CALCULATION OF RADIAL RADIATION OF THE SINGLE ROUND RIBBED PIPE

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***Summary*. A comparison of the calculation results for radiation of tubes with circular ribs and beams from them to the environment according to the average slope of the reduced degree of blackness and zonal method is held.**

***Keywords:* an effulgent heat exchange, zonal method, plain-tube pinches.**

Formulation of the problem. Pipes with transversal round ribs find wide application in a technique. From them the heat-exchange sections of vehicles of the air cooling, heaters, are made, and others like that. During exploitation of heat-exchanger in the mode of free convection noticeable part of warmth is taken by a radiation and her it takes into account. Part of effulgent constituent for the single ribbed pipe always more than in a bunch, and can come to 50% from a general thermal stream. There is a necessity of comparison of different methods of calculation of heat exchange by the radiation of single round-ribbed pipe and bunches with an environment.

Analysis of recent research. Two basic methods of calculation of heat exchange to the radiations are used in engineering practice [1-2]: calculation after an angular mid-coefficient and zonal method. In-process [3] expounded methodology, that is used for technical calculations only to such ribbed pipes that have relative intercostals strides enough and case-insensitive influence of thickness of rib. The calculation of radiation of the ribbed bunches is difficult, and in this direction it is necessary to continue research. Passing to the methods of calculation effulgent heat exchange it follows to take into account [2] condition

$$\frac{\varphi_{m-c} F_m}{F_0} \geq 0.9, \tag{1}$$

where $\varphi_{т-c}$ - value of angular coefficient of radiation from the single ribbed pipe to the environment $F_т$ - is an area of surface of pipe, that ribbed; F_0 - it is an area of surface that rounds the ribbed pipe on the tops of ribs (smooth pipe diameter d), the ribbed bunch can be examined as plain-tubed with the degree of blackness of surface of pipes $\varepsilon_{eф}$. Thus for simplification of calculations there are all angular coefficients, and in a

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zonal method also and permissive coefficients of radiation, it follows to determine, considering pipes smooth. According to given [2], an angular mid-coefficient is from a pipe bunch to the environment, and also and from a row to the row depends mainly on the transversal step of pipes S_1. Influence of longitudinal step S_2 is small, it is important only, that a condition was executed $S_2 \geq d$. Consider that angular coefficients small depend on the type of arrangement of pipes in a bunch.

Thus, it is enough to analyze a heat exchange the radiation of bunches from smooth pipes, considering that terms (1) are executed $S_2 \geq d$ and, and all conclusions got for them, practically in an equal degree will be just and for bunches from the ribbed pipes.

Formulation of article purposes. To carry out comparing of results of calculations of radiation of pipes with round ribs and bunches from them to the environment after an angular mid-coefficient through resulted degree of blackness and by a zonal method.

Main part. Examine one, two-, three- and five row plain-tune pinches in the turn-down of relative transversal step $S_1 / d = 1{,}0 \div 3{,}0$ and at $\varepsilon_{еф} = 0{,}3; 0{,}5; 0{,}7; 0{,}9$. Conduct calculations with suppositions [4]. At an analysis compare the value of effulgent thermal stream Q from a bunch to the environment, expected after an angular mid-coefficient (will designate this method "S ") and zonal method at fragmentation of bunch on the several of zones (method "Zn ", where is a number of zones). In all calculations consider an environment one absolutely black body (by one zone) with a stationary temperature T_2 and showed a soba two planes that limit a bunch.

For bunches Q a calculation on a method " S" comes true so:

$$Q = \varepsilon_{зв} c_0 \varphi_{1-2} F_1 \left[\left(\frac{T_1}{100} \right)^4 - \left(\frac{T_2}{100} \right)^4 \right], \tag{2}$$

Where $\varepsilon_{зв}$ is the erected degree of blackness of the system of bodies; c_0 is a coefficient of radiation black body, $c_0 = 5{,}67\, W / \left(m^2 \cdot K^4 \right)$ φ_{1-2} is an angular mid-coefficient of radiation from a body 1 to the body 2; F_1 is an area of surface of a 1 body, m^2; T_1, T_2 are absolute temperatures 1 and 2 bodies accordingly, K°.

Resulted calculate the degree of blackness $\varepsilon_{зв}$ after a formula

$$\varepsilon_{зв} = \left[1 + \left(\frac{1}{\varepsilon_1} - 1 \right) \varphi_{1-2} + \left(\frac{1}{\varepsilon_2} - 1 \right) \varphi_{2-1} \right]^{-1}, \tag{3}$$

Where ε_1 is a degree of blackness of a 1 body; ε_2 is a degree of blackness 2 bodies, putting instead of value ε_1 and taking into account, that $\varepsilon_2 = \varepsilon_c = 1$. An angular mid-coefficient from a bunch to the environment φ_{1-2} was determined concordantly [2].

Will consider a one row bunch. As shown on rice. 1, at a calculation a zonal method the system was broken up on three zones, here two zones are distinguished in a bunch - 1 and 2. Clear, under a zone in a bunch here and farther part of cylindrical surface of diameter d, understands and in no way part of circle.

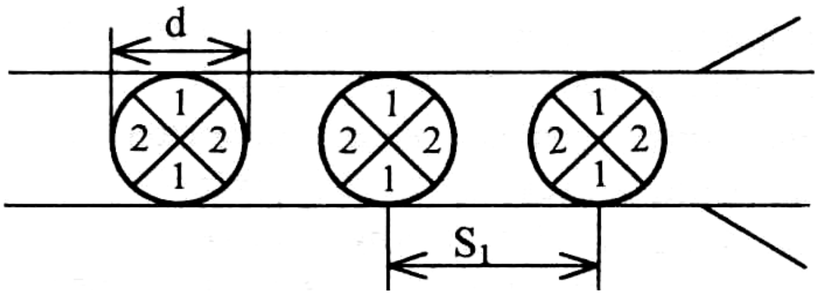

Fig. 1. A chart is for the calculation of radiation of one row bunch.

Angular coefficients between zones were determined by means of method of the strained filaments [2].

Comparison of values of Q, expected by methods " S" and "Z3 ", showed that clarification did not exceed 5% even at subzero values $\varepsilon_{e\phi}$. It means that calculation of one row bunches it is possible with sufficient exactness to carry out after an angular mid-coefficient, not succeeding to the zonal method.

On fig. 2 the shown chart of fragmentation on the zones of double-row bunch. The halves of pipes, convolute outside, show a soba the first zone; halves of pipes, convolute inward, - second.

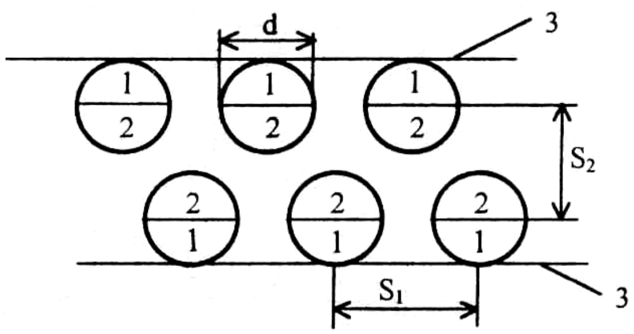

Fig. 2. A chart is for the calculation of radiation of double-row bunch.

Percentage ratios of the thermal streams got methods "S " and " Z3", for corresponding values S_1/d and $\varepsilon_{e\phi}$, presented graphically on fig.3. From charts evidently, that than less than S_1/d and $\varepsilon_{e\phi}$, the anymore divergence of results. Maximal overstating of result on 42% after a method " S" educed at $\varepsilon_{e\phi} = 0{,}3$ and $S_1/d = 1{,}0$. Considerable divergence is first of all explained by that at small S_1/d value of angular coefficients φ_{1-3} and φ_{2-3} strongly differ one from other. In maximum case, when $S_1/d = 1{,}0$

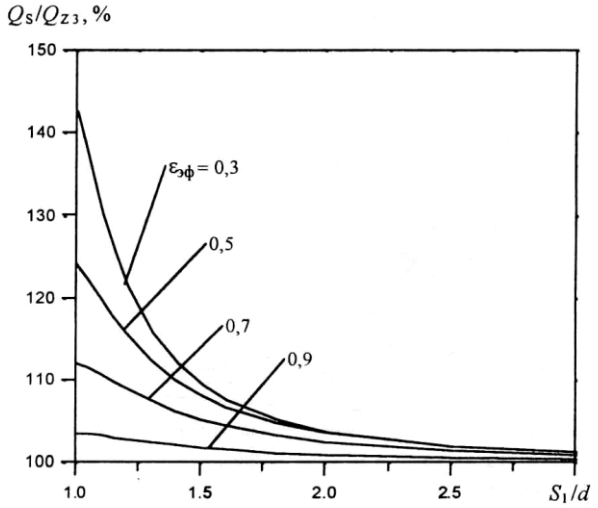

Fig. 3. Comparison of results of calculations by methods "S " and " Z3".

, the internal halves of pipes are fully closed from an environment, and all the external halves of pipes shed (take in) heat only. Clear that for $\varepsilon_{e\phi} = 1$ at any value S_1/d results will meet on 100%.

It is like possible to investigate the case of three-ordinary bunch. Thus have three zones of division. For a middle row the overhead and lower halves of pipes in force of symmetry are incorporated in one zone. It is shown that for three-row bunches a zonal method finds out yet greater clarification, than for double-row. As a rule, clarification the more than less than S_1/d and $\varepsilon_{e\phi}$, and his maximal size laid down 65%. However for $\varepsilon_{e\phi} = 0{,}9$ there is some increase of relationship $Q_s/Q_{z\,4}$ with an increase S_1/d, but as additional calculations showed, a difference will not exceed 8%, and at an achievement $S_1/d \approx 4$ a size Q_s/Q_{z4} again begins to go down.

Fragmentation on the zones of five row bunch was conducted like three-row to the bunch, id est the pipes of all rows except middle were divided by overhead and lower halves. Thus, in a bunch five zones were distinguished plus an environment. Relation of the thermal streams calculated by methods "S " and "Z6 ", presented graphicly on fig. 6. Maximal divergence is fixed at $S_1/d = 1$ and $\varepsilon_{e\phi} = 0{,}3$ and presents close 90%.

For bunches with plenty of rows a difference of the results got methods "S " and " Zn", probably will be yet higher.

Conclusion. Calculation of radiation of one row bunches it is possible with sufficient exactness to carry out, not succeeding to the zonal methods. The calculation of radiation of bunches with the amount of rows, that equals two and anymore, after an angular mid-coefficient can result in the serious overstating of result, thus error the more than less than relative transversal step $S_1 / d\ \varepsilon_{еф}$.

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