Research of the coefficient of hydraulic resistance of padding with triangular channels of the package of cold and hot layer of RAH

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Abstract – Research of the coefficient of hydraulic resistance of padding with triangular channels of the package of cold and hot layer of RAH is described in article. The graphic dependence of the change in the coefficient of hydraulic resistance of the padding with triangular channels from the Reynolds number for different values of the length of the replaced areas was constructed.

Keywords – boiler installation, regenerative rotary air heater (RAH), cold layer padding, hot layer padding, hydraulic resistance.

Introduction

Increasing the efficiency of the convective heating surfaces of the thermal power plant, taking into account the features of their layout and construction, the uneven distribution of thermal and hydraulic parameters, is an actual and important scientific and applied task. Research of hydrodynamic processes in existing structures of convective regenerative rotary air heaters (RAH) is necessary for the improvement of these structures, in particular, for comparison with the energy characteristics of new upgraded structures of RAH.

Presenting main material

Hot and cold layer packages with intensified padding of high thermal efficiency are heat exchange surface of the RAH of various modifications and are destineded for the transfer of heat from exhaust gases to the air, that enter in a burning room of steam boiler for combustion of fuel. From the point of view of compactness, the paddings with triangular channels are promising [1]. These surfaces, in optimum performance, are also characterized by the maximum thermal perception of the appositional resistances.

The paddings with triangular channels are represented on fig. 1. Intensification of heat exchange in this case is achieved due to the displacement of the wavy surface of one wall and the displacements of two smooth walls alternating. The above result causes to effect of updating the boundary layer and its turbulence.

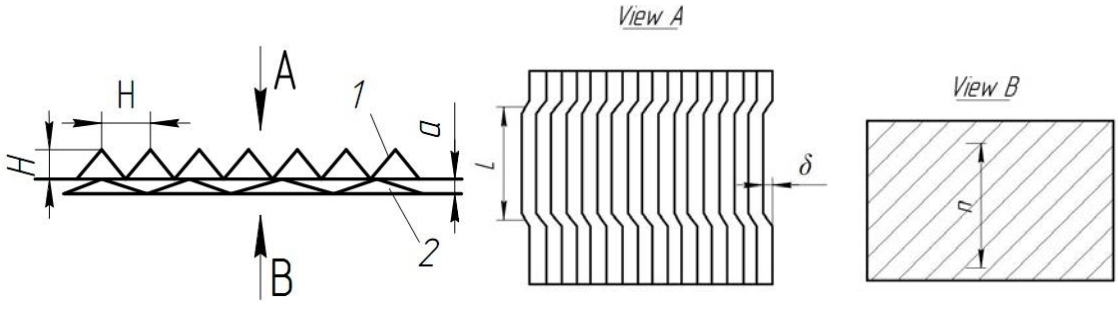

Fig. 1. Padding with triangular channels: 1 - a sheet with triangular corrugation; 2 - sheet with wavy corrugation; a - the size in the lumen, without taking into account the thickness of the sheet

Hydraulic resistance for padding, represented on fig. 1, is calculated by the formula [1]:

$$\frac{l}{l_0} = 4{,}47 \cdot \left(\frac{L}{d_e} \right)^{-0{,}248}, \qquad (1)$$

$l_0 = \frac{0{,}303}{(\lg \mathrm{Re} - 0{,}9)^2}$ – coefficient of resistance of the smooth channel.

Formula (1) is valid for values: $\delta = 2$ mm, $3{,}5 \le L/d_e \le 40$; $1{,}6 \cdot 10^3 \le \mathrm{Re} \le 10^4$. In the given range of values of the Reynolds number for values $d_e = 6{,}7$ mm and $\delta = 2$ mm for different values of the length of replaced sections L graphic dependences (fig. 2) are constructed by the formula (1).

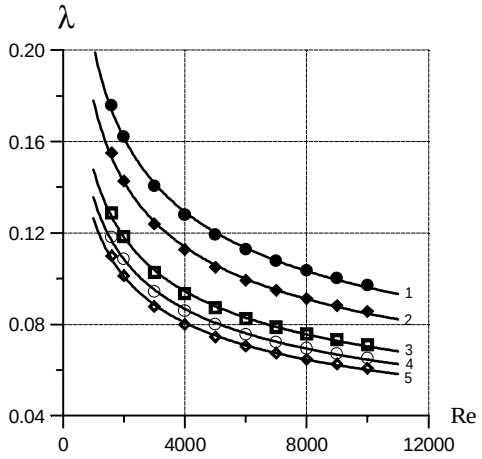

Fig. 2. Dependence of the coefficient of resistance of the padding with triangular channels from the Reynolds number for different values of the length of the replaced sections L:
1 – 30 mm, 2 – 50 mm; 3 – 100 mm; 4 – 150 mm; 5 – 200 mm

As we see on fig. 2, in the area close to the turbulent regime ($\mathrm{Re} \approx 10^4$), an increase in the length L of 6,67 times leads to a decrease in the coefficient of resistance by 1,6 times. Dependence of change of resistance coefficient of the investigated padding in an area close to the laminar regime ($\mathrm{Re} \approx 2000$), from the length L has a similar character, however, the value of the resistance coefficient λ is 1,7 times more compared to the exploitation of this padding layer in the turbulent motion of the heat carrier ($\mathrm{Re} \approx 10000$) in all researched range of variation of the length of replaced areas L. The energy comparison of the padding with triangular channels, which differ in the lengths of the displaced sections L = 100 mm, L = 50 mm, L = 30 mm, shows that at the same power required to overcome the resistance, for the case L = 30 ÷ 50 mm, the thermal perception at 8 – 10 % higher [2], than for case L = 100 mm. Given the fact that for large values of the length of the replaced area the danger of contamination decreases, it is necessary to recommend for practical use the value L = 50 ÷ 70 mm, $L / d_e = 7{,}5 \div 10$.

Conclusion

The most promising intensified packing with triangular channels of the hot and cold layer of the RAH were used for research the hydraulic resistance coefficient, because it is characterized by the maximum thermal perception of the appositional resistances. For a area close to the turbulent regime, an increase in the length of the replaced sections L in 6,67 times leads to a decrease in the resistance coefficient by 1,6 times. However, taking into account the danger of surface contamination, it is necessary to recommend for practical use the value L = 50 ÷ 70 mm, $L / d_e = 7{,}5 \div 10$.

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