

Airfoil force approach to the rocket propulsion

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Current approach

The thrust of a rocket can be modeled from a generalization of Newton's 2nd Law to include a variable mass¹:

$$F_{net\ external} = \frac{d(mv)}{dt} = m \frac{dv}{dt} + v \frac{dm}{dt}$$

Which eventually give us expression for rocket thrust:

$$F = -vR = -v \frac{dM}{dt}$$

v -velocity of exhaust relative to rocket

R - rate of mass ejection

Similar expression here:



Rocket Thrust Summary



$$\text{Thrust: } F = \dot{m} V_e + (p_e - p_0) A_e \quad \text{ii}$$

$V_e = v$ - velocity of exhaust relative to rocket

$$\dot{m} = R - \text{rate of mass ejection}$$

Note that in this approach force (rocket thrust) is linearly dependent of:

1. Exhaust velocity.
2. Rate of the mass ejection (propellant loss rate.)

Airfoil force approach (my proposal)

If we force the exhaust gases to go around airfoils we will have upward lift (airfoil is connected to the rocket).

Note that in this approach force (rocket thrust) has **quadratic dependence on the velocity**:

This quadratic dependence on the velocity is giving us opportunity to reduce rate of mass ejection (fuel loss).

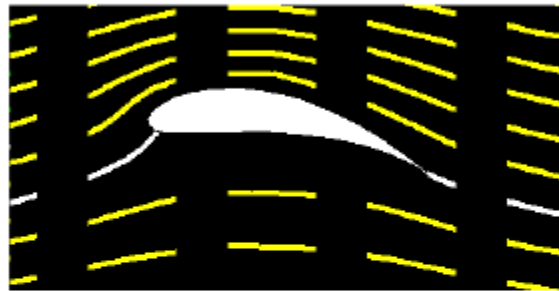
To maximize the effect biggest possible exhaust velocity is needed.



Velocity Effects on Aerodynamic Forces

Glenn
Research
Center

F = Force
L = Lift
D = Drag



V = Velocity

Aerodynamic force is related to square of velocity.

$$F = \text{Constant} \times V^2$$

then

$$L = \text{Constant} \times V^2$$

Double the Velocity --> Quadruple the Lift

and

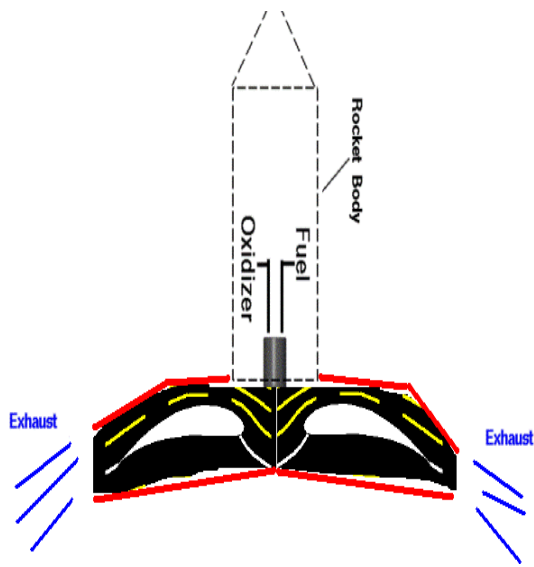
$$D = \text{Constant} \times V^2$$

Double the Velocity --> Quadruple the Drag

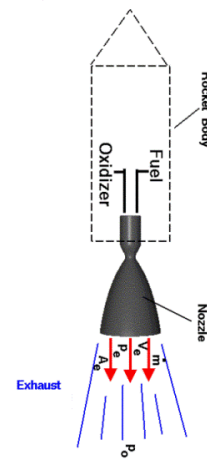
In other words

My proposal for initial testing

Current situation



 **Rocket Thrust Equation** Glenn Research Center



The end

Interesting demonstration for the nonbelievers ☺

<http://www.nhn.ou.edu/~see/fluid/2c20.35.gif>

<https://www.youtube.com/watch?v=lnSk7C6LsUU>

<https://www.youtube.com/watch?v=89-V410VhFw>

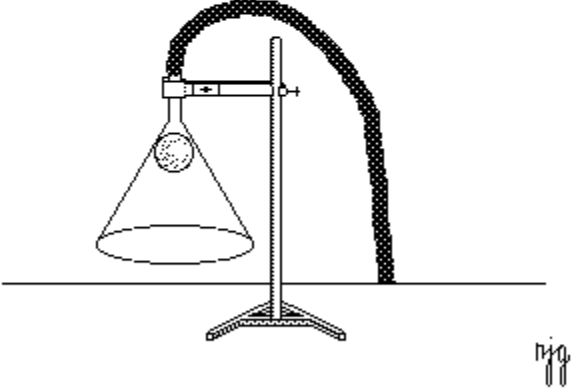
<http://www.nhn.ou.edu/~see/fluid/2c20.35.gif>

FLUID MECHANICS 2C20.35 DYNAMICS OF FLUIDS

Setup **Bernoulli Force** Text

BALL AND FUNNEL

-A large, glass funnel hangs upside-down.
Its narrow end is connected to the air supply under the lecture bench.
-Turn on the air supply.
-Hold the ping-pong ball in the funnel and release it. It remains.



nfg

ⁱ <http://hyperphysics.phy-astr.gsu.edu/hbase/rocket.html>

ⁱⁱ <https://exploration.grc.nasa.gov/education/rocket/rktthsum.html>

ⁱⁱⁱ <http://wright.nasa.gov/airplane/vel.html>