the ethanol ultralight

allowing corn to take flight

IPRO Projects Day  May 3, 2002
Overview

• Project Purpose
• Background
• Funding
• Equipment
• Ethanol
• Experiment
• Results
Objectives

• To convert an ultra light aircraft’s two stroke engine to run on ethanol fuel
• Prove aviation can rely on ethanol fuel
• Obtain knowledge of aircraft systems
• Acquire adequate funding
• Modify structure of ultra light
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
### Quick Silver – MX2

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>18.5 ft</td>
</tr>
<tr>
<td>Wingspan</td>
<td>32.6 ft</td>
</tr>
<tr>
<td>Wing Area</td>
<td>180 sq ft</td>
</tr>
<tr>
<td>Seats</td>
<td>2</td>
</tr>
<tr>
<td>Empty Weight</td>
<td>325 lbs</td>
</tr>
<tr>
<td>Payload w/ Fuel</td>
<td>359 lbs</td>
</tr>
<tr>
<td>Max T/O Weight</td>
<td>720 lbs</td>
</tr>
<tr>
<td>Max Speed</td>
<td>55 mph</td>
</tr>
</tbody>
</table>
FAA Regulations

• Certified instructor required
• Max empty weight: 496 pounds
• Max fuel capacity: 10 U.S. gallons
• Not capable of more than 75 knots airspeed at full power in level flight,
• Have a power-off stall speed that does not exceed 35 knots
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:
  - Ultra light Aircraft
  - Water Sport Vehicles (jet skis, PWC)
  - Snowmobiles
  - Outboard Engines
What is Ethanol?

• Grain Alcohol
• Sources
  – Corn
  – Biomass (Garbage)
• E85
  – 85% denatured ethanol and 15% natural gasoline.
  – Gasoline added for improved cold-starting.
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
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</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>$1.35-1.70 /gallon</td>
<td>Approx. $1.47 /gallon</td>
</tr>
<tr>
<td>Growth Opportunity</td>
<td>Dependant on perspective</td>
<td>High potential</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>Formula</td>
<td>$\text{C}<em>8\text{H}</em>{18}$</td>
<td>$\text{C}_2\text{H}_5\text{OH}$</td>
</tr>
<tr>
<td>Tailpipe emissions</td>
<td>BASE</td>
<td>30 % less CO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12% less HC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3% less NOx</td>
</tr>
<tr>
<td>Consumption</td>
<td>BASE</td>
<td>40-45% more</td>
</tr>
<tr>
<td>Air-to-Fuel</td>
<td>14.7:1</td>
<td>8.95:1</td>
</tr>
</tbody>
</table>
Experimental Setup

- Engine
- Gas Analyzer
- Oil-Fuel Mixture
Results

- Refastened to frame
- Engine range
- 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 (gas)</td>
<td>14.0:1</td>
<td>14.2:1</td>
<td>14.7:1</td>
</tr>
<tr>
<td>Air/Fuel Ratio (E85)</td>
<td>7.8:1</td>
<td>8.0:1</td>
<td>8.7:1</td>
</tr>
</tbody>
</table>
Team Members

Bhuan Agarwal
Jason Allen
Brian Demanett
Robbie Faith
Nekheel Gajjar
Amine Hammouni
Emanuel Idikeo
Josh Jump
Jongwon Kim
Jason Kozmic
Tom Malewicki
Adnan Malik

Loren McDaniel
Dave Muliere
Eskender Mulugeta
Talha Naveed
David Ofori-Amoah
Aidar Omarov
Katin Pandya
Bhuvana Srinivasan
Theron Voran
Steven Yap
Michael Yuan
Thank You

Questions?