University of Tennessee, Knoxville
TRACE: Tennessee Research and Creative Exchange

Chancellor's Honors Program Projects

Supervised Undergraduate Student Research and Creative Work

12-2010

Design and Installation of a Compressed Hydrogen Fueling System in a 2009 Chevrolet Colorado

Nick Edward Shaffer
University of Tennessee - Knoxville, nshaffer@utk.edu

Dean Deter
University of Tennessee - Knoxville

Terrance Johnson
University of Tennessee - Knoxville

John Pate
University of Tennessee - Knoxville

Follow this and additional works at: https://trace.tennessee.edu/utk_chanhonoproj

 Part of the Energy Systems Commons

Recommended Citation

Shaffer, Nick Edward; Deter, Dean; Johnson, Terrance; and Pate, John, "Design and Installation of a Compressed Hydrogen Fueling System in a 2009 Chevrolet Colorado" (2010). *Chancellor's Honors Program Projects.*
https://trace.tennessee.edu/utk_chanhonoproj/1352

This Dissertation/Thesis is brought to you for free and open access by the Supervised Undergraduate Student Research and Creative Work at TRACE: Tennessee Research and Creative Exchange. It has been accepted for inclusion in Chancellor's Honors Program Projects by an authorized administrator of TRACE: Tennessee Research and Creative Exchange. For more information, please contact trace@utk.edu.

ME 450 & 460 Capstone Senior Design Project:

Design and Installation of a Compressed Hydrogen Fueling System in a 2009 Chevrolet Colorado

By:

Dean Deter

Terrance Johnson

John Pate

Nick Shaffer

Advisor:

Dr. David K. Irick

Abstract: This project involves the design and installation of a compressed hydrogen fueling system in a 2009 Chevrolet Colorado pickup truck. The design tasks consisted of developing the high-pressure tank mounting system, designing the hydrogen delivery system, and specifying the engine fueling system. All systems had to be in compliance with federal motor vehicle standards. These systems were incorporated with the goal of minimizing changes to the vehicles exterior appearance.

Introduction: As the world burns more and more crude oil and coal our supplies slowly deplete and the pollution generated also increases. It is because of these problems that we as engineers must now, more than ever, explore new types of alternative fuels. . These new fuels may not be cost effective now. But without the new technologies generated from research, economic viability is an impossible goal. This is true of hydrogen. So the purpose of this senior design project was to show that a standard car can be fairly easily converted to hydrogen with some simple vehicular modifications. Our only limitations for this project were more or less time constraints.

Literature Review: As far as our research goes the majority of what we found came from SAE papers, the Challenge X rules, and the Future Truck rules. Through our readings and findings we were able to develop a plan of attack.

Methodology: The first objective was mounting the three 5000psi hydrogen tanks. The tanks are aluminum pressure vessels with either a fiber glass or carbon fiber wrap to improve strength and also protect from debris. They came with circular mounting loops that we then mounted to a 3/16” and 1/4” thick steel ladder style frame. The frame is held together with both MIG welds and bolts to insure strength. After that a common rail bar or steel bolts to the top as seen in figures 1, 2, and 3.

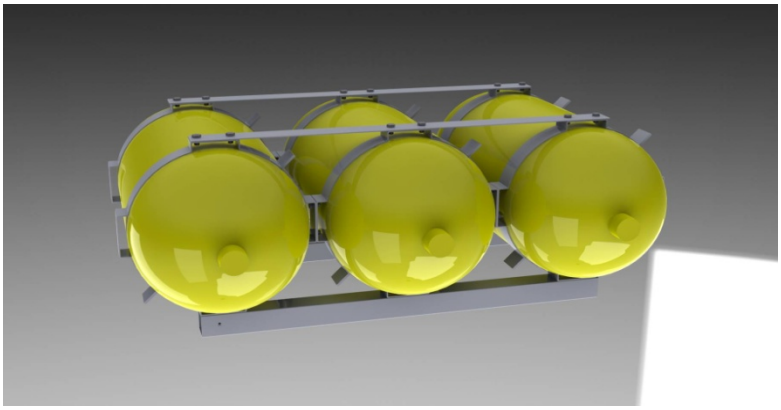

Figure 1

Figure 2

Figure 3

Next the problem of fuel injection was tackled. We wanted an injector that was able to fit into the OEM fuel rail as well as not require and modifications to the head. We were able to find just this with RC Engineering's gaseous fuel injectors that flow.8 grams of H_2 per second at 75 psi. This meets our fuel flow requirements and thus was a perfect match except for one issue. The new fuel injectors were peak and hold type, which are driven by a square wave signal. The trucks OEM injectors were saturation type injectors. We were able to fix that problem with an AEM Peak-Hold injector driver that was wired into the existing wiring harness. Thus, we maintained an OEM-like appearance. As seen in figures 4 and 5.

Figures 4 & 5

Now that the truck was able to store and inject the new fuel, the plumbing was the next focus. We ran the stainless-steel double-walled tubing along the bottom of the truck from the bed to the engine. Compression fittings were employed to insure a good seal. The tubing runs and is compression fit to the OEM fuel rail, making it look stock in appearance. Also the tubing is held under the car with

rubber coated hangers to prevent abrasion and dissimilar metals corrosion. This can be seen in figure 6. With the low pressure side taken care of, the high pressure side was more of a challenge. Because of the angle constraints of the tank necks, hard plumbing would have been very difficult. So instead we obtained flexible high pressure fuel lines rated at 5000 psi working pressure. This allowed us to have a very large tolerance when trying to align fittings. This also allowed us to attach the filler very easily, which was installed in the OEM location as seen in figure 6. A ball valve was also installed between the filler and the tanks for safety against back flow.

Figures 6 & 7

The high pressure lines will soon be plumbed to a regulator made by Tescom that allows us to take the tank pressure of 5000psi and convert it to the injector working pressure of 75 psi. Currently we are waiting on the part to come in from Parker for this last step in plumbing.

With the plumbing almost finished we have moved on to the sensors for the pressure transducers and leak detectors. We obtained the pressure transducers from Omega Engineering. There is one in the high pressure side and one in the low pressure side. With these readings and a

temperature reading from a simple thermocouple, an equation can be used to approximate tank fullness. The leak detectors were sourced to H2Scan. They were installed in the cabin and at the top of the tank holding section. Since H_2 is the smallest atom it will float to the top so we mounted the sensors as high as possible as seen in figures 7 and 8.

Figures 7 & 8

A PLC is currently being ordered that we will program to receive these signals and display a fuel gauge in the cabin. The PLC has been found, but the LCD display is still being selected. This display would also allow the driver to see pressure/temperature information and would warn the driver of any detected leaks.

Discussion: The project has been very successful. We have run into many snags along the way, but with enough searching the right products have been found and matched to the vehicle. Currently the group does not feel like the truck is finished enough to leave to the next group or person. So we have decided to work on the project some in the summer to finish the plumbing to the regulator and wire up the PLC.

Conclusion: Other than the two small issues that have slightly delayed completion of the truck, the overall project has been very well executed. Once a bed cover of some type is added to the truck, it will appear to the naked eye to be 100% stock. In fact most of the truck, even after the modifications, has an OEM feel. Our additions have done very little to change the vehicle's overall drivability or looks. And once a professional tuner flashes the ECU, the new fuel system should be fully operational. The final product will be an effective demonstration of compressed hydrogen as a vehicular fueling system.