For engineering purposes, a simple representation of our results for the liquid metal range is

\[ \text{Nu}_x = 0.565 \left( \text{Gr}_x \text{Pr}^2 \right)^{1/4} \]

(8)

This formula represents the numerical solutions to an accuracy of better than 3%.

For an isothermal plate of length \( L \), it is easy to show that the average heat-transfer coefficient \( h_x \) is equal to \( 4/3 \) of the local coefficient at \( x = L \).

**REFERENCES**


**Zusammenfassung**

Eine Untersuchung der freien Konvektion wurde an einer senkrechten isothermen Platte bei Prandtlscher Zahl im Bereiche von 0,003–0,03 (das heisst flüssige Metalle) durchgeführt. Dabei wurden zahlenmäßige Lösungen der laminaren Grenzschichtgleichungen erhalten. Für die örtlichen Wärmeübergänge bei diesem Bereich der Prandtlschen Zahl lassen sich die Resultate als \( \text{Nu}_x = 0.565 \left( \text{Gr}_x \text{Pr}^2 \right)^{1/4} \) darstellen.

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**A Note on Magneto-Hydrodynamics of a Finite Rotating Disk**

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In a recent paper STEWARTSON\(^2\) has considered the problem of steady rotation of a finite disk in an electrically conducting liquid in the presence of a magnetic field. In the solution of the problem, the radial component \( H_r \) of the magnetic field has been neglected in comparison with the 'strong' external field \( H \) imposed along the axis of rotation. In this note it is shown from considerations of geometric dimensions that for a rotationally symmetric steady hydromagnetic field the radial component of the magnetic field can always be neglected in comparison with the field \( H_z \) along the axis of rotation if the depth of liquid column \( d \) is small compared with the radius \( a \) of the disk. It is also shown that in LEHNERT's\(^3\) experiments this condition is satisfied.

\(^1\) Indian Institute of Technology.
Proof. Since the disk is in steady rotation the relevant equations are

$$\text{curl } \mathbf{E} = 0,$$  \hspace{1cm} (1)

$$\text{curl } \mathbf{H} = 4 \pi \mathbf{j},$$  \hspace{1cm} (2)

$$\mathbf{j} = \sigma [\mathbf{E} + \mu (\mathbf{v} \times \mathbf{H})],$$  \hspace{1cm} (3)

where the vectors and the constants ($\mu$, $\sigma$) have their usual meaning. From (2) and (3)

$$\text{curl } \mathbf{H} = 4 \pi \sigma [\mathbf{E} + \mu (\mathbf{v} \times \mathbf{H})].$$  \hspace{1cm} (4)

In a system of cylindrical polar co-ordinates ($r$, $\theta$, $z$) on account of rotational symmetry all dependent variables are independent of $\theta$. Hence the radial component of (1) and the azimuthal component of (4) reduce to

$$\frac{\partial E_\theta}{\partial z} = 0,$$  \hspace{1cm} (5)

$$\frac{\partial H_r}{\partial z} - \frac{\partial H_z}{\partial r} = \sigma E_\theta.$$  \hspace{1cm} (6)

From (5) and (6) one obtains

$$\frac{\partial^2 H_r}{\partial z^2} = \frac{\partial^2 H_z}{\partial r \partial z}.$$  \hspace{1cm} (7)

Since $a$ and $d$ are representative lengths in the radial and axial directions respectively, equation (7) suggests the following relation between the orders of magnitude

$$\frac{H_r}{a^2} = \frac{H_z}{d}.$$  \hspace{1cm} (8)

or

$$H_r = \frac{a}{d} H_z.$$  \hspace{1cm} (8')

Thus if $d/a \ll 1$, $H_r$ is small compared to $H_z$.

In the experiment described by Lehnert the mean diameter of the rotating copper rings is 7 cm and the depth of mercury is 6 mm; consequently the neglect of radial magnetic field is justified.

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