**AD NUMBER**

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**AUTHORITY**

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The boundary value problem
\[
\frac{1}{a} \frac{\partial T}{\partial t} = \frac{\partial^2 T}{\partial y^2} + \frac{\mu}{\kappa} \frac{U_0^2 y}{k} \left(1 - \frac{y}{h}\right) \quad (3)
\]
\[T(y, 0) = T_s \quad \frac{\mu U_0^2 y}{2k} \left(1 - \frac{y}{h}\right) \quad T(0, t) = T_w \quad T(h, t) = T_1.
\]
is solved by the expression
\[
\Theta = \eta + S \eta (1 - \eta) + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin(n \pi \eta) \exp(-n^2 \pi^2 \Theta).
\]
(4)

where \( \Theta = (T - T_0)/(T_1 - T_0), \) \( \beta = at/h^2, \) \( \eta = y/h, \) and \( S = (PrB)/2 \)
\( \frac{\sigma^2}{\pi}(T_1 - T_0). \) It is shown that for \( S > 1 \) the cooling of the wall
ceases at \( \frac{\beta_0}{2} = \frac{v_{cr}}{h^2} \) and that its heating is due to the dissipation
energy of the fluid. The figure illustrates the dependence of \( \beta_0 \) on \( S \)
(the indices 1 and 2 refer to the steady and to the unsteady flow, respectively). For an unsteady flow, the temperature distribution is
obtained only for \( Pr \gg 1, \)
\[
\Theta = \eta + S \eta (1 - \eta) + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin(n \pi \eta) \exp(-n^2 \pi^2 \Theta) +
\]
\[1 \sin((2n-1)\pi \eta) \exp\left(-\frac{1}{2}(2n-1)^2\pi^2\Theta\right). \quad (6)
\]
and for \( Pr \ll 1, \)
\[
\Theta = \eta + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin(n \pi \eta) \exp(-n^2 \pi^2 \Theta) +
\]
\[+ S \left\{(1 + \exp(-2n\pi \eta)) + \frac{8}{\pi^4} \exp(-n^2 \pi^2) \right\}, \quad (7)
\]
Equation (6) can be used to calculate the temperature distribution in a
lubricant \( Pr \gg 1 \) which takes up the play between the crank journal and
the bearing when rapid changes occur in the rpm of the shaft. There are
3 figures.

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