# CONCERNING THE ERRONEOUS INTERPRETATION OF LANGMUIR'S FORMULAS

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In computing the effective surface of a shell wall the corner correction should be divided by six, and not by three.

The thermal resistance of a parallelepiped shell with isothermal surfaces is found from

$$R_\tau = \frac{\delta}{\lambda S_{\text{eff}}}. \qquad (1)$$

Here, $\delta$ is the shell thickness, $\lambda$ is its thermal conductivity, and $S_{\text{eff}}$ is the effective wall surface determined from one of Langmuir's formulas, for example,

$$S_{\text{eff}} = S_i + 0.54\,\delta \sum_{i=1}^{12} l_i + 1.2\,\delta^2. \qquad (2)$$

$S_i$ is the area of the inside surface of the shell and the $l_i$ are the inside dimensions of the shell.

In formula (2) the second term gives the correction for the edges, and the third term the correction for the corners. The formula is valid when the walls are of the same thickness and the condition $l_i > \delta/5$ is satisfied.

Langmuir's empirical formulas can also be used when the walls have different thicknesses. In this case it is necessary to compute the effective surface and conductivity separately for each wall. The total conductivity for the entire shell is found as the sum of the conductivities of each wall [1, 2]. In the literature it is asserted that in this approach: "the edges are taken into account twice and the corners three times. To avoid this it is necessary simply to use half the correction for the edges and a third of the correction for the corners, which for each wall gives

$$S'_{\text{eff}} = S'_i + \frac{0.54}{2}\,\delta \sum_{i=1}^{4} l_i + \frac{1.2}{3}\,\delta^2, \qquad (3)$$

where $S'_i$ is the inside surface of the corresponding wall" [2].

The assertion that a third should be used for the corners is erroneous. In fact, the last term in formula (2) should be divided by six. This can be seen with a simple example.

We find the effective surface of a symmetrical cubic shell, using (2), and compare the result obtained with that derived from (3). These values should coincide.

According to (2)

$$S_{\text{eff}} = S_i + 0.54\,\delta \cdot 12\,l_i + 1.2\,\delta^2.$$

The effective surface of one wall found from the corrected formula (3) is

$$S'_{\text{eff}} = \frac{S_i}{6} + \frac{0.54}{2}\,\delta \cdot 4\,l_i + \frac{1.2}{6}\,\delta^2.$$

The total effective surface

$$S_{\text{eff}} = 6S'_{\text{eff}} = S_i + 0.54\,\delta \cdot 12\,l_i + 1.2\delta^2.$$

If the last term in formula (3) were divided by three, as maintained in the literature, the results would differ.

## REFERENCES

1. G. M. Kondrat'ev, Thermal Measurements [in Russian], Mashgiz, Moscow-Leningrad, 1957.

2. P. J. Schneider, Conduction Heat Transfer [Russian translation], IL, 1960.

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