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A Mean Flow Equation and Solution Problem

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***Abstract* – Picture a function U(2h) = 0. Y = h and U(0) = 0. Symmetric flow implies the following: The only non-zero term is – rho u_1u_2 bar which depends on x_2 = y. Also, Where P of Omega is mean pressure at walls, u_2 = 0 by no-slip depends on streamwise coordinates x_1 = x_i = x. We have the following: Where Tau at the other wall, x_2 = 2D, should be – Tau of omega. Therefore, from above, we have the following: Then, it follows that the above reads as follows where tau = 0 on channel center plane and x of 2 or y = D. Therefore, we get the following: This is for Reynolds shear stress as a function of x of 2, otherwise y.**

***Keywords* – Mean Flow Equations, Flow, Symmetric, Streamwise, Reynolds, Fluid Dynamics.**

Picture a diagram here with the following flow and parameters:
U(2h) = 0
Y = h
U(0) = 0

$$(\bar{U_i})_t + \bar{U_j}(\bar{U_i})_y = -\frac{1}{\rho}\bar{P}_x + \nu(\bar{U_i})_{yy} - (u_i\bar{u}_j)_y$$

$$= \frac{1}{\rho}[-\bar{P}\delta_{ij} + \mu((\bar{U_i})_y + (\bar{U_j})_x) - \rho u_i\bar{u}_j]$$

Symmetric flow implies the following:

$$\Rightarrow x_3 = 0 \Rightarrow u_1\bar{u}_3 = u_2\bar{u}_3 = 0 \Rightarrow$$

The only non-zero term is – rho u_1u_2 bar which depends on x_2 = y. Also,

$$\bar{u_2} = \bar{u_3} = 0$$

$$\Rightarrow \mu(\bar{U_1})_{yy} = \bar{P}_x + \rho(u_1\bar{u}_2)_y$$

$$\bar{P}_y + \rho(u_2^2)_y = 0$$

$$(\bar{P})_z = 0$$

$$\Rightarrow \bar{P} = P_\omega(x_1) - \rho u_2^2(x_2)$$

Where P of Omega is mean pressure at walls , u_2 = 0 by no-slip depends on streamwise coordinates x_1 = x_i = x.

$$\Rightarrow (P_\omega)_x = (\tau)_y$$

Where

$$\tau(x_2) = \mu(\bar{U_1})_y - \rho u_1\bar{u}_2$$

We have the following:

$$\tau = x_2(P_\omega)_x + \tau_\omega$$

$$\tau_\omega = \mu(\bar{U_1})_y|_{y=0}$$

Where Tau at the other wall, x_2 = 2D, should be – Tau of omega. Therefore, from above, we have the following:

$$\tau_\omega = -D(P_\omega)_x$$

Then, it follows that the above reads as follows where tau = 0 on channel center plane and x of 2 or y = D.

$$\tau/\tau_\omega = 1 - (x_2/D) = 1 - (y/D)$$

Therefore, we get the following:

$$\Rightarrow \tau_\omega(1 - (x_2/D)) + \rho u_1\bar{u}_2 = \mu(\bar{U_1})_y$$

$$\Rightarrow -\rho u_1\bar{u}_2 = \tau_\omega(1 - (x_2/D))$$

This is for Reynolds shear stress as a function of x of 2, otherwise y.

Compliance with Ethical Standards

The author declares that they have no conflict of interest.

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Author's Profile

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