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LETTERS TO THE EDITORS

COMMENTS ON EDDY-SHEDDING FROM A SPHERE IN TURBULENT FREE STREAMS

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FOR FLOW normal to circular cylinders, Van Der Hegge Zijnen [1] observed that the heat transfer was a maximum, for any free stream turbulence intensity, at a ratio of the integral scale of turbulence to cylinder diameter, L/D, equal to about 1·6. It was proposed [2] that this "optimum" value resulted from a resonance between the energy-containing eddies and the shedding frequency. Mujumder and Douglas [3], by measuring auto-correlations in the near wake of a sphere and cylinder, concluded that there may be a resonance effect for cylinders but not for spheres. I would like to make two points relevant to the latter measurements.

First, the presence of the crossflow support could drastically alter the shedding pattern and frequency. At least at higher Reynolds numbers than those in [3], it has been shown the flow pattern near the sphere surface is dramatically altered by the presence of a crossflow support [4].

The second point is that other investigators have failed to find any "optimum" L/D ratio for circular cylinders like that reported by Van Der Hegge Zijnen. Kestin and his co-workers at Brown University have reported no significant dependence of the heat transfer on L/D. In addition, and it is perhaps important to point this out in the open literature, further experiments in Holland [5] have failed to confirm Van Der Hegge Zijnen's measurements. This was reported only in a verbal communication and apparently no report exists. However, in these experiments, the heat transfer was found to increase monotonically with D/L in agreement with the results for spheres quoted in [3].

It is perhaps time to lay the resonance theory to rest, at least for the Reynolds number range in [3].

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HEAT TRANSFER AT A MELTING FLAT SURFACE UNDER CONDITIONS OF FORCED CONVECTION AND LAMINAR BOUNDARY LAYER

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THE PROBLEM investigated by Pozvonkov *et al.* [1] is very similar to our published work [2] although the approach is different. However the latter work is apparently unknown to them. In their paper, the boundary-layer equations of energy and motion were solved with the von Kármán–Pohlhausen integral method. In the analysis, the ratio of the thickness of hydrodynamic boundary layer to thermal boundary layer was assumed constant. Thus, the following expression which

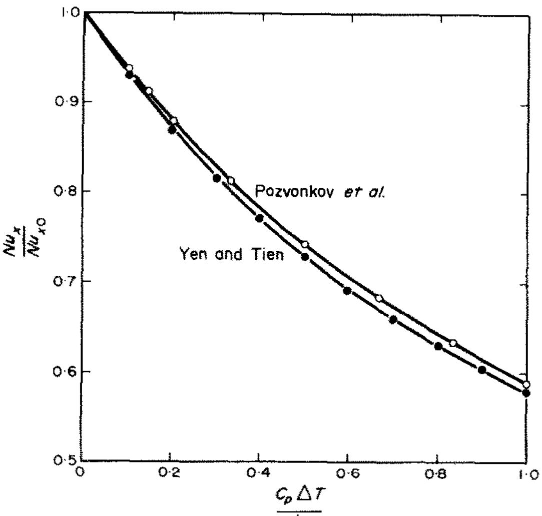

FIG. 1.

relates the local Nusselt number for heat transfer at a melting surface to that at a non-melting surface was derived.

$$\frac{Nu_x}{Nu_{x0}} = \sqrt{\left(\frac{a}{2}\frac{1}{1 + 1/k_f}\right)\left(\frac{\delta^{**}}{\delta_0^{**}}\right)} \qquad (1)$$

In our paper, the same problem was considered as a modified Leveque problem. Thus, the following expression was derived.

$$\frac{Nu_x}{Nu_{x0}} = \left(\frac{a_0}{a_N}\right)^{\frac{1}{3}} \qquad (2)$$

where

$$a_0 = \int_0^\infty \exp(-\lambda^3)\,d\lambda$$

$$a_N = \int_0^\infty \exp(-\lambda^3 + \beta\lambda/a_N)\,d\lambda$$

in which β is a dimensionless parameter defined as $C_p\Delta T/L$ (this is the reciprocal of the Kutateladze number as given in [1]) where C_p is the specific heat of water, ΔT is the temperature difference between the main water stream and the melting ice, and L is the latent heat of fusion. The value of a_N is unique and depends only on β. Figure 1 shows the comparison between equations (1) and (2).

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COMMENTS ON THE PAPER "CONVECTION NATURELLE TURBULENTE SUR UNE PLAQUE VERTICALE ISOTHERME, TRANSITION, ECHANGE DE CHALEUR ET FROTTEMENT PARIETAL, LOIS DE REPARTITION DE VITESSE ET DE TEMPERATURE"

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IN A RECENT paper of Coutanceau [1] it is uncertain whether the turbulent boundary layer measured is fully developed or not. Figure 1 shows a comparison on the relation of Nu_x vs. Gr_x among the experimental results by Coutanceau and by Cheesewright [2] and a curve recommended by Fujii *et al.* [3]. The Grashof number corresponding to the