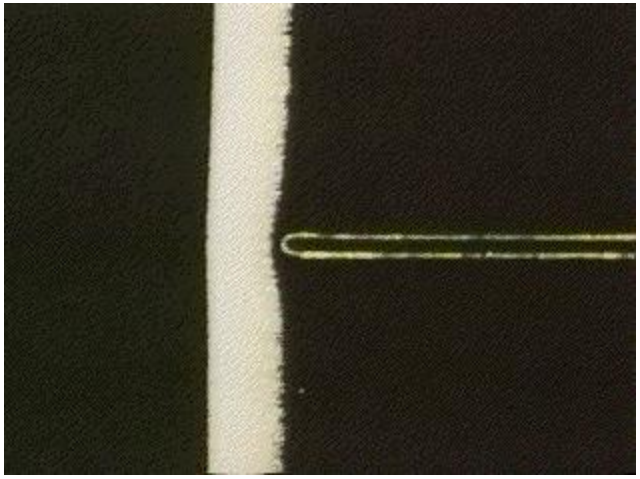
FLUID MECHANICS FOR MECHANICAL ENGINEERING (ME 208F)

Section D:
Boundary Layer Flow - II

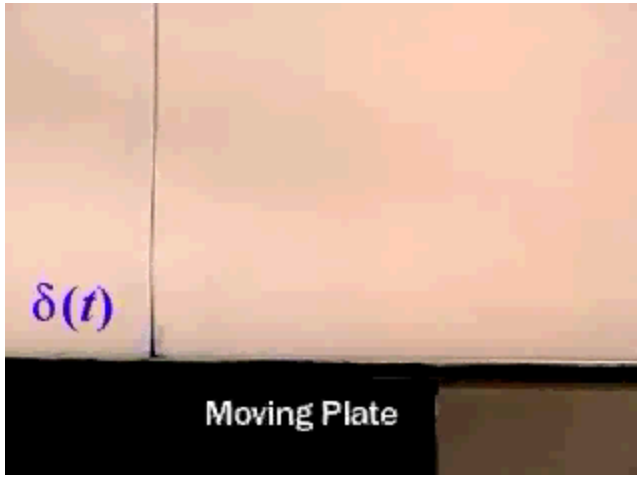
Viscous boundary layer



- An originally laminar flow is affected by the presence of the walls.
- Flow over flat plate is visualized by introducing bubbles that follow the local fluid velocity.
- Most of the flow is unaffected by the presence of the plate.
- However, in the region closest to the wall, the velocity decreases to zero.
- The flow away from the walls can be treated as inviscid, and can sometimes be approximated as potential flow.
- The region near the wall where the viscous forces are of the same order as the inertial forces is termed the boundary layer.
- The distance over which the viscous forces have an effect is termed the boundary layer thickness.
- The thickness is a function of the ratio between the inertial forces and the viscous forces, i.e. the Reynolds number. As Re increases, the thickness decreases.

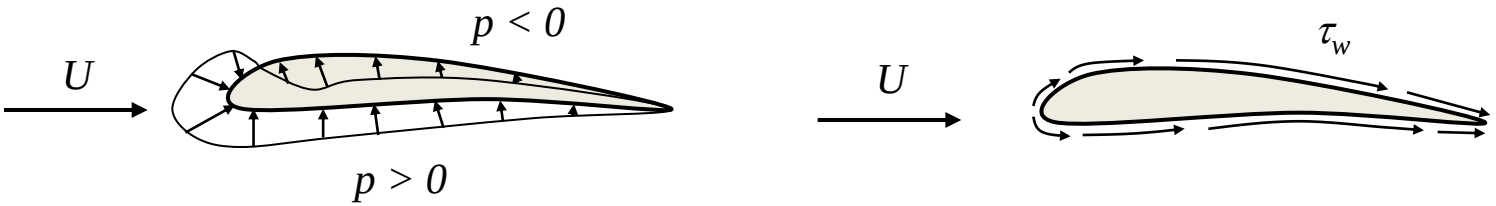
Moving plate boundary layer

- An impulsively started plate in a stagnant fluid.
- When the wall in contact with the still fluid suddenly starts to move, the layers of fluid close to the wall are dragged along while the layers farther away from the wall move with a lower velocity.
- The viscous layer develops as a result of the no-slip boundary condition at the wall.



The drag force

- The surrounding fluid exerts pressure forces and viscous forces on an object.



- The components of the resultant force acting on the object immersed in the fluid are the drag force and the lift force.
- The drag force acts in the direction of the motion of the fluid relative to the object.
- The lift force acts normal to the flow direction.
- Both are influenced by the size and shape of the object and the Reynolds number of the flow.