the ethanol ultralight

allowing corn to take flight

IPRO Projects Day      December 7, 2001
Overview

• Team Members
• Project Purpose
• Background
• Funding
• Equipment
• Ethanol
• Experiment
• Results
Team Members

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Abigail Parsons
Ben Williams

Faculty Advisor: Prof. Ruiz
Objectives

• To convert an ultralight aircraft’s two stroke engine to run on ethanol fuel
• Prove aviation can rely on ethanol fuel
• Students to gain knowledge on aircraft systems integration, airframe maintenance, performance measurements, and operations
Background

• Ethanol projects at IIT
• Project started Spring 2001
  – Found an airport and instructor for the ultralight
  – Devised a way to mix the fuel and oil
Funding

• Funding Proposal
• Targeted sponsors
• Responses
• Budget Overview
The Aircraft

- **Length**: 18.5 ft
- **Wingspan**: 32.6 ft
- **Wing Area**: 180 sq ft
- **Seats**: 2
- **Empty Weight**: 325 lbs
- **Payload w/ Fuel**: 359 lbs
- **Max T/O Weight**: 720 lbs
- **Max Speed**: 55 mph
The Engine

- Bombardier Rotax 503
  - Twin Cylinder
  - Two-Stroke
  - Fuel/Oil Lubrication
  - Air-Cooled
  - 500cc, 53 hp
The Two-Stroke Engine

• Sources of Pollution
• Widely used in:
  – Ultralight Aircraft
  – Water Sport Vehicles (jet skis, PWC)
  – Snowmobiles
  – Outboard Engines
Why Ethanol?

• Cleaner Burning
• Less Volatile
• No Hazardous Vapors
• Essentially Non-Toxic
• High Octane Rating
  – Can be used to replace highly leaded aviation fuel
• Boosts Local Economy
What is Ethanol?

- Grain Alcohol
- Sources
  - Corn
  - Biomass (Garbage)
- E85
  - 85% denatured ethanol and 15% natural gasoline.
  - Gasoline added for improved cold-starting.
Challenges

• Limited Availability
• Difficult Cold Starts
• Determining Correct Fuel/Air Mixture
• Determine Engine’s Compatibility
• Lubrication
## E85 vs. Gasoline

<table>
<thead>
<tr>
<th>Issue</th>
<th>Gasoline</th>
<th>E85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Oil (domestic and foreign)</td>
<td>Renewable agricultural crops and waste</td>
</tr>
<tr>
<td>Current Availability</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Supply</td>
<td>High, 500 million barrels in US reserve</td>
<td>Low, 2.7 gallons of E85 can be produced per bushel of corn.</td>
</tr>
<tr>
<td>Cost</td>
<td>$1.30-1.50 /gallon</td>
<td>Approx. $2.30 /gallon</td>
</tr>
<tr>
<td>Growth Opportunity</td>
<td>Negligible Increase dependence up or further oil drilling</td>
<td>High Market opportunity for agricultural crops.</td>
</tr>
</tbody>
</table>
## E85 vs. Gasoline cont.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Gasoline</th>
<th>E85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning</td>
<td>Carbon from gasoline burning engines can form deposits.</td>
<td>E85 burns cleaner and at a cooler temperature</td>
</tr>
<tr>
<td>Octane</td>
<td>87-93</td>
<td>96</td>
</tr>
<tr>
<td>Tailpipe emissions</td>
<td>BASE</td>
<td>30 % less CO 12% less HC 3% less NOx</td>
</tr>
<tr>
<td>Range</td>
<td>BASE</td>
<td>Requires 1.4 volume</td>
</tr>
<tr>
<td>Air-to-Fuel</td>
<td>14.7:1</td>
<td>8.95:1</td>
</tr>
<tr>
<td>Formula</td>
<td>C₈H₁₈</td>
<td>C₂H₅OH</td>
</tr>
</tbody>
</table>
Experimental Setup

Gas Analyzer

Engine

Oil-Fuel Mixture
Results

- Trouble cold-starting
- Air/Fuel Ratio

<table>
<thead>
<tr>
<th>Needle Position</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air/Fuel Ratio</td>
<td>7.8:1</td>
<td>8.0:1</td>
<td>8.7:1</td>
</tr>
</tbody>
</table>
Thank You

Questions?