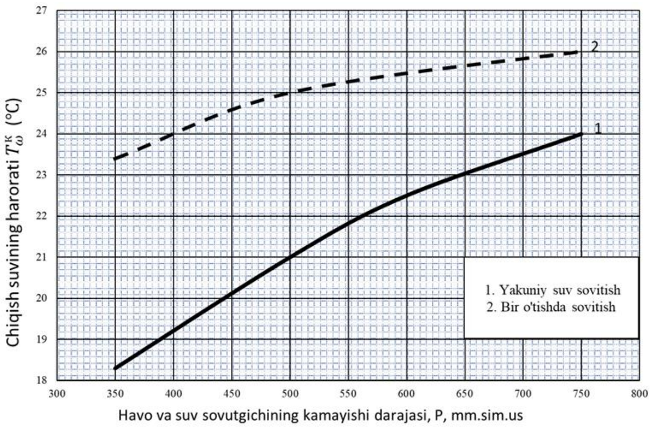

Figure 1.3. Graph of the dependence of the final water temperature at the outlet of the water cooler on the degree of air depletion

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In countercurrent (figure 1.3), the temperature of a cold heat carrier can be much greater than the temperature of a boiling heat carrier. So it turns out that in counter-current apparatus, the temperature of the cold heat carrier can be increased higher than in a straight-current apparatus.[9]

In addition, as can be seen from the pictures, along with temperature changes, the temperature difference of liquids Δt also changes.[10]

Magnitudes Δt and k can only be considered invariant on the boundary of the elementary surface. Therefore, the heat transfer equation for an elementary dF surface is true only in differential form:

$$dQ = kdF \cdot \Delta t \tag{1.6}$$

The heat flux (1.6) transmitted over the entire surface F is determined from the equation integralization:

$$Q = \int_0^F kdF\Delta t = kF\Delta t_{o'rt} \tag{1.7}$$

In this case, $\Delta t_{o'rt}$- is the average logarithmic pressure of the temperature over the entire heating surface. If the heat transfer coefficient changes much more along the surface of the water cooling, then its average value is obtained:

$$k_{o'rt} = \frac{F_1k_1 + F_2k_2 + ... + F_nk_n}{F_1 + F_2 + ...F_n} \tag{1.8}$$

Then when $k_{o'rt}$ = const, the equation (1.8) follows:

$$Q = k_{o'rt}\int_0^F \Delta tdF \text{ yoki } Q = k_{o'rt}\Delta t_{o'rt}F \tag{1.9}$$

If the temperatures of the heat carriers change in a straight line then the average temperature pressure is equal to the subtraction of the middle arithmetic values of the temperatures:[11]

$$\Delta t_{o'rt} = (t_1^{!} + t_1^{!!})/2 - (t_2^{!} + t_2^{!!})/2 \tag{1.10}$$

However, changes in the temperature of working fluids will not be rectilinear. Therefore, equation (1.10) can be applied where the temperatures have not changed much. we define the magnitude $\Delta t_{o'rt}$ for the direct current, for the nonlinear variation.

Optionally obtained a be the temperature of the boiling heat carrier t' in the cross section, and the temperature of the cold heat carrier t''. Their difference will be as follows:

$$t'' - t' = \tau \tag{1.11}$$

we determine the amount of heat transferred from the dF elementary surface from the following equation:

$$dQ = kdF\tau \tag{1.12}$$

when dQ heat is transferred, the temperature of the boiling heat carrier decreases to dt', while the temperature of the cold heat carrier increases to dt'', then:[12]

$$dQ = -m_1c_{p1}dt' = m_2c_{p2}dt''$$

or:

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$$dt' = -\frac{dQ}{m_1 c_{p1}} \text{ va } dt'' = \frac{dQ}{m_2 c_{p2}} \quad (1.13)$$

(1.13) differentiating the equation into which we put the values of dt' and dt'', and form:

$$d\tau = -\frac{dQ}{m_1 c_{p1}} - \frac{dQ}{m_2 c_{p2}} \quad (1.14)$$

or:

$$dQ = \frac{\frac{d\tau}{\frac{1}{m_1 c_{p1}} + \frac{1}{m_2 c_{p2}}}\left(\frac{1}{m_1 c_{p1}} + \frac{1}{m_2 c_{p2}}\right)}{n} \quad (1.15)$$

we define as, then:

$$dQ = \frac{-d\tau}{n} \quad (1.16)$$

we put the expression of dQ in equation (1.16):

$$\frac{-d\tau}{n} = kdF\tau$$

or:

$$\frac{-d\tau}{\tau} = kdFn \quad (1.17)$$

If the magnitudes n and k are constant, then integrating equation (1.17) from $(t_1^{!} - t_2^{!}) = \tau_1$ to $(t_1^{!!} - t_2^{!!}) = \tau_2$ and 0 to F we find.

$$-\int_{\tau_1}^{\tau_2} d\tau / \tau = nk \int_0^F dF \quad (1.18)$$

or:

$$ln\frac{\tau_1}{\tau_2} = nkF \quad (1.19)$$

from this:

$$n = \frac{ln\frac{\tau_1}{\tau_2}}{kF} \quad (1.20)$$

(1.20) we integral the equation:

$$Q = \frac{\tau_1 - \tau_2}{n} \quad (1.21)$$

and we put in it the value of n from equation (1.21) .

$$Q = \frac{\tau_1 - \tau_2}{ln\frac{\tau_1}{\tau_2}} \quad (1.22)$$

The $\Delta t_{o'rt}$ magnitude in equation (1.22) is said to be the average logarithmic pressure of temperature.[13]

For straight-current heat exchange apparatus:

$$\Delta t_{o'rt} = \frac{(t_1' - t_2') - (t_1'' - t_2'')}{(2.3lg[(t_1' - t_2') - (t_1'' - t_2'')]} \quad (1.23)$$

In a similar way $\Delta t_{o'rt}$ is defined for counter-current heat exchange apparatus.

$$\Delta t_{o'rt} = \frac{(t_1' - t_2'') - (t_1'' - t_2')}{(2.3lg[(t_1' - t_2'') - (t_1'' - t_2')]} \quad (1.24)$$

The value $\Delta t_{o'rt}$ of countercurrent heat exchange apparatus is always greater than the value $\Delta t_{o'rt}$ of DC heat exchange apparatus. Therefore, counter-current heat exchange apparatus will be small in size. The economy of heat-exchange apparatus is determined by its useful coefficient of work (F.I.K.) is determined by . F.I.K. the boiling heat spent on heating the cold heat carrier shows the heat share of the carrier.[14]

The thermal balance of heat exchange apparatus is usually expressed in the following terms:

$Q_1+Q_2+Q_3=Q_{XIS}$ yoki $q_1+q_2+q_3=100\%$ (1.25)Where Qxis is the heat mixer that a boiling heat carrier can give when cooled to ambient temperature; Q1 is the amount of heat spent heating a cold liquid; Q2 is the heat waste with boiling liquid coming out of heat exchange apparatus; Q3 is the waste of heat to the environment. The following ratio is given by the heat exchanger F.I.K. is called.[15]

$$\frac{Q_1}{Q_{хис}} \cdot 100\% = q_1 = \eta, \% \quad (1.26)$$

CONCLUSION

A mathematical model was developed to learn how to cool water by supplying air to the working area of the cooling tower. Developed a mathematical model of the processes of cooling circulating water in a thermal power plant, taking into account the presence of temperature differences, on the basis of indicators of cooling processes and heat transfer. This made it possible to determine the factors affecting the cooling process.

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