Analysis over the Factors Which Effect the Boundary Layer Formation

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Abstract— We know that boundary layer is formed when any obstacle is placed at the way of fluid flow. If the fluid is flowing through the channel where the one or more partitions are provided then the number of boundary layers are formed and further these layers develop the turbulent flow. By this the overall flow of fluid becomes turbulence mixed. So to avoid the turbulence and eddies in the flow the boundary layer formation and its separation should be limited as far as possible. For this we can use the various type physical and geometrical changes.

Keywords: Boundary Layer Formation

I. INTRODUCTION

The formation of boundary layer is a common phenomenon when the flow of fluid or liquid is provided over the obstacle or partition. But it is important to know that what are the factors which are responsible for boundary layer formation heavily or lightly and its separation also. By controlling these factors we can control boundary layer formation and separation and its bad effects and losses. These factors are generally velocity of flow(u), dynamic viscosity of fluid(μ), angle of ascending of fluid(θ), height of surface finish of contact surface(k), temperature of fluid(T), density of fluid(ρ), adhesive force(F_A).

II. METHODOLOGY OR LITERATURE SURVEY

A. Methodology Based On Dynamic Viscosity –

As well as the dynamic viscosity of fluid(μ) is low the flow of fluid will be easy and eddyless because the non viscous fluid provides the proper flow of fluid with the good velocity. So we can say that we should use such type fluid whose viscosity is low. Besides it by using other chemicals the viscosity of fluid(liquid) also may be reduced till a limit. Besides it we know that –

$$\tau = \mu(du/dy) \quad \text{or} \quad \mu = \tau/(du/dy)$$

Means to reduce the viscosity the value of shear stress should be lowest and the value of velocity gradient high.

B. Methodology Based On the Velocity of the Fluid Flow –

If the velocity of the fluid is high the boundary layers are formed fastly and also separates fastly and develop the turbulence in the fluid(liquid) flow. So we can say that the velocity of fluid flow should be low before passing over the obstacle or partition. For this we can use a net before obstacle or partition in which the small holes are provided from diameter 1mm to 5mm it depends on the initial velocity of fluid(liquid) and its purity.

C. Methodology Based On the Temperature of Fluid (Liquid) –

By using the fluid(liquid) with some high temperature than normal the viscosity of the fluid is reduced fastly. So we should use the some warm fluid when it is passed over the obstacle or partition.

D. Methodology Based On the Density of the Fluid(Liquid) –

The low density of the fluid is responsible for the high velocity of liquid. To provide the low viscosity of liquid the density of fluid should be low. Means the liquid should be pure and thin as far as possible to reduce the viscosity of fluid(liquid). The density of the fluid also may be reduced by mixing the required chemicals.

E. Methodology Based On the Adhesive Force Between Fluid(Liquid) and Contact Surface –

The adhesive force applied between fluid and contact surface should be low as far as possible. By this the viscosity of fluid(liquid) near the contact surface will be reduced till a limit. For this the material of contact of obstacle or partition should be such type that there is less adhesive force between fluid and contact surface.

F. Methodology Based On the Geometry of Obstacle

1) When obstacle is solid –

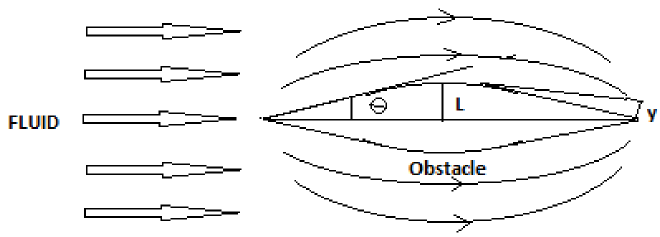

Fig. (A)

If the obstacle is made solid like figure (A) and it has lower slop to the middle position then the fluid glides smoothly over the contact surface. By this there is less formation and separation of boundary layers.

2) When obstacle is hollow

If the obstacle is made hollow like figure (B) then the fluid is flown through the both channels also provided on the both sides of the partition. By this the boundary layer formation and its separation phenomenon are eliminated till a limit.

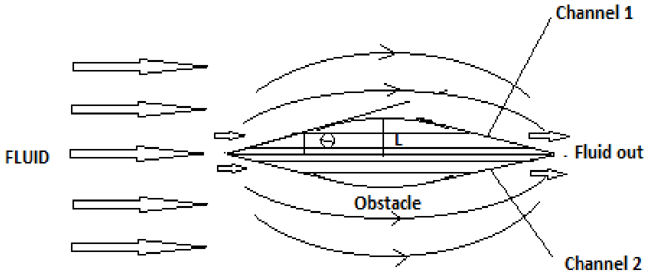

Fig. (B)

III. ANALYSIS –

Analysis over the relation between maximum deflection of boundary(y),velocity of fluid flow(u), height of body to the middle(L), coefficient of viscosity(μ), surface finish in average height(k) and adhesive force(F_A) →

So by Buckingham ,s π theorem →

f(y,u,Lμ,k,T) = 0

→ Equation (A)

Then number of variables (n) = 6

Now on putting the all dimensions of all variables →

y = (L), u= (LT^{-1}), L = (L), μ = ($ML^{-1}T^{-1}$), F_A = (MLT^{-2}), k = (L)

So the number of dimensions (m) = 3

So the number of π – terms = 6-3 =3

So we write as $f_1(\pi_1, \pi_2, \pi_3) = 0$ → Equation (B)

Where $\pi_1 = (L^{a1} * u^{b1} * \mu^{c1} * y)$ → Equation (C)

$\pi_2 = (L^{a2} * u^{b2} * \mu^{c2} * k)$ → Equation (D)

$\pi_3 = (L^{a3} * u^{b3} * \mu^{c3} * F_A)$ → Equation (E)

Now on putting the all dimensions on both sides in Equation(C) →

$(M^0L^0T^0)=\{(L)^{a1}*(LT^{-1})^{b1}*(M L^{-1} T^{-1})^{c1}*(L)\}$

On comparing the dimensions on both sides →

a1+b1-c1+1 = 0 → Equation (F),

- b1 - c1 = 0 → Equation (G)

c1 = 0 , then from Equation (G) → b1 = 0

then from Equation(F) →a1= -1

then again from Equation(C) → $\pi_1 = (y / l)$ → Equation (H)

Now on putting the all dimensions on both sides in Equation(D) →

$(M^0L^0T^0)=\{(L)^{a2}*(LT^{-1})^{b2}* (ML^{-1} T^{-1})^{c2}*(L)\}$

On comparing the dimensions on both sides →

a2+b2-c2+1 = 0 →Equation (I), - b2 - c2 = 0 →Equation (J)

c2 = 0 , then from Equation (J) → b2 = 0

then from Equation (I)→a_2 = -1

then again from Equation (D) → $\pi_2 = (k / l)$ → Equation (J)

Now on putting the all dimensions on both sides in Equation(E) →

$(M^0L^0T^0)=\{(L)^{a2}*(LT^{-1})^{b2}* (ML^{-1} T^{-1})^{c2}*(MLT^{-2})\}$

On comparing the dimensions on both sides →

a3+b3-c3+1 = 0 →Equation (K),

- b3 – c3 -2 = 0 →Equation (L)

c3 +1= 0 or c3 = -1 then from Equation (L) → b3 = -1

then from Equation(K)→ a3= -1

then again from Equation (E) →$\pi_3 = (F_A/Lu\mu)$→ Equation (M)

then from equation (B) → $f_1(y/L, k/L, F_A/Lu\mu) = 0$

or $y/L = \phi(k/L, F_A/Lu\mu)$

or $y = k\,\phi(F_A/Lu\mu, 1)$ → Equation (N)

If $\phi(F_A/Lu\mu, 1)$ is constant then from equation(N) → y α k

Means the deflection of boundary layer(y) will be maximum if the contact surface is rough while the F_A, u, μ are constant.

A. Analysis over the Type of Boundary Layer –

Obviously the laminar boundary layer is better than turbulent boundary layer, because it glides smoothly over the contact surface. But to obtain the laminar boundary layer the Reynolds number should be low. We know that $R_e = \rho uL/\mu$

If μ is constant then → $R_e \,\boldsymbol{\alpha}\, (\rho uL)$

Means to obtain the low value of R_e the value of density(ρ), velocity of fluid(u) and the width of contact(L) should be low.

IV. FINAL RESULT

Hence we can say that if required changes are provided in the flow techniques of the fluid the boundary layer formation may be avoided sufficiently.

V. CONCLUSION

Here it is important to know that the fluid behavior depends on its density, its dynamic viscosity, its physical conditions, its type of flow and finish of contact surface etc. mainly. Means in improvement of the other fluid phenomenon these above given factors have their important participation.

REFERENCES OF THE BOOKS

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