Kettering University

2008 Clean Snowmobile Challenge

Kettering Yamaha Phazer GT

Design Goals

- **Significantly reduce exhaust emissions**
- **Decrease noise output from all possible sources**
- **Maintain reliability and practicality**
- **Keep increased costs to a minimum to make design more viable for production**

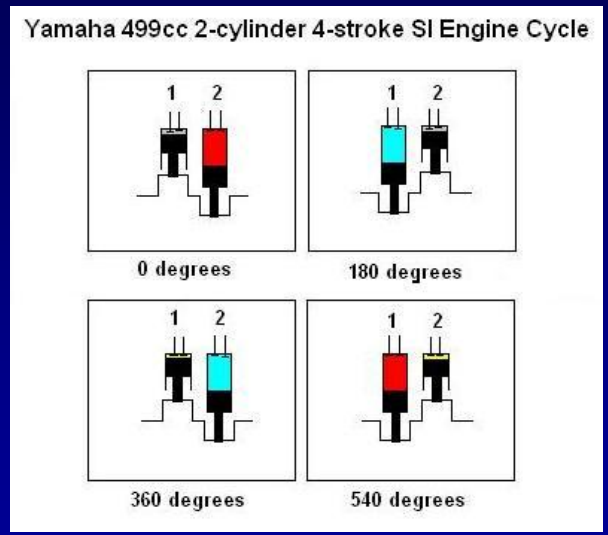
E85 Conversion Methodology

The 2008 CSC rules mandate the use of a bio-fuel blend, the benefits of such a conversion are:

- **Cleaner exhaust emissions**
- **Higher power potential**
- **Portion of fuel is derived from a renewable resource**

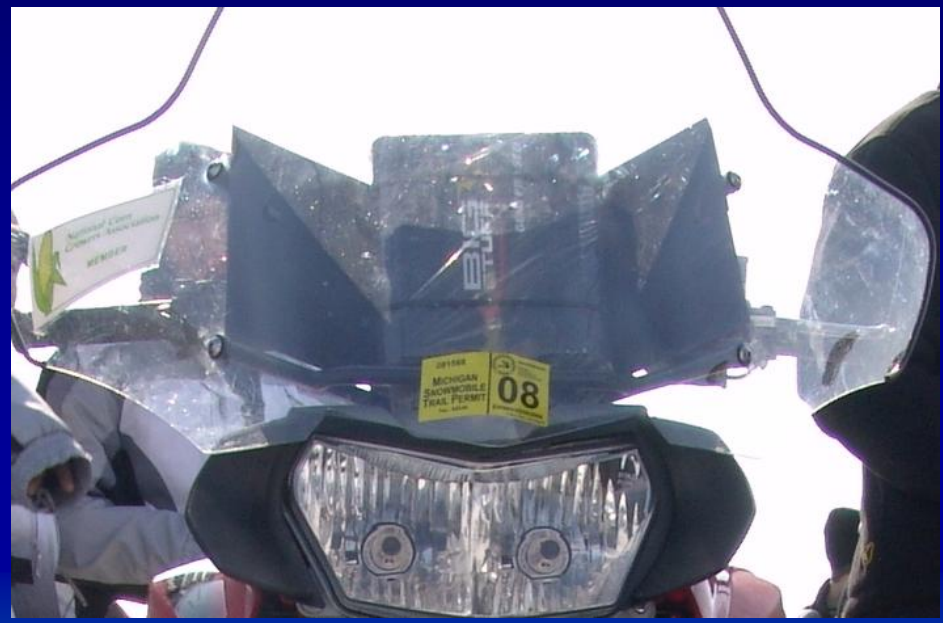
Engine Specifications

- **499 cc (30.5 in^3)**
- **Parallel twin cylinder**
- **4-stroke; 5 valves/cylinder**
- **12.4:1 compression ratio**
- **Naturally aspirated**
- **Converted to run E85**



Engine Control Units

- **The standard Yamaha controller built by Mitsubishi was retained for spark control, as well as to operate the stock gauges**
- **A BigStuff3 GEN3 controller with closed loop fuel control was integrated to control the fuel injection system**

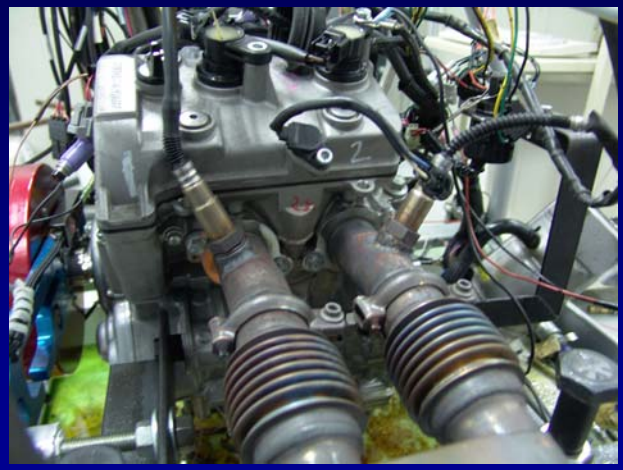


Emissions Testing

- **Baseline emissions testing was done in stock configuration as a benchmarking exercise. Testing utilized the Horiba Mexa 7100 Exhaust Gas Analyzer in Kettering's Engine Test Cell.**

Mode	Engine Speed (rpm)	Torque (ft lb)	CO(H) (% vol)	CO2 (% vol)	O2 (% vol)	THC (ppmC)	NOx (ppm)
1	10500	50	9.006	8.974	0.562	6524.6	462.8
2	8900	25.5	2.798	12.854	0.584	3199.8	2773.6
3	8000	16.5	8.048	9.88	0.272	2908.2	366
4	6860	9.5	6.024	11.088	0.36	2718.2	251.4
5	2400	0	7.502	9.688	0.876	7357	60

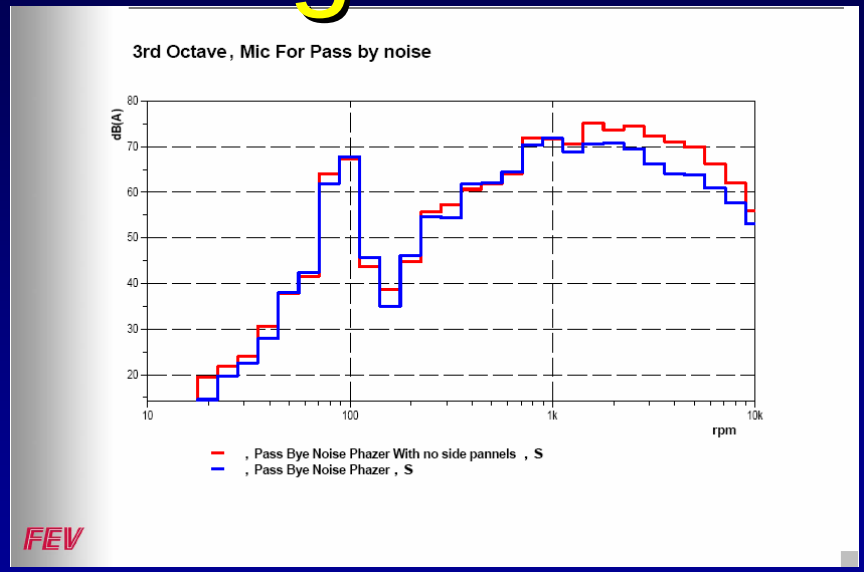
Emissions Reducing Enhancements

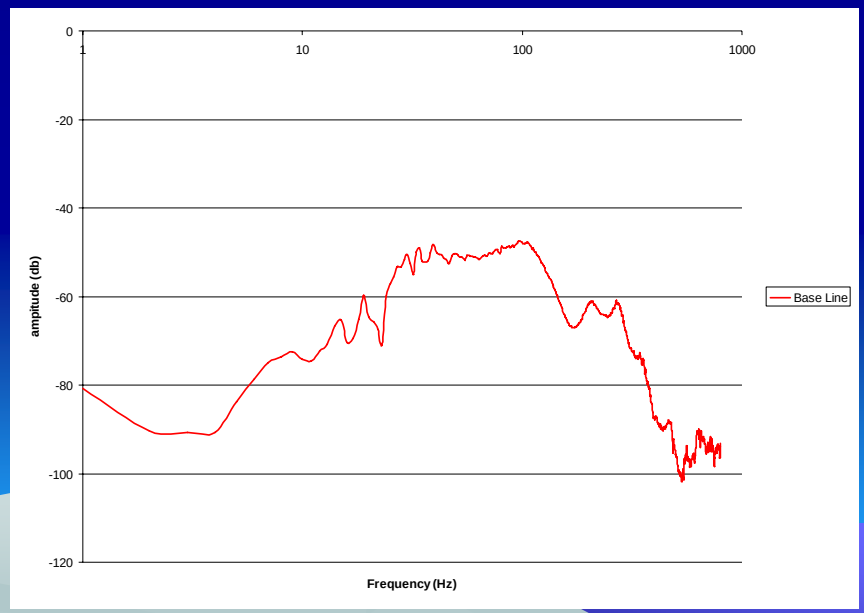


- **Three-way catalytic converter**
- **Wide band O_2 sensor**
- **Use of a fuel controller that can operate closed loop for precise control of air-fuel mixture**
- **E85 also reduces emissions from stock output levels**

Noise Testing

- **Preliminary pass-by testing was done on the stock configuration to determine the major sources of noise**
- **This information pinpointed several areas, including the tunnel and side panels**





Noise Reduction

- **Neoprene rubber side skirts were installed to isolate track noise**
- **Noisekiller™ coating was used to coat the tunnel**
- **Various types of sound deadening mat were used in the side panels**

Muffler Design

- **The stock Yamaha muffler was retained**
- **A glass pack muffler was placed in series downstream**
- **The exhaust exits into the tunnel to further reduce exhaust noise**

Body Modifications

- **A replacement side panel was fabricated from glass fiber reinforced plastic to accommodate the clutch guard and sound deadening material**
- **Aluminum shielding was installed at the rear of the snowmobile to further isolate exhaust noise**

Final Overview

- **Exhaust emissions**
- **Decrease noise output**
- **Maintain reliability and practicality**
- **Keep increased costs to a minimum**

- **Runs on E85 with catalyst**
- **Twin mufflers and sound deadening materials**
- **Completed tech inspection and endurance run**
- **Dual ECU's substantially increased cost, but could be replaced with single for production**

The 2008 Kettering University Clean Snowmobile Challenge Team would like to give a special thanks to the following sponsors: