Aqua Scooter

Analysis Presentation

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aqua SCOOTER

Overview

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- Objectives
- Engine Analysis
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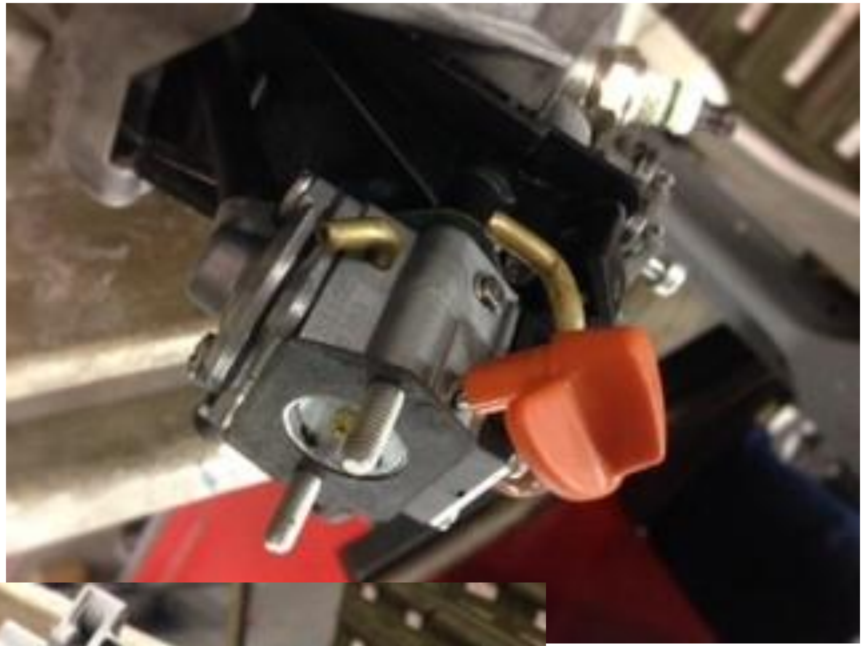
- Shell Analysis
  - Drag Coefficient
- Conclusion



Problem Definition

- Design a hydrodynamic, inexpensive, aesthetically pleasing Aqua Scooter, with a marine engine that complies with EPA regulations.

Objectives

- Analyze and compare gasoline, propane, and butane 4-stroke engine concepts.
- Quantify the ability for each fuel source to meet EPA regulations.
- Calculate the drag coefficients for the two final outer shell designs.
- Design a propeller that will generate 222 N thrust.

Gasoline Analysis

Dimensions	Aqua Scooter 2-Stroke Engine (AS 650)	4-Stroke Engine (Honda GXH50)
Length (mm)	530	225
Width (mm)	195	274
Height (mm)	320	353
Weight (lb)	16.53	12.1
Bore (mm)	40	41.8
Stroke (mm)	39	36
Displacement (cc)	49	49.4
Power (HP)	2	2.1 @ 7000rpm
Thrust (kg)	22	22
Fuel	Mixture	Unleaded 87 Octane or Higher
Fuel Tank Capacity (L)	2	1.89271
Price ($)	(+/-) 970	420

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Propane and Butane Analysis

- Assumptions
  - Calculated using Honda GXH50 converted to propane or butane.
  - Running time of 3 hours.
  - Not Adjusted for Efficiency.

- Results
  - Calculated weight of propane is 12.52 ounces.
  - Calculated weight of butane is 12.50 ounces.

Velocity Based on Thrust Calculations

Variable Values

- $V_e = 2.235 \left[\frac{m}{s}\right]$
- $T = 50lbf * \frac{4.448N}{1\ lbf} = 222\ [N]$
- $A = 0.0324\ [m^2]$
  - $diameter = 8in = .2032m$

- $T = \dot{m}V_e - \dot{m}V_o$
- $\dot{m} = \rho V_i A$
- $T = 2\rho A V_i^2$
- $T = \rho V_i A(V_e - V_0)$

Chemical Calculations

Propane Stoichiometry

- $C_3H_8 + 5O_2 + 18.8N_2 \rightarrow 3CO_2 + 4H_2O + 18.8N_2$

Butane Stoichiometry

- $C_4H_{10} + 9O_2 + 33.84N_2 \rightarrow 4CO_2 + 10H_2O + 33.84N_2$

Air Fuel Ratio Calculations

AF Ratio for 87 Octane is 15:1

AF Ratio for Propane

- $M_{air} = 28.97$
- $M_{propane} = 44.09$
- $AF_{propane} = (5 + 18.8) * \frac{28.97}{44.09}$
- $AF_{propane} = 15.66 \frac{lb\ air}{lb\ propane} : 1$

AF Ratio for Butane

- $M_{air} = 28.97$
- $M_{butane} = 58.12$
- $AF_{butane} = (5 + 33.84) * \frac{28.97}{58.12}$
- $AF_{butane} = 21.36 \frac{lb\ air}{lb\ butane} : 1$

Shell Analysis

Drag Force

$F = 0.5\rho V^2 C_d A$

Where:

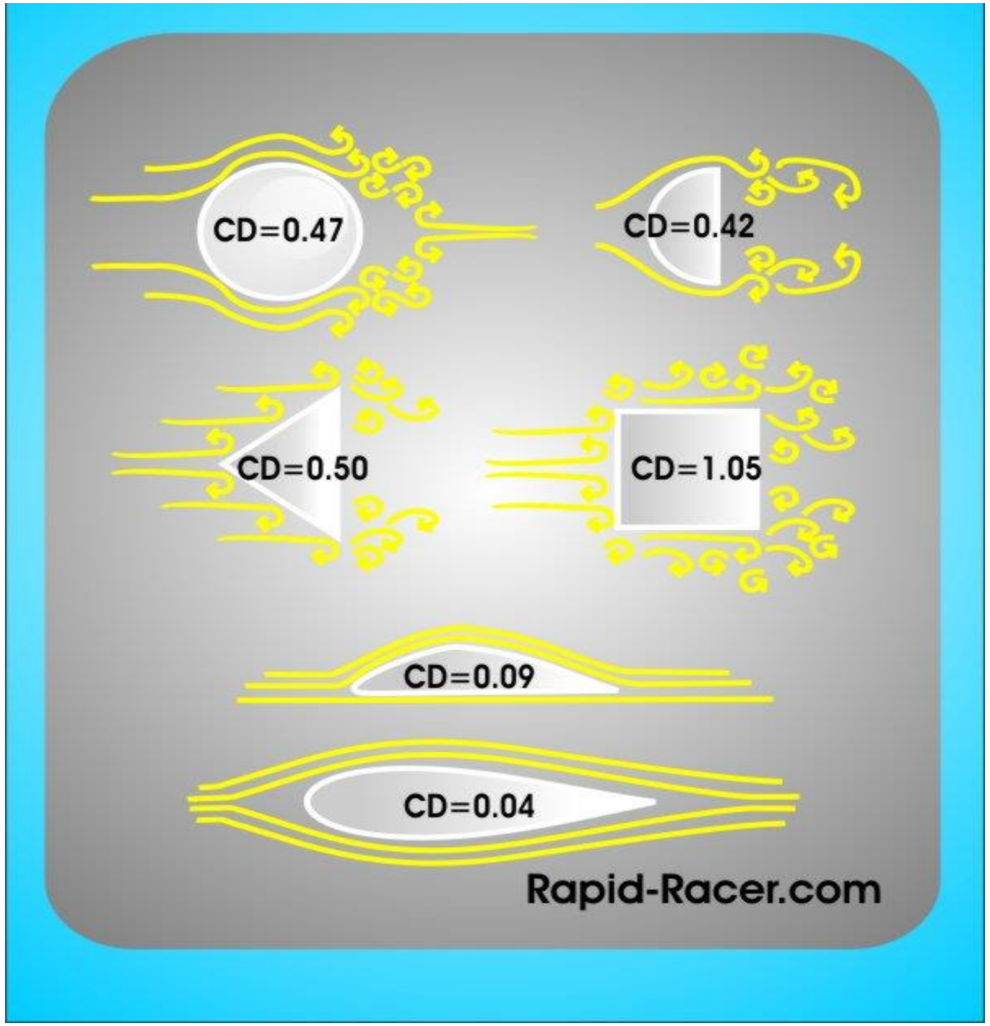
$F = Drag\ force\ [N]$

$\rho = Density\ \left[\frac{kg}{m^3}\right]$

$V = Velocity\ \left[\frac{m}{s}\right]$

$C_d = Drag\ Coefficient\ [\text{unitless}]$

$A = Area\ orthogonal\ to\ flow\ [m^2]$



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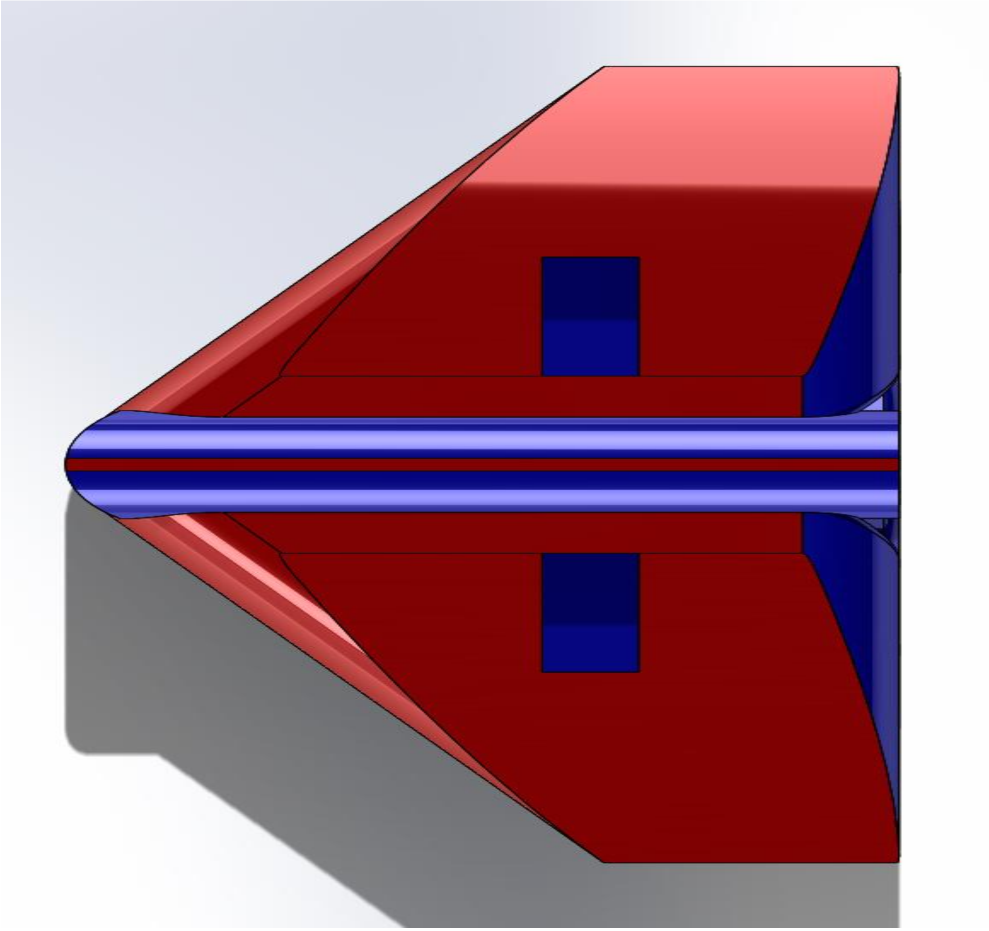
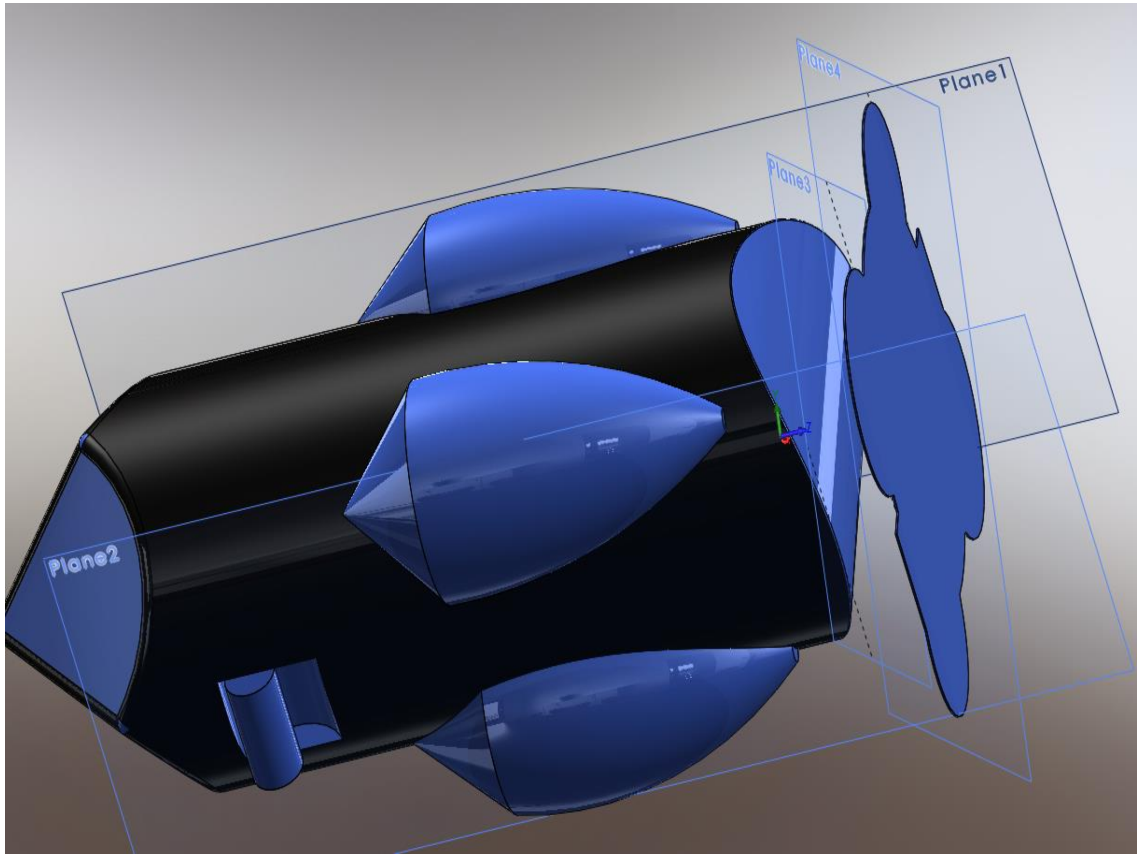
Shell Analysis- Boomerang

- **Assumptions**
  - $C_d = 0.5$
  - $A = 1106.3in^2 = 0.714m^2$
  - $\rho = 999\frac{kg}{m^3}$
  - $V_e = 2.235\ \left[\frac{m}{s}\right]$
- **Drag Force**
  - $F = 0.5\rho V^2 C_d A$
  - $F = 0.5(999)(2.235^2)(.5)(0.714)$
  - $F = 890.75\ N$



Shell Analysis- Triton

- **Assumptions**
- $C_d = 0.10$
- $A = 513.20in^2 = 0.3311m^2$
- $\rho = 999\frac{kg}{m^3}$
- $V_e = 2.235 \left[\frac{m}{s}\right]$
- **Drag Force**
- $F = 0.5\rho V^2 C_d A$
- $F = 0.5(999)(2.235^2)(.1)(0.3311)$
- $F = 82.6N$



Shell Analysis cont'd

- $v = 2.235\ \left[\frac{m}{s}\right]$
- $g = 9.81\,\frac{m}{s^2}$

Boomerang

- $Froude\ Number$
- $Fr = \frac{v}{\sqrt{gL}} = \frac{2.235}{\sqrt{9.81 * .6096}} = 0.914$

Triton

- $Froude\ Number$
- $Fr = \frac{v}{\sqrt{gL}} = \frac{2.235}{\sqrt{9.81 * .9144}} = 0.746$

Power Calculation

- $V_e = 2.235 \left[\frac{m}{s}\right]$
- $\mathcal{P}_d = \boldsymbol{F}_d \cdot \boldsymbol{v}$

$$= \frac{1}{2}\rho v^3 A C_d$$

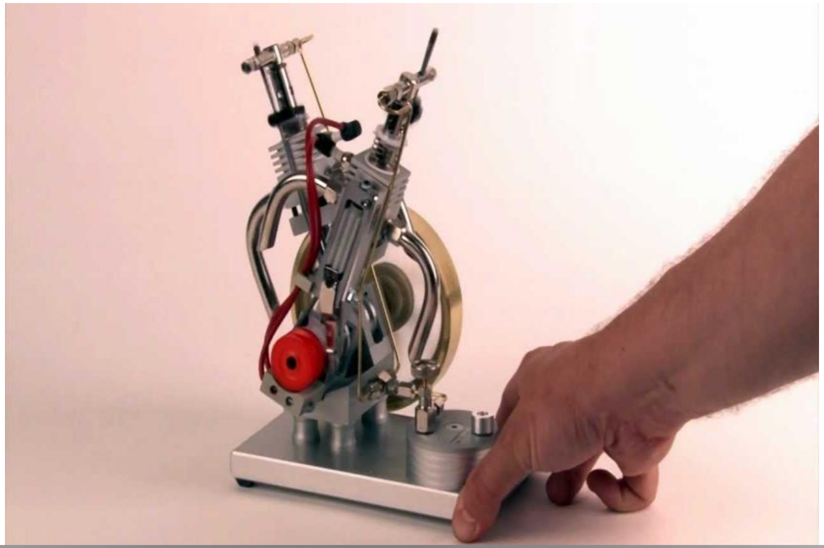
- $\mathcal{P}_{d(boomerang)} = 1990.82W = 2.669hp$
- $\mathcal{P}_{d(Triton)} = 184.611W = 0.2475hp$

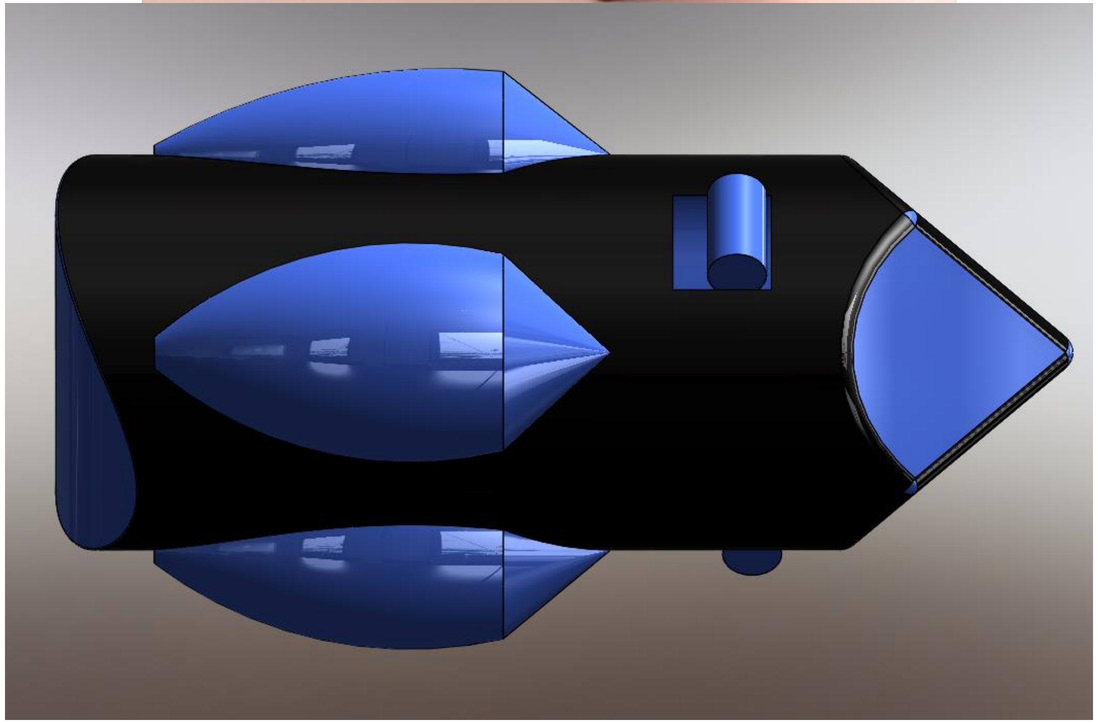
Conclusion

- Butane and Propane are viable options for engine fuel

- $\downarrow\ C_d\ \downarrow F_d$

- Emissions are lower





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Any Questions?