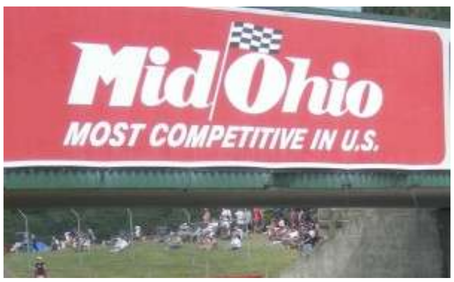
Advanced Biofuels USA, a nonprofit educational organization, advocates for the adoption of advanced biofuels as an energy security, economic development, military flexibility and climate change solution.

E85 + Small Displacement Turbocharged Engine = High Efficiency and Mileage: Proof from the Racetrack

Robert E. Kozak



IndyCar fans watch the action at Turn 1.

"2 more laps on 4 or 5 less gallons." Mid-Ohio Honda Indy 200 Winner Scott Dixon in post-race interview

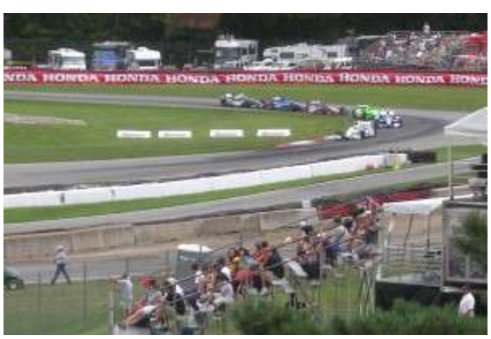
Abstract

We added Green Racing to the Advanced Biofuels USA website to show how racing technology combined with biofuels helps improve production car efficiency.

In all major US racing series; NASCAR, IndyCar, and American Le Mans, ethanol is now almost commonplace and the racing teams are using its high octane and vaporization characteristics to improve performance.

However, because of the anti-ethanol onslaught, many people have been led to believe that the use of ethanol in race cars is simply a promotional deal and has no performance or technological significance.

This past weekend at the beautiful Mid-Ohio race course the new generation of IndyCars completed a high pressure, maximum performance laboratory session that demonstrated beyond a doubt the fuel economy and performance benefits of high ethanol blend fuels in small displacement, turbocharged engines.

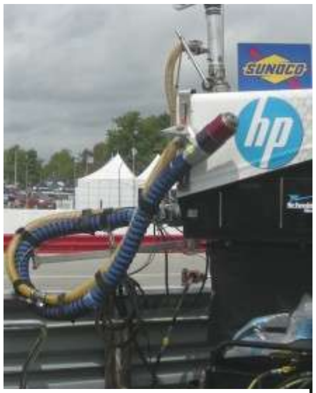


Third through 8th in the Honda Indy 200 race through the Carousel at Mid-Ohio.

Experimental Design

This controlled experiment was called the Mid-Ohio Honda Indy 200. What made this race so much fun to watch and what made the data so meaningful, was that there were no "Yellow Flag" caution laps. Instead, the 25 race drivers had to go all-out for 85 laps around a very tight, 13 turn course. They reached over 180 mph on the longest straightaway, braked to 60 mph for corners, and accelerated hard again to over 140 mph for the next straight. Not exactly a high mileage driving profile.

The Indy DW12 race cars this year have 19 gallon fuel tanks. This meant fuel economy was a major issue. If a car could complete the race with 2 instead of 3 pit stops to refuel, they would be in contention at the finish.



Fueling rig for IndyCar E85.

The 1st place through 5th place finishers were able to do that. Two pit stops and a new race record speed of 115.379 mph.

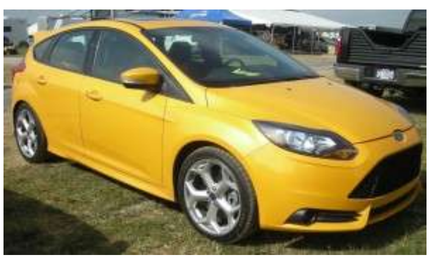
Engine Performance Comparison

What made this "experiment" even more important for the discussion about the need for high ethanol blends in cars designed to meet the proposed 54.5 mpg CAFE fuel standard is the change in engines IndyCar made between 2011 and 2012. In 2011, the engine specification called for a naturally aspired 3.5 L (214 cubic inches), ported fuel injection V8 engine.

If you compare this specification with 2005-2011 production car engines you'll see many similarities. 3.0-3.6L V-6 naturally aspired engines with ported fuel injection were standard in all the mass-sellers; Accords, Camrys, and Fusions to name three.

For the 2012 racing machine, the folks at IndyCar wanted an engine specification that, as Mid-Ohio Honda Indy 200 race winner Scott Dixon said, *was getting in line with where production car technology was going*.

And what is the new engine specification? It calls for a 2.2L (134 cubic inches) direct injected turbocharged engine that produces a minimum of **35% more horsepower (and lasts for 1,800 racing miles) from an engine that is about 37% smaller and uses 100+ octane fuel.** To meet the 1,800 mile reliability and cost reduction specification, the engine uses design parameters that are closer to production engines than to all-out "cost is no object" racing engines of the past. So, how does that specification compare with the high efficiency, high mileage engines now appearing in mass-market cars?

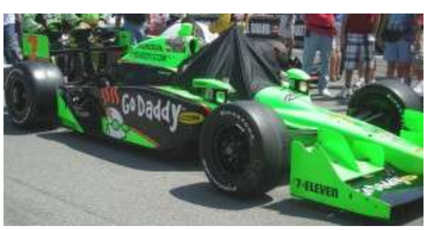


Ford Focus ST.

The version of the Ford Ecoboost used in everything from the Escape to the Focus ST is a 2.0L direct injected turbocharged engine. GM's *Ecotec* engine that is used in an expanding collection of Buick and Chevy models is also a light-weight 2.0L turbocharged engine with direct fuel injection, variable valve and ignition timing, and computer controls.

These engines produce about **15% more horsepower (and meet 100,000 mile warrantees) from engines that are about 37% smaller while using 87 octane E-10 fuel**. Chevy supplies the majority of IndyCar car engines and is using the series as a R&D center for the technologies needed to reach the 54.5 mpg fuel economy standard. (We'll have more on this a later report.)

Since we have reams of data on fuel economy from the old 3.5L IndyCar from the same tracks we will be able to compare fuel economy between the pre 2012 engines and cars with the new DW12 model.



The 2011 model IndyCar.

The new 2012 model IndyCar; Scott Dixon's winning #9.

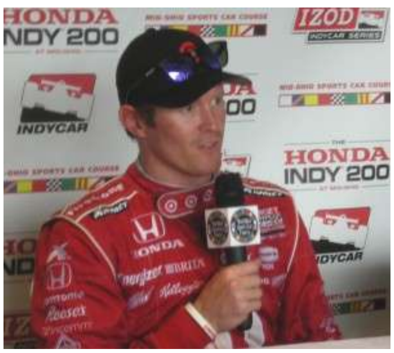
Other Experimental Parameters

The fuel that is used in 2012 is also a change. In 2011 E-98 was used. E-85 was selected for 2012 since IndyCar wanted a commercially available fuel that race fans could use in their cars. For the purpose of fuel economy comparisons, differences in fuel combustion characteristics between the fuels are minimal.

The 2012 DW12 IndyCar has new fairing around the rear wheels and a larger underbody platform. While no drag comparison numbers have been released, speeds achieved by the new car with the added horsepower are not significantly higher which indicates that total drag on the DW12 is not less than the 2011 model. Hence, any measurable 2012 fuel economy improvements are probably not due to aerodynamic improvements.

Weight of the 2011 and 2012 cars are also very similar. Race conditions were also similar with temperatures in the 80^0 F range and humidity over 50%.

Honda Indy 200 at Mid-Ohio winner, Scott Dixon, describes how E85 performance characteristics contributed to his win.



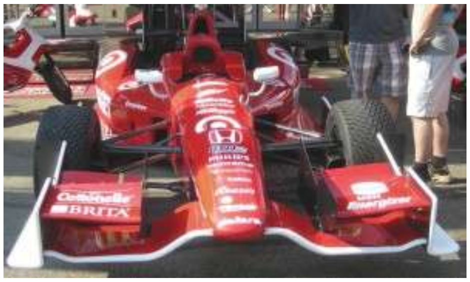
Honda Indy 200 at Mid-Ohio winner, Scott Dixon, describes how E85 performance characteristics contributed to his win.

Results

Scott Dixon covered 191.2 miles in 1 hour, 39 minutes and 48 seconds for an average speed (including pit stops) of 115.379 mph. He started the race with about 17 gallons in his car (about 2 gallons were used in the warm-up) and filled the 19 gallon tank twice. He used a total of about 51-53 gallons in his Honda 2.2L turbocharged V6 for the race so his mileage was around 3.6-3.7 mpg. How does this compare with the normally aspirated 3.5L V8 Honda engine he used in the 2011 race? (Which he also won.)

In answer to a question about this at the post-race press conference, Scott Dixon said they went 2 more laps this year on 4 or 5 less gallons of fuel. This year Scott went 27 laps (2.249 miles/lap) without running out of 19 gallons of fuel. In addition, he went about 2-3% faster in 2012. Putting his 2011 data into this equation meant 25 laps with a minimum of 23 gallons. 2011 and 2012 data is compared in Table 1.

Table 1: Mid Ohio Fuel Use	
2011 V8 Normally Aspired 3.5L	
Gallons of Fuel	23
Distance (25 laps @2.249 miles)	59
MPG	**2.6**
2012 V6 Turbo 2.2 L	
Gallons of Fuel	19
Distance (27 laps @2.249 miles)	63.75
MPG	**3.4**
% MPG Increase	**30%**



Target Chip Ganassi #9 Honda Indy 200 winning car driven by Scott Dixon.

Significance of Results

A fuel mileage improvement of about 30% clearly shows the efficiency gains that a small-displacement turbocharged engine fueled with a high ethanol mixture can obtain over a larger naturally aspired engine.

Target Chip Ganassi #9 Honda Indy 200 winning car driven by Scott Dixon.

What does this mean for Ecoboost, *Ecotec*, and similar engines that will be the powerplants in vehicles that will meet the 2022 CAFE standards? Those engines will need to produce increases of over 30% in efficiency and performance (going from 42 to 54.5 mpg in a drive cycle is 35%) over current larger displacement (3.5L) naturally aspirated engines.

These engines are making progress, about 15% as discussed above with 87 octane E-10. A number of papers have been published and meetings have been held where the benefits of high ethanol on performance and mileage have been discussed. However, there has been a dearth of on-the-road data from these small- displacement, turbo-boosted engines running high ethanol blends.

So, we respectfully submit for your consideration the 30% improvement in fuel consumption that was seen in this experiment (and damn good race) at the Mid-Ohio Sports Car Course on 5 August 2012. These new technology engines and high ethanol content fuel were made for each other. QED.

Photos by J. Ivancic

Old IndyCar design.

New IndyCar design.

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Our key tool for accomplishing this is our web site, www.AdvancedBiofuelsUSA.org, a one-stop-shop library for everyone from opinion-leaders, decision-makers and legislators to industry professionals, investors, feedstock growers and researchers; as well as teachers and students.

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