Fluid Mechanics and Locomotion

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Fluids are always opposing the motion

Figure: Ducati Wind Tunnel Experiment

Often propulsion requires a working fluid

Sometimes the two combine

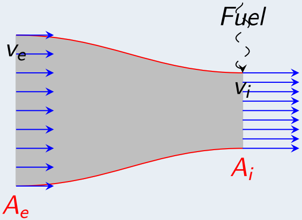
Fluid dynamics of carburation. Otto cycle engines used for the propulsion motorcycle - either two-stroke or four-stroke - they require a premixed air-fuel mixture (commercial gasoline, special gasolines for certain competitive uses or, in some rare cases , methyl alcohol and/or ethyl) that can be ignited by the spark produced by a spark plug .

Engine Cooling: require heat exchange between the engine and the outside air (either direct or via a radiator).

Overview of Aerodynamic forces on ground vehicles. On a streighaway these are drag (opposing the motion), downforce.

Venturi effect

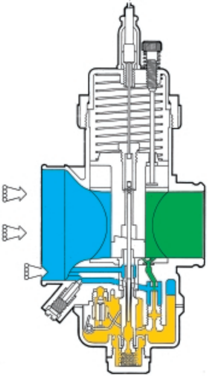
For an incompressible flow, a reduction of area causes an increase in local flow velocity and a consequent decrease in pressure



$$\frac{1}{2}\rho_e v_e^2 + p_e = \frac{1}{2}\rho_i v_i^2 + p_i$$

The carburetor then fulfills the following three main functions:

1. control the engine power by adjusting the air intake flow according to the command of the rider
2. meter the fuel flow in the air flow aspirated maintaining the ratio air/fuel to optimal values throughout the engine operating range
3. homogenize the mixture of air and fuel to enable the subsequent combustion



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The temperature of the hot gases inside the cylinder can be as high as 2000 C (3630 F) .

The cylinder head is at a much lower temperature, the recommended maximum temperature measured at the spark plug base being about 230 to 260 C (446 to 500 F).

The temperature on the inside of the wall can be as high as 315 to 345 C (600 to 653 F).

Thus, the temperature difference between the outside of the cylinder head wall (at the base of the fins) and the cooling air is several times smaller than that from the combustion gas to the wall.

Convective Heat Transfer

$$\dot{q} = Ah(T_b - T_\infty)$$

Increasing h requires a pump or a fan - $Nu = f(Re, Pr)$ -, otherwise we can increase A.

Assumptions

- steady state
- thin fin $t << p$
- Fourier heat conduction law.

Energy balance for a fin results in the following equation

$$\frac{d^2\theta}{dx^2} - \frac{hp}{kA_{cs}}\theta = 0. \quad , \quad \theta = (T - T_\infty).$$

with the following boundary conditions

$$\theta(0) = \theta_b \quad , \quad \begin{cases} & \theta(L) = 0 \\ \text{or} & \dot{q}(L) = 0 \\ \text{or} & \dot{q}(L) = \dot{q}_{cv} \end{cases}$$

where p is the perimeter, A_{cs} cross sectional area, L the length of the fin, k is the coefficient of conduction.

It is possible to obtained optimal thicknesses, spacing of the fins by mathematical computations