Answer on Question #71250, Physics / Other

The pressure drop across a wing foil on an experimental plane can be determined from the average air velocity over the wing's top-side at 115 mph and from the bottom-side at 92 mph. The plane's total weight with fuel and load is 3000 lbs. At this moment the plane is accelerating to obtain sufficient speed to lift-off the end of the runway and fly. Assume the wing-span surface area is 205 square feet. Is there sufficient lift force to bring the plane airborne?

Solution:

The lift force, L comes from a pressure difference above and below the wing so that

$$L = (p_1 - p_2)A$$

where A is surface area.

We can use the Bernoulli equation assuming a negligible difference in height to express the pressure difference as

$$p_1 - p_2 = \frac{\rho}{2}(v_2^2 - v_1^2)$$

where ρ = 0.0765 lb/ft^3 is density of air.

So,

$$L = \frac{\rho}{2}(v_2^2 - v_1^2)A$$

1 mile per hour (mph) = 1.47 feet per second (ft/sec).

Thus,

$$L = \frac{0.0765\ \text{lb/ft}^3}{2}((115 * 1.47)^2 - (92 * 1.47)^2) * 205\ ft^2 = 80671\ lbf$$

To fly we need

$$L \geq Mg$$

$$Mg = 3000\ lbs * 32.17405\ ft/s^2\ =\ 96522.15\ lbf$$

In our case

$$L < Mg$$

Answer. The lift force is **insufficient** to bring the plane airborne.