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Hydrogen on Demand

We know that CNG/LNG and natural gas all leave a reduced carbon footprint identical to hydrogen infusion used on diesel engines. However, we also know that those fuels reduce torque and lower mileage, while increasing costs (for re-fueling infrastructure, engine conversions, etc). The resulting reduced power/higher fuel volume consumption increases emissions when compared to hydrogen infusion on diesel engines. We know our technology improves MPG by at least 10% and requires no costly engine conversions or changes to fueling infrastructure. Our technology increases torque, thereby allowing diesel fleets to do more and carry bigger loads while simultaneously using less fuel and thereby producing less emissions.

As for electric powered (re: battery) fleets, the consensus is the technology is not yet robust enough to supplant hydrogen assisted diesel fleets, thereby making us and our technology, the bridge to future zero emissions power for transportation, such as mass produced battery or hydrogen fuel cell technology, now estimated to be a decade away.

I've also attached an update, consolidated paper on hydrogen technology and our D-HAT hydrogen assist units, as well as the comparison of LNG/CNG versus hydrogen infusion,

You Cannot Violate the Laws of Physics

Why On-Board Diesel Hydrogen Assist Technology
Delivers Improved MPG, and Reduces Harmful Diesel Exhaust Emissions

Opinions differ about Hydrogen On-Demand systems. These are systems that produce small amounts of hydrogen gas using electrolysis (the separation of water, H2O, into gas that is 2 atoms of hydrogen and one atom of oxygen) and then deliver the hydrogen to the combustion chambers of a running diesel engine to enhance the fuel burn and increase the efficiency of engine performance. Some say this "can't work" or that it violates the first law of thermodynamics, regarding conservation of energy, which states "you can't get something from nothing".

The Diesel Hydrogen Assist Technology (D-HATTM) from HoD Pros has taken a new approach. We donâ€™t make grandiose claims of the achieved savings, but instead provide from the field and 3rd party testing demonstrating 8-20% savings in fuel consumption, depending on driving habits and displacement. Emission reductions range from 10-35% for greenhouse gasses (CO, CO2, NOx) and 65% or more for particulates.

Letâ€™s dispel the myths and look at the facts about Hydrogen On-Demand HoD/D-HATTM Systems:

1-The HoD Pros D-HATTM system produces, at peak power, 6 liters per minute (LPM) of gasses, 4 LPM of hydrogen and 2 LPM of oxygen. It should be noted that ambient air contains approximately 21% oxygen, the balance being nitrogen (78%) and argon (1%).

2-Nascent (atomic) hydrogen (H2) and oxygen (O2) are produced through the electrolysis of pure distilled water. The hydrogen and oxygen are completely separated and not allowed to mix to form Brownâ€™s gas/HHO.
3-The HoD Pros D-HATTM draws a maximum of 65 amps on a 12 volt DC diesel engine so our power

consumption for electrolysis is 780 watts. One horsepower = 745.7 watts so our system requires 1.05 hp to function at its maximum output. The typical diesel engine application for D-HAT system is 150-450 hp, so we use 2.3%-7% of 1 hp, a negligible use of the available horsepower.

4-The comment that we are â€œgetting something for nothingâ€ or â€œsomething from nothingâ€ is invalid. We are actually adding a small amount of hydrogen as a combustion catalyst to the running diesel engine. Just like the addition of diesel fuel, engines require external fuels to function. We use a very small percentage of the available energy for the engine to split the molecular bonds to create nascent hydrogen and oxygen. This exothermic reaction produces heat and non-processed water. Our system is around 72% efficient.

5-It takes very little energy to ignite hydrogen-air mixtures. It requires less than one-tenth the energy to ignite hydrogen-air as it does to ignite diesel-air mixtures. (Enrico Conte, et.al. â€“ ETH Swiss Federal Institute of Technology, Zurich).

6- Engine efficiency is measured as the maximum temperature less the minimum temperature divided by the minimum temperature. In other words, if an engine combusts at a higher temperature and exhausts at a lower temperature, itâ€™s more efficient. (Enrico Conte, et.al. â€“ ETH Swiss Federal Institute of Technology, Zurich).

7-Under little to no pressure, the flame speed of hydrogen in oxygen is ~390 cm/s, while petroleum in oxygen is ~30 cm/s. This 10x plus increased flame speed allows a chain reaction to be initiated between the nascent hydrogen atoms and the existing diesel to simultaneously ignite all the fuel in the chamber. (Combustion Science and Technology: Fast Flame Propagation in Hydrogen/Oxygen Mixture â€“ Aoyama Gakuin University, Japan).

8-Evidence suggests the presence of nascent hydrogen and oxygen decreases the burn time of the entire air/fuel mix by a factor of ten (10). If ignition typically occurs at around -4 degrees rotation, the entire burn would be complete at around 13 degrees. The burn would have been completed within less than 10% of its complete 180 degree stroke cycle.

9-Due to the very small percentage of hydrogen in the air mix, the hydrogen produced by the HoD Pros D-HATTM system is not intended to replace or displace the fuel in the engine but to act as a catalyst to increase the burn rate and efficiency of the combustion cycle.

10- What is a catalyst? Catalysts speed up a chemical reaction by lowering the amount of energy you need to get a reaction going. In most cases, you need just a tiny amount of catalyst to make a difference. At its heart, a catalyst is a way to save energy. (Louise Lerner â€“ Argonne National Laboratory, 2011)

Based on the Above Facts

Normally, fuel is ignited several degrees before the beginning of the combustion/power stroke and is still burning when the piston reaches the bottom of the power stroke. The remaining, un-combusted fuel is passed through the exhaust system as hydrocarbon emissions. (ETH Swiss Federal Institute of Technology, Zurich).

The injection of higher flame rate hydrogen acts as a combustion catalyst to more completely combust the available diesel fuel faster, hotter, and earlier in the power stroke. The effect is multi-fold:

1-When available fuel is burned faster at the top of the power stroke you generate more heat in less time. More heat is less time means more pressure due to the Law of Ideal Gasses ($PV=nRT$, where P is pressure, V is volume, nR are constants, and T is temperature). If the temperature rapidly increases, either the pressure or the volume must increase to compensate. Volume (mechanical piston stroke), cannot compensate for the increased temperature as fast as the pressure. Increased pressure pushes harder on the piston head, therefore there is an increase in TORQUE, or work executed by the piston. An increase (shift) in the TORQUE curve means you get the same work out of the engine with less RPM, which means less fuel.

In addition, with each gallon of diesel not combusted you do not release 22.4 pounds of CO_2 (greenhouse gas) into the air. (US Environmental Protection Agency).

2-With the HIGHER COMBUSTION temperature, you more completely consume the hydrocarbons in the fuel, reducing overall hydrocarbon emissions (particulates).

3-It is essential to have time and high temperatures to form NO_x gas. With the FASTER COMBUSTION process, the essential element of time is reduced. The extreme combustion temperatures are of such short duration that through the remainder of the power stroke, and entre exhaust stroke, the engine, on average will be much cooler. This means less NO_x production.

4-With a COOLER ENGINE, the definition of engine efficiency is realized: maximum temperature minus minimum temperature divided by minimum temperature. Therefore, with a very high combustion temperature, for a very short time, the exhaust is cooler, and the efficiency of the entire combustion process is enhanced.

Supporting Research

The conclusions presented above are supported by numerous reputable organizations such as NASA and JPL. Below are sample of studies.

â€¢ â€œThe JPL Concept has unquestionably demonstrated that the addition of small quantities of gaseous hydrogen to the primary hydrocarbon fuel significantly reduces CO and NO_x exhaust emissions while improving engine thermal efficiencyâ€ â€“ California Institute of Technology, Jet Propulsion Lab, Pasadena
â€¢ â€œThe additional of some hydrogen to the methane, speeds up the rates of initiation and subsequent propagation of flames over the whole combustible mixture range, including very fast flowing mixture. â€œThe JPL Concept has unquestionably demonstrated that the addition of small quantities of gaseous hydrogen to the primary hydrocarbon fuel significantly reduces CO and NO_x exhaust emissions while improving engine thermal efficiencyâ€ â€“ California Institute of Technology, Jet Propulsion Lab, Pasadena
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â€¢ â€œAs hydrogen has a flame spread rate over 10 times faster than that of diesel, when it is injected into the combustion sequence, it ignites the fuel from all sides as opposed to the point of initial ignition. This increases the flame speed of combustion and extracts more energy from the fuelâ€ â€“ ETH Swiss Federal Institute of Technology, Zurich
â€¢ â€œMixing hydrogen with hydrocarbon fuels provides combustion stimulation by increasing the rate of the molecular-cracking processes in which large hydrocarbons are broken into smaller fragments. Expediting production of smaller molecular fragments is beneficial in increasing the surface-to-volume ration and consequent exposure to oxygen for completion of the combustion process. Relatively small amount of hydrogen can dramatically increase torque and reduce emissions of atmospheric pollutantsâ€ â€“ American Hydrogen Association Newsletter
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â€¢ 3rd Party Field Testing: â€œEmissions Evaluation of Hydrogen on Demand systemâ€ â€“ Damon Atkinson â€“ Dixie State University, St. George UT
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Additional submitted attachment is included below.

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