Ethanol 85 (E-85) Versus Unleaded Gasoline: Comparison of Power and Efficiency in Single Cylinder, Air-Cooled Engines

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Introduction

With a rise in fuel prices and a decreasing stock of non-renewable resources there is a need to seek alternative fuels. Ethanol 85 (E- 85) is an alternative fuel that contains 85 percent ethanol and 15 percent unleaded gasoline. A benefit of burning E-85 over gasoline is reduced emissions of carbon monoxide, total hydrocarbons, and nitrogen oxides (Sheehan, et al. 2004). Ethanol-powered vehicles reduce greenhouse gases by up to 37.1 percent and lower carbon monoxide levels by 25 to 30 percent over similar gasoline vehicles (Canadian Renewable Fuels Association, 2004). Although emissions are lower, the key drawback of ethanol is reduced fuel economy (Yacobucci, 2004). In a study on automobiles on E-85 and gasoline it was found that fuel efficiency was reduced 27 percent with ethanol (Sheehan, et al. 2004).

The purpose of this project was to compare the fuel consumption and power output of small gas engines using unleaded gasoline and Ethanol 85 (E-85) to determine if there was a difference in fuel efficiency or horsepower production. This was an undergraduate research project.

Methodology

The engines used were four identical, new Honda GX 110 2.61 kilowatt (3.5 horsepower) engines. Each was tested using a Land and Sea DYNOmite Kart Engine Dynamometer. Each engine was subjected to a thorough and identical "motor break in" process. Then, each engine was labeled and two were randomly selected to run on E-85 and two were randomly selected to run on unleaded gasoline. Ten dynamometer runs were done on each engine to determine peak horsepower. The stock carburetor jets were not capable of making the E-85 engines run so replacement jets were ordered. One of the E-85 engines was tested on the dynamometer with various jet sizes (.060, .070, .075, .080, .085) to determine which jet produced the most horsepower. The .075 jet was thus used in both E-85 engines on the fuel consumption test.

To test the fuel consumption of each motor, the engines were connected to a graduated cylinder. Each engine was hooked to the dynamometer, accelerated to full throttle, and brought to a normal operating temperature. At full throttle a load was then placed on the engine to bring the revolutions per minute (rpms) down to 3000. The rpm was chosen *a priori* using the manufacturer's recommended speed for operation. Each engine was then held at approximately 3000 rpms for exactly 15 minutes using the manually controlled load valve on the dynamometer. The fuel consumption was measured using the graduated cylinder and a valve controlling fuel flow from the graduated cylinder. This allowed all fuel that was used in the fuel consumption tests to be measured.

Results

The first null hypothesis posited that there would be no significant ($p \leq .05$) difference between E-85 and gasoline in horsepower produced. This null hypothesis was rejected based on the results of an independent t-test, $t\ (10) = 3.08; \leq .019$. Engines run on E-85 produced more horsepower. The second null hypothesis posited that there would be no significant ($p \leq .05$) difference between E-85 and gasoline in specific fuel consumption measured by pounds per horsepower-hour. This null hypothesis was rejected based on the results of an independent t-test, $t(10) = 10.95$; $p < .009$. As shown in Table 1, engines run on unleaded gasoline were significantly more efficient than engines run on E-85.

Table 1
Fuel Efficiency and Horsepower by Fuel Type

		Fuel Efficiency		Horsepower	
Fuel Type	n	M	SD	M	SD
E-85	6	1.11	0.09	2.14	0.07
Unleaded Gasoline	6	0.50	0.10	1.90	0.18

Implications/Future Plans

The data indicated that E-85 has more horsepower generating potential than 87 octane unleaded gasoline, but has a higher consumption rate. On November 2, 2004 the price of E-85 was $1.81 and the price of 87 octane unleaded gasoline was $1.88 at the Petro Plus Station in Garnett, Kansas. At these fuel prices the cost to produce one horsepower per hour with E-85 is $0.31 and is $0.15with 87 octane unleaded gasoline. Thus, 87 octane unleaded gasoline is more efficient in small gas engines. For E-85 to be more efficient the price per gallon of E-85 would have to be nearly 50 percent of the price per gallon of unleaded gasoline. Future plans include running engines for extended periods of time then disassembling the engines and measuring the internal parts to compare them for any differences in wear. This project will serve as a model for future undergraduate research.

Costs/Resources Needed

Qty.	Resource	Cost
1	Land and Sea Kart Engine Dynamometer	$5,995.00
4	Honda GX 110 Engines	$175.00 each
5	Gallons Ethanol-85 Blend	$1.81 per gallon
5	Gallons Unleaded Gasoline	$1.88 per gallon

References

Sheehan, J.; Aden, A.; Paustian, K.; Killian, K.; Brenner, J.; Walsh, M. and Nelson, R. (2004). Energy and environmental aspects of using corn stover for fuel ethanol. Journal of Industrial Ecology, Volume 7, Number 3-4, 117-146.

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