# TWO DIMENSIONAL STEADY IMCOMPRESSIBLE LAMINAR BOUNDARY LAYERALONG A POROUS WALL

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**ABSTRACT :** The point of separation for the two dimensional incompressible boundary layer with uniform Suction Anlong a porous wall in Tani's flow for which the potential flow velocity is given by $U_{(x)} = U_0\left(1-\frac{x^2}{a^2}\right)$ has been obtained. The momentum integral, the K.E. integral equation and wall compatibility conditions have been employed for numerical solution by Runge kutta method.

**Key words:** Runge-Kutta method, Momentum integral equation, K.E. integral equation, wall compatibility condition, divergent channel.

**BOUNDARY LAYER ALONG POROUS WALL IN TANI'S FLOW**

It is proposed to investigate the boundary layer with suction along porous wall in Tani's flow for which the potential flow velocity is given by $U_{(x)} = U_0\left(1-\frac{x^2}{a^2}\right)$.

This type of flow occurs when a straight channel with parallel walls is succeeded by divergent channel with adverse pressure gradient. $U_0$ is the velocity at the entrance where the diverging flow states and '$a$' is reference length.

for this flow $\frac{U_{(x)}}{U_0} = 1-\frac{x^2}{a^2}$

i.e. $\bar{U} = 1-\bar{x}^2$

and $\wedge = \frac{\theta^2}{v}\frac{dU}{dx} = t^*\frac{d\bar{U}}{d\bar{x}} = -2\bar{x}t^*$

The momentum integral equation

$$\frac{dt*}{d\bar{x}} = \frac{2}{\bar{U}}\left[I-(H+2)\wedge+\lambda\right] \tag{1}$$

The K.E integral equation

$$\frac{dH_\epsilon}{d\bar{x}} = \frac{1}{\bar{U}t^*}\left[2D-H_\epsilon\left\{I-(H-1)\wedge+\lambda\right\}\lambda\right] \tag{2}$$

$$\frac{dH_\epsilon}{d\bar{x}} = g\left(\bar{x},t^*,H_\epsilon\right) \tag{2a}$$

and the wall compatibility condition.

$$(K+1)\left(\frac{\theta}{\delta}\right)^2+\lambda\left(\frac{\theta}{\delta}\right)^2\left\{1+\left(1-\frac{\pi}{\sigma}\right)K\right\}-\wedge=0 \tag{3}$$

becomes

$$\frac{dt^*}{\partial\bar{x}} = f\left(\bar{x},t^*,H_\epsilon\right) \tag{4}$$

**VALUES AT STARTING POINT**

The entrance suction $(\bar{x}=0)$ of the diverging flow is taken as the starting point for the numerical step by step calculation.

At $\bar{x}=0, t^*=0$ and hence from equation

$$\left(\lambda'^2+15\lambda+90\right)K_8 = -90Xt^*\left(\frac{\delta^2}{\theta^2}\right)-100.17\lambda'$$

we have

$$K_8 = \frac{-100.17\lambda'}{\lambda'^2+15\lambda+90} \tag{5}$$

$\lambda'=0$ then $K_8=0$

and

$\frac{\theta}{\delta} = 0.09997$

$H = 2.5900$

$I = 0.2225$

$H_{\epsilon} = 1.5699$

$D = 0.1685$

**SOLUTION OF THE MOMENTUM INTEGRAL AND KINETIC ENERGY INTEGRAL EQUATIONS**

With the values at the starting point numerical solutions of the momentum integral equation (4) and K.E. Integral equation 2(a) has been obtained for $\lambda' = 0$ and sililarty, we obtained $\lambda' = -0.5, -1.0, \ldots$

Numerical integration has been carried out for constant values of $\lambda' = 0.0, -0.5$ and $-1.0$ by Runge-Kutta method.

**DISCUSSION OF RESULT**

The momentum integral and the K.E integral equation have been solved numerically by Runge-Kutta method with the aid of

(i) Eight degree velocity profile $P_8$ and

(ii) Schlichting profile for

$\lambda' = 0$ in case of $P_8$ and $\lambda = 0$ in case of schlichting profile.

**COMPATISON TABLE:**

Point of separation in Tani's flow for solid (wall)

| **Authors** | **Point of separation** $\bar{x}$ |
|---|---|
| Tani | 0.2710 (Exact method) |
| Pohlhausen | 0.3180 |
| Schlichting Profile | 0.3400 |
| Eight degree velocity profile (*Ps*) (Present method) | 0.2650 |

The point of separation with the aid of eight degree velocity profile ($P_8$) is $\bar{x} = 0.2650$ which is very close to the result of Tani which is $\bar{x} = 0.2710$. Hence, it is excepted the results obtained for porous wall with the aid of eight degree velocity profile would be suficiently accurate.

**REFERENCES**

Kapur, J.N. and Bhatia, B.L. : Flow of a viscous incompressible fluid in an annuls with rasiable suction and injection along the wall, J. Phys. Soc., Japan, 19, P. 125-129 (1964).

Choudhary. R.C. : Steady Laminar flow of a viscous incompressible fluid through a uniform circular pipe with uniform suction. Proc. National Acad. of Sciences, India sec A Val. xxiv, Part II, P. 203-210 (1964).

Mistra B.N and Choudhary, R.C. : Axi, Symmetric stagnation point flow with uniform suction. Indi. Journal Pure and Appl. Math., Vol. 3, No. 3 (1972).