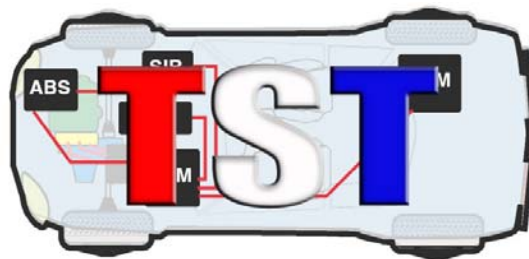


March 2017



Technicians Service Training

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Editor

"G" Jerry Truglia

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"Maintaining Hybrid Fuel Economy"

Two reasons many vehicle owners state for purchasing a hybrid vehicle are better miles per gallon and helping make the environment cleaner. Working on hybrid vehicles for years, I have noticed that most of the hybrid vehicle owners do not properly maintain



their vehicle and therefore do not achieve the advertised miles (Figure 1) per gallon. It's such a problem that some state emission programs are starting to look into the EPA rating vs. the actual hybrid vehicle miles per gallon. Since every new vehicle is certified by the federal government for emissions and miles per gallon, there is an issue when hybrid vehicles do not achieve the posted numbers. Many of the hybrids I have worked on do not

(Con't on page 2)

"Maintaining Hybrid Fuel Economy" (con't from p. 1)

average anywhere near the suggested EPA ratings. One such example is a 2008 Toyota Prius that only averages 30.5 **(Figure 1)** when it should be averaging about

46 mpg. That's a very large difference from what the vehicle owner is actually getting compared to the EPA rating. Think about how much more pollution the vehicle is emitting now compared to when it was certified.

We know that all vehicles need routine maintenance, and hybrid vehicles are no exception, especially as they get older and the high voltage (HV) battery starts to deteriorate. Vehicle maintenance from an oil change to tire pressure to a tune up can all affect the performance of the vehicle. With hybrid vehicles there is also HV battery maintenance. It is important to check the status of the HV battery for proper vehicle operation. If we go back to the first hybrid that hit the streets, we would be looking at a Honda Insight that had a 3-cylinder motor. The Insight was dependent on the Integrated Motor Assist (IMA) electric motor that was sandwiched between the engine and the transmission to help do its part in propelling the vehicle. If the HV battery on the Insight was depleted, it became very difficult to drive up steep inclines or maintain a steady speed on a hilly road. Just like everything else on the vehicle, the HV battery sometimes needs maintenance. What happens over time to the HV battery is that it becomes unbalanced and the cells begin to lose their capacity. Take notice of the HV battery level when driving a hybrid vehicle that has some miles on it or one that has been sitting around for a while. You will notice that the HV battery pack indicator seems to drain quickly. When this occurs, there will be a noticeable power loss and a drop in fuel economy. Many vehicle owners do not notice these issues since the power loss and the lower fuel mileage numbers are gradual, so they just keep on driving. If the vehicle owner checked the mpg as seen in **(Figure 1)**, where it is 16 mpg less than what the vehicle should be averaging, the owner would most likely bring the vehicle in for a diagnosis. Most of the time the HV battery has problems with voltage drop (VD) at the bus bar connections to the stud.

(Con't on page 4)

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“Maintaining Hybrid Fuel Economy” (con’t from p. 2)

The bus bars (**Figure 2**) get corroded and start to resemble the Statue of Liberty. In many cases, HV battery maintenance does the trick in getting the HV battery back up to its normal state — that is, if there is no battery cell damage. There are certain factors with HV batteries that involve age, discharge and charging cycles. In the case of the HV

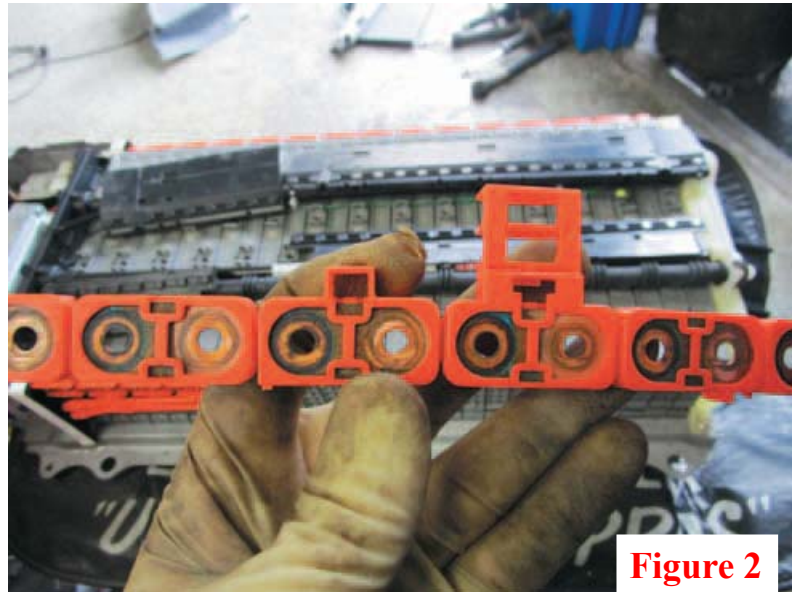


Figure 2

battery, the life span depends on temperature, vehicle use, discharge and charge cycles, among other factors. If the HV battery cell or module is dead, it cannot be brought back to life. We always examine the causes of the HV battery deterioration, which can be heat, time or air flow, to name a few.

Let’s look at the heat factor and ways that all hybrid or electric vehicles have to cool their HV batteries. A technician working on one of these vehicles must make sure that adequate air is circulated through and around the HV battery pack. In many cases, I have seen premature HV battery problems or failure due to airflow obstructions. Most of the obstructions are manmade, caused by debris blocking the air flow vents, or a connection hose being detached from the HV battery blower motor assembly. All the OEs have installed cooling fans, while some use the A/C system, and others circulate engine coolant around the battery to make sure that the HV battery temperature stays in check. Heat is the No. 1 killer of the HV battery. Now let’s move on to what we can do as service technicians.

The first items you should check when servicing the hybrid vehicle are the air vent and ducts to the HV battery to ensure they are not obstructed, clogged or disconnected. The next step would be to use the scan tool to activate the blower motor to make sure that all the fan speeds work. It is imperative that the vents are not obstructed and the

(Con’t on page 7)

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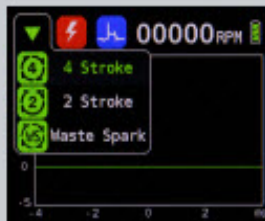
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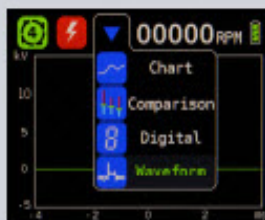
Displays secondary ignition waveforms.



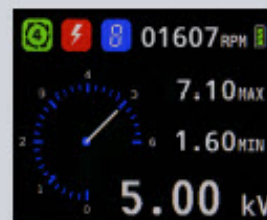
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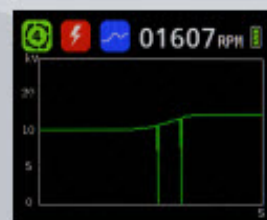


Chart mode used for detecting intermittent or infrequent failures and misfires.

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“Maintaining Hybrid Fuel Economy” (con’t from p. 4)

If the cooling system is working properly, it’s now time to test the HV battery by using a tool like the Midtronics HYB hybrid battery tester or a scan tool that can read the HV battery PIDs correctly. I like the Midtronics HYB tester because it performs a test that provides results on the state of the HV battery very quickly, and it prints. I use the results along with factory scan data to inform and help sell the vehicle owner a battery reconditioning service.

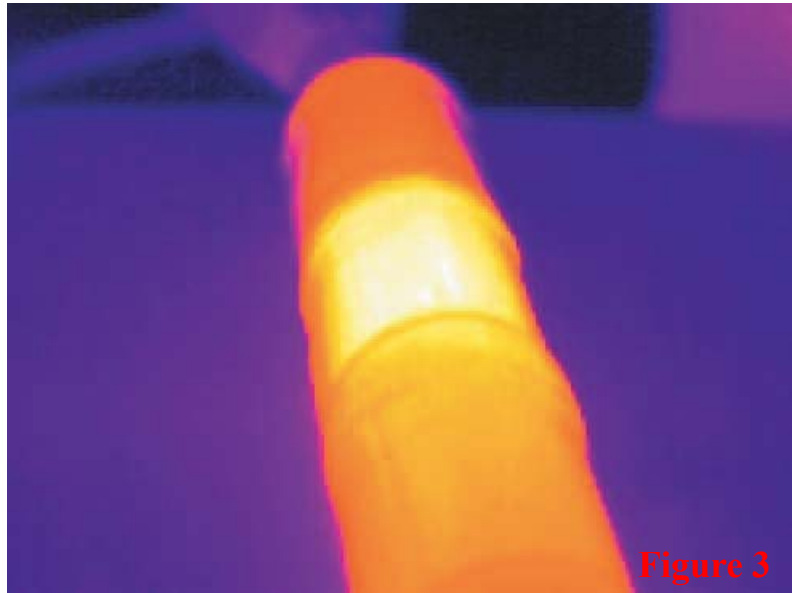


Figure 3

Our next step is to remove the HV battery and connect it to a grid charger. Some grid chargers perform tests on the HV battery cells/pack as it discharges and charges the cells.

The charging and discharging, if done early enough, will help balance the battery cells in the pack and in many cases with the right equipment identify a cell or stick that is no longer able to pull its own weight. Take a look at a Honda battery stick

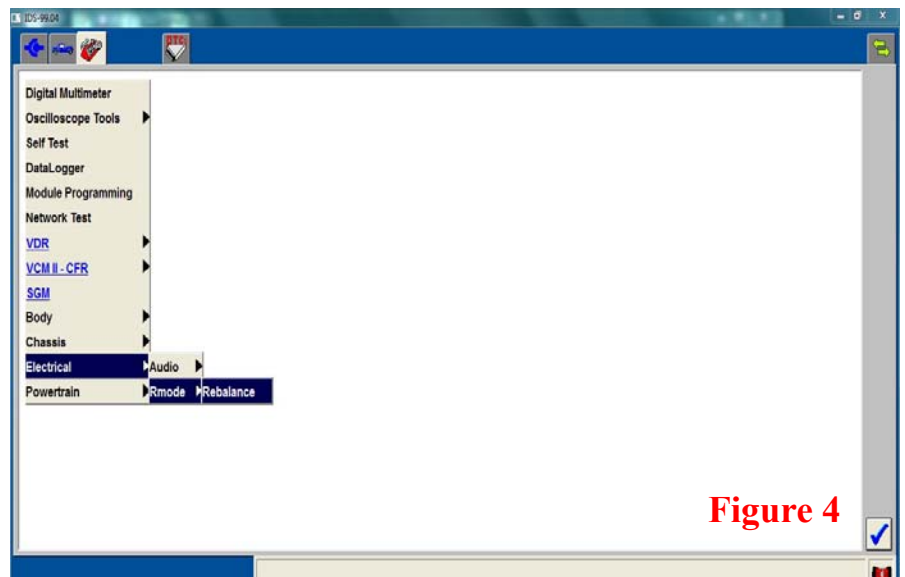


Figure 4

(Figure 3) that has one cell overheating due to internal resistance issues. Ford has programmed in a battery balance test **(Figure 4)** in their factory scan tool (IDS) that helps keep the 250 D size cells in the HV battery pack balanced.

There are grid chargers such as the one Mike Dabrowski came up with originally for his own Honda Insight to maintain and prolong

(Con’t on page 8)

“Maintaining Hybrid Fuel Economy” (con’t from p. 7)

the life of the HV battery. Mike has sold many of these chargers **(Figure 5)** to hybrid vehicle owners, especially Honda Insight owners, since the battery packs have encountered problems. There are others, such as the one the Hybrid Shop had made by Nuvant **(Figure 6)**, that are more involved in conditioning HV batteries. Owning and having experience with both of them has allowed me to recondition and rebuild many battery packs successfully. Midtronics is another company that has experience building charge/discharge units for the OEs and is now making their GRX-5100 EV/HEV **(Figure 7)** battery service tool available to the aftermarket.



Figure 5

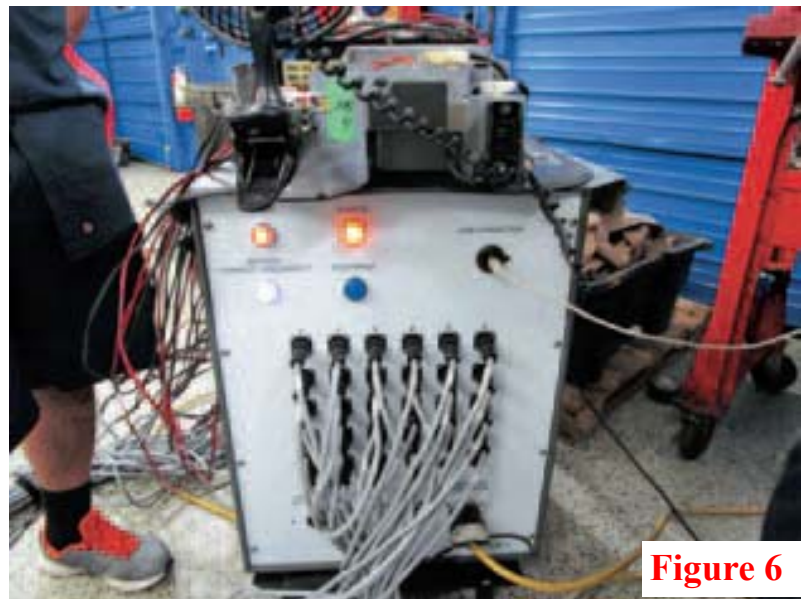


Figure 6

Many of the hybrid vehicles on the road are now older and out of warranty, needing the HV battery tested and reconditioned. There will be many more vehicles that will have an HV battery installed in them because of the government rule that is slated for 2025 when vehicles must average 54.5 mpg. This regulation maybe relaxed as President Trump is looking to change the ruling in order to give the OEs some-time. Even if the regulation is change battery powered vehicle are not going away in fact everyday more and more vehicles will add-



Figure 7

(Con't on page 10)

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“Maintaining Hybrid Fuel Economy” (con’t from p. 8)

-ed. Most likely if the goal stands it will be achieved by electrification of the vehicle. Many OEs and Tier 1 suppliers such as Delphi are back to work on the 48-volt system that will be showing up soon. With more hybrid and electric vehicles on the road, it will be commonplace to use equipment that checks, discharges, charges and exercises the HV battery.

Some examples from my shop

Our first problem vehicle is a 2008 Toyota Prius that came in with a complaint of poor mileage. The vehicle owner is experienced with hybrid vehicles, since he owned a 2005 Honda Civic hybrid and currently owns a 2014 Toyota Prius. As a previous and current owner, he was able to compare his 2014 Prius to the 2008 Prius, noticing a big difference in mpgs. To confirm the concern over his poor fuel mileage, our first course of action was to check the vehicle display to see the average mpg the vehicle was achieving. The vehicle owner thought that his 2008 Prius needed a tune up since it had more than 110K on it. We checked his service history and found that we performed a tune up at 90k after the engine had a misfire problem. Most likely since we tuned the engine up recently it was not going to be an ICE problem, but rather an HV battery problem.

We checked scan data for engine misfires along with the GTC 505 “scope on a rope” tool



(Figure 8) that easily identifies engine misfires caused by an ignition issue, but none were found. Our diagnosis on this 8-year-old Prius would concentrate on the HV side of the vehicle to see if we had an HV battery that had deteriorated.

The next logical step in our diagnosis was to connect our Midtronics HYB tester and test drive the vehicle to identify the HV battery state of health.

(Con’t on page 11)

"Maintaining Hybrid Fuel Economy" (con't from p. 10)

The HYB reported that the "HV Battery Pack Requires Service – Pack Out Of Balance" (**Figure 9**) (Fig. 6), making it easier to explain to the Prius owner that the HV battery needed to be serviced. Once the vehicle owner gave us the OK, we powered down the high-voltage system by turning off the ignition, followed by removing the service plug (high-voltage connector). After that, we were able to remove the HV battery and started removing the bus bars. The bus bars were totally corroded, causing a huge voltage drop. This confirmed our scan data, HYB test results and test drive where we noticed that the HV battery indicator was displaying a quick drop and rise in HV battery voltage. When the HV battery level either drops or rises quickly, it indicates that the HV battery has a capacity issue.

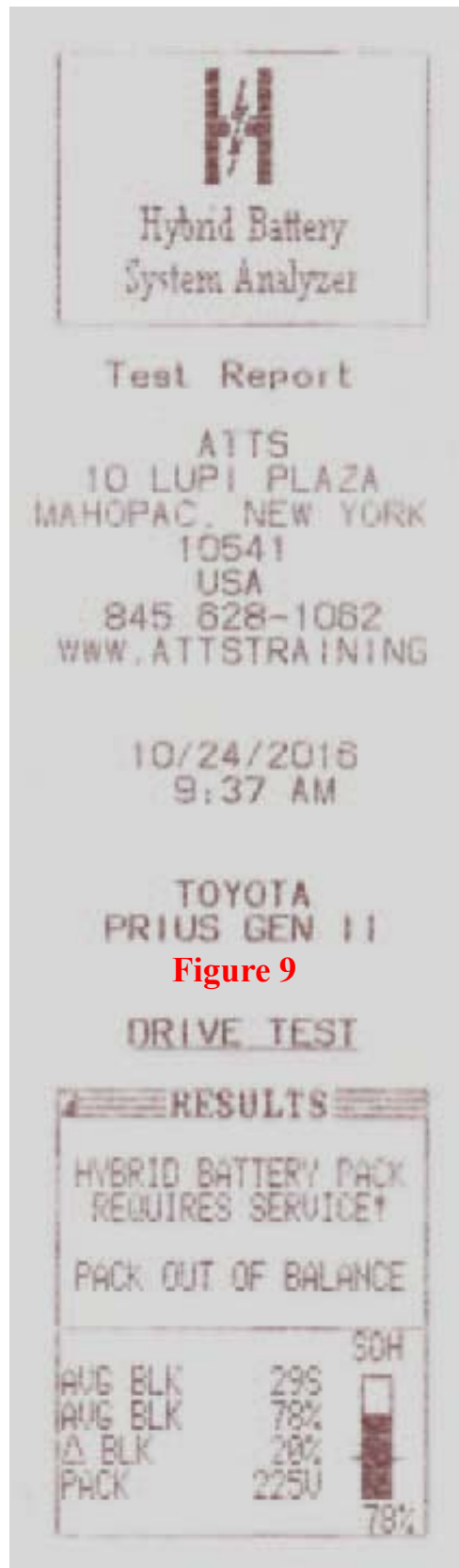


Figure 9

Getting to Know Automotive Electricity
Part One

Batteries
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Getting to Know the Automotive Lab Scope

(Con't on page 12)

“Maintaining Hybrid Fuel Economy” (con’t from p. 11)

The HYB reported that the “HV Battery Pack Requires Service – Pack Out Of Balance” (**Figure 10**), making it easier to explain to the Prius owner that the HV battery needed to be serviced. Once the vehicle owner gave us the OK, we

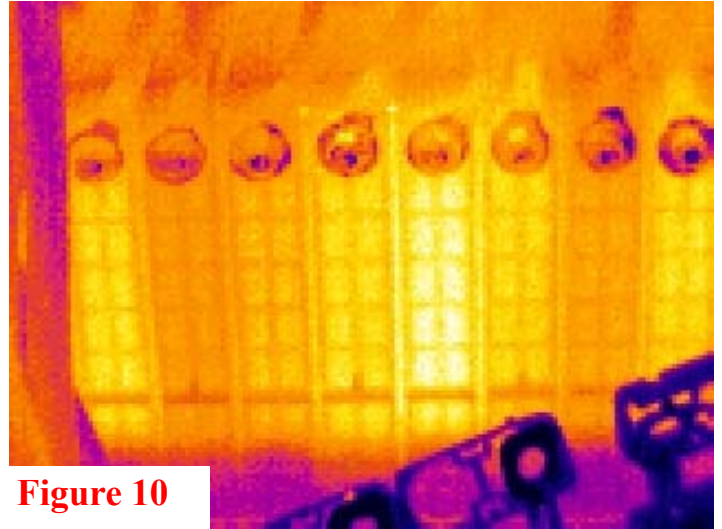


Figure 10

powered down the high-voltage system by turning off the ignition, followed by removing the service plug (high-voltage connector). After that, we were able to remove the HV battery and started removing the bus bars. The bus bars were totally corroded, causing a huge voltage drop. This confirmed our scan data, HYB test results and test drive where we noticed that the HV battery indicator was displaying a quick drop and rise in HV battery voltage. When the HV battery level either drops or rises quickly, it indicates that the HV battery has a capacity issue. We proceeded to remove the bus bars and clean them in a solution that prevents damage while getting them back to (**Figure 11**), normal. We connected our Nuvant/Hybrid Shop HV battery reconditioning equipment to each of the 28 individual modules. This Prius pack was way out of balance and had one module, No. 22, that took extra time in coming up to a normal level.

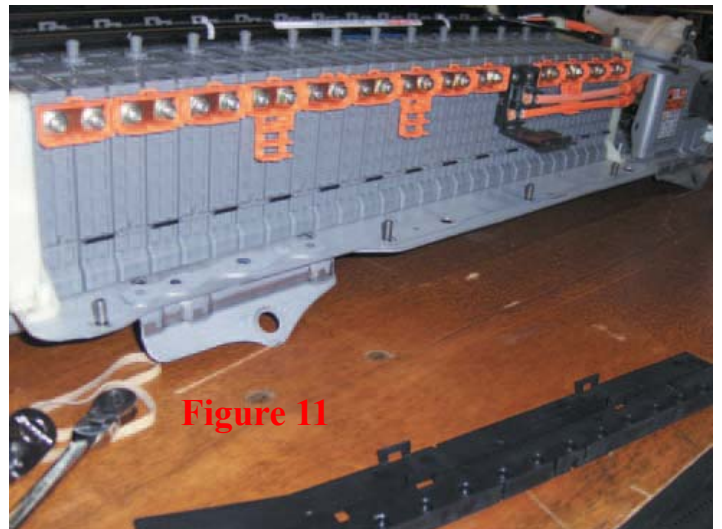


Figure 11

I would like to note here that GEN II Prius models are getting old, and their HV battery modules are getting to the end of their life. I mentioned earlier that there is a life span on these modules. In this case, reconditioning was the way to go, but there are many times when good donor HV batteries are just not available, such as on a GEN I Prius, where we must purchase a new one from Toyota. When the reconditioning was completed, we installed the HV battery and test drove the vehicle with the HYB installed so we could compare the before and after readings.

(Con't on page 13)

"Maintaining Hybrid Fuel Economy" (con't from p. 12)

We found that the HV battery was now up to 92 percent compared to 78 percent when we started. The battery reconditioning service was performed successfully, and the Prius was back to operating normally.

Next let's look at Honda IMA problems that cause an issue with mpgs. The Honda hybrid system is unique in that the vehicle can still be driven even with a bad HV battery. The vehicle will have much less power and of course mpg will be greatly affected. The mistake that most Honda hybrid owners make involves the vehicle HV cooling ducts that are restricted with debris, making it difficult for the cooling fan to do its job. There is a procedure that can be performed on the HV battery that helps drain and recharge the battery pack and should be performed often once the vehicle is more than three years old. Be aware that Honda has warranted many of the Hybrid HV battery packs even if the mileage was over 80k, or in some states 150K. In some cases, we have contacted the dealer on behalf of the vehicle owner and explained the HV battery problem. We backed up our explanation with both the Honda factory scan data and the Midtronics HYB tester. In many cases, the Honda dealer was able to provide a new replacement free of charge to the owner. Since Honda hybrids have many HV battery problems due to improper airflow and heat buildup, it's a good idea to add an additional fan to keep the batteries cooler. Look at an additional fan **(Figure 12)** that one of my students from North Carolina has made up to help alleviate HV battery overheating issues.



Let's move on to other issues that can prevent Honda hybrid vehicles from getting the proper mpgs. One is the AutoStop/IdleStop function that is used to save fuel and has now been adopted by many other manufacturers, known as Start/Stop. In stop-and-go traffic, there is a huge efficiency loss due to the engine running while the vehicle is immobile. All hybrids have a form of Idle AutoStop that will turn off the ICE

(Con't on page 14)

"Maintaining Hybrid Fuel Economy" (con't from p. 13)

when the vehicle is stopped in order to save fuel. Once you release your foot from the brake pedal, or touch the throttle, the ICE will automatically be started. With that being said, think about if the AutoStop is not operating as designed. What would be the result? You guessed it — less mpgs, due to the engine running more than it should. One of the ways a Honda hybrid system is able to achieve better mpgs is to use this feature, but before it can go into that AutoStop mode, there are some criteria that have to be met, such as the ICE has to be at a certain operating temperature, the MAP voltage has to be correct, the brake pedal has to be depressed and so on. So, if Auto-Stop is functioning properly and the HV battery is in good condition and there is still an mpg concern, there is yet another problem that is often overlooked.

The Honda Civic hybrid utilizes a valve pause system (VPS) that needs the proper weight oil to operate correctly. The VPS is used to control oil flow to the cylinder head that allows the rocker arms to disengage, thus providing ICE power from only one cylinder on 2003 to 2005; on 2006 and up vehicles, it shuts off all four cylinders. This engine requires 0w20 weight oil that is usually only found in a synthetic and in limited supply as a semi-synthetic blend. If the wrong oil is installed in the engine, it will prevent the VPS from properly operating, and the valves will not close as they are designed. The lack of proper operation will cause the ICE to stay running and not provide proper electric power from the battery. Using the wrong oil will also result in less Regen (power that the motor generator/integrated motor assist [MG/ IMA] supply to the HV battery), causing premature HV battery failure due to the battery not being properly charged and discharged. I have repaired many Honda Civic hybrid vehicles that were only getting 30 mpgs with a simple oil change, since the engine had the wrong oil in it.

I hope this article has shed some light and understanding on mpgs in hybrid vehicles. Remember that the ICE and HV both need to function as designed or the mpgs will not be achieved.

*Article By G Truglia TST Founder, President and ASE World Class Triple Master
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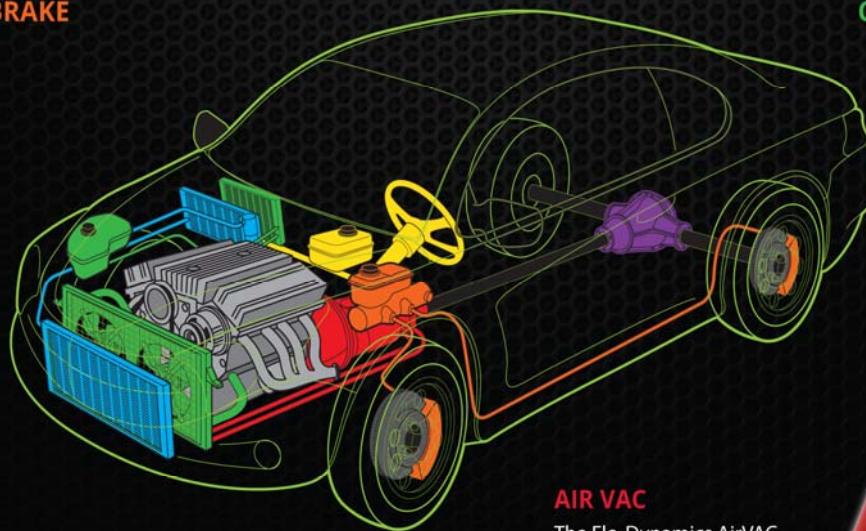
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10AM	Smith	Wooden	Cisco	Chin	Chang	King
11AM	Moore	Baker	Glass	Burton	Ellis	Cassidy
12PM	Daniels	Amber	Green	Alph	Fullerton	Dink
1PM	Wright	Fisch	Smith	Ricco	Nichols	Blake
2PM	Hovan	Perry	Green	Line Co.	Treash	Carissim
3PM	Allen	Capstone	Testa	Baxter	McArthur	Conica
4PM	Williams	Getz	Longo	Pitts	Blow	Donovan
5PM	Merry	Papa	Warshi	Quincy	Donovan	



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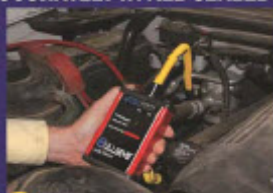
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