

High Performance Clean Diesel Technical Overview



Developed by the technical staff of
EcoChem Alternative Fuels, LLC
January 2022

Technical Abstract:

This paper presents the results of analysis for addressing inherent degradation of diesel fuel due to an antiquated fuel infrastructure, contaminants found in fuel storage tanks and outdated ASTM & ISO fuel cleanliness standards. The analyses show how each technology addresses multiple deficiencies that effect combustion characteristics and how the combination of these tech' serve as a holistic approach to addressing todays fuel quality demands.

Outdated fuel quality standards set by ISO over 20 years ago, now severely breach the damage threshold tolerances of todays engines. Fuel related maintenance costs are skyrocketing due to new engine technology and increasing gap in fuel quality requirement. Downtime costs substantially impact both company profits and service reliability & reputation.

Every gallon of fuel that is purchased at the pump most likely is heavily contaminated, fouled with dirt and rust, degraded in quality, and in generally suboptimal condition. At best, this leads to less than optimal operations of the vehicle/equipment/weapon system, and at worst, the premature failure of the system. Moreover, burning dirty fuel leads to significant increases in hazardous emissions.

"Diesel fuel quality has not kept up with engine changes," says Rebecca Monroe, the fuel trademark and Infrastructure lead at General Motors. She says "emissions regulations are driving diesel engine changes-again." Fuels that do not exceed the OEM engine and injector fuel quality requirements can cause premature parts failure in equipment of any age, and the OEMs have recommended diesel fuel have a "first-pass efficiency" of 99.9 percent in the 2-3 Micron range.

Introduction

Since 2007, EcoChem Alternative Fuels, LLC has been working on a new approach to close the gap between existing ISO fuel specifications and current OEM engine requirements or recommendations.

EcoChem is a commercial company using patented technology to produce a premium, OEM Compliant fuel as its being bought at the pump. Our integrated SMART PUMP provides fuel quality control and enhances the fuel characteristics eliminating typical quality and contamination issues associated with consumer grade diesel fuel and its supply chain. The SMART PUMP will immediately provide; site compliance, fuel & equipment protection, intelligent fuel management, increased fleet useful life, reduced maintenance costs, reduced fuel usage and emissions.

EcoChem has patented a logical solution at a logical point in the supply chain where it matters the most. This process takes regular diesel fuel from the contaminated storage tank and through its multi-stage/multi-tech process, produces an ultra-pure high performance, cleaner burning fuel right at the pump.

HPCD™ is a high-performance diesel fuel converted by EcoChem's patented "Fuel Refinement System" to eliminate fuel quality deficiency and bridge the gap

between today's engines and yesterday's fuels. The SmartPump will provide a cleaner burning, more efficient premium diesel at the pump. No other commercial technology presents both fuel purification and fuel reformulation that our HPCD™ processing system provides.

Current Supply Chain Challenges

All class of diesel engine technology and diesel fuel quality have made huge advances since the black smoke-belching days of the 1960s and 1970s. Yet fuel storage and fuel quality are still in a vulnerable state due to the antiquated contaminated supply chain compounded with obsolete storage and dispensing technology. Today's transportation fuels are subject to contamination from starting from refining methods to every transfer point up to the pump. Water, dirt, corrosion products, and microbial growth are all common fuel contaminants that degrade fuel. Additionally, diesel fuel begins to naturally degrade as soon as it is produced. Within days of refining, all fuel goes through a process called re-polymerization and oxidation. This process forms varnishes and insoluble gums in the fuel by causing the molecules of the fuel to lengthen and bond together to form asphaltene, sometimes called diesel sludge. This leads to excessive carbon formation and soot build up, yielding black smoke.

The issues of diesel cleanliness and fuel contamination are not new, but with ever-stricter fuel emissions standards and the rapid pace of change in turbo diesel engine technology, the quality of the fuel feeding these engines has become an increasingly important factor in ensuring equipment performs as efficiently as it's supposed to. Fuel related maintenance costs are skyrocketing due to new engine technology and increasing gap in fuel quality requirement. Truck repair stations are backlogged due to increased equipment failure and shortage of qualified mechanics. ALL FUELS that do not exceed the engine & injector OEM's fuel quality requirements cause premature parts failure in equipment of any age. OEM's have been insistent that damage caused by fuel contamination is not a factory defect. A recent U.S. EPA study finds 87% underground fuel storage tanks have moderate to severe corrosion and 75% are unaware of the problem.

Fact: ISO Cleanliness Code 4406:1999 calls for filtration of 18/16/13 microns but that fuel quality standard is outdated and breaches the damage threshold of most modern equipment. Outdated fuel quality standards set by ISO over 20 years ago, now severely breach the damage threshold tolerances of today's engines. Diesel engines, and in particular - their high speed, high pressure fuel injection systems - have become 100 times more sensitive to fuel qualities that were once common and a non-issue for most diesel engines. Engine OEM's now recommend filtration of 14/13/11 microns and injector OEM's 12/9/6 microns.

Fact: ALL FUELS that do not exceed the engine & injector OEM's fuel quality requirements cause premature parts failure in equipment of any age. OEM's have been insistent that damage caused by fuel contamination is not a factory defect. To address the problem, OEMs have recommended that final diesel fuel filters (on vehicle) have a first-pass efficiency of 99.9 percent in the 2-3µm range.

The *World Wide Fuel Charter* states, "Over 50% of all diesel fuel dispensed does not meet the ISO codes for cleanliness". Diesel Progress cited "poor quality fuel to be the #1 cause of engine failure."

A Simple, Logical & Effective Solution

EcoChem has designed, built and successfully tested integrated refining and dispensing technologies that takes moderately degraded Ultra Low Sulfur Diesel (ULSD # 2) from the storage tank and dispenses a purified, molecularly superior fuel with virtually no contamination, ensuring the highest fuel quality in every drop. EcoChem's patented "Fuel Refinement System" eliminates most fuel quality deficiencies and provide a clean and economically viable, premium alternative to Ultra Low Sulphur Diesel (ULSD) at the pump.

The Logic And Science of Stacking Fine Filters, Gauss Fields And Additives

EcoChem's patented and proprietary processes have been proven to convert moderately degraded fuels into a premium finished fuel that: 1) increases MPG, 2) reduces emissions, and 3) significantly increases engine lubricity, reducing wear and tear on critical diesel engine components 4) exceeds ISO, ASTM and OEM standards as required by engine manufacturers to warranty their equipment.


This is achieved by;


- Fine filtration of particles below the damage threshold to a 2-3 μm (micron) range to ensure operation without incident
- Eliminating inherent diesel fuel deficiencies through a specific restructuring process of the hydrocarbon chains
- Reformulating for ultimate protection and performance

1) FILTERS - This cleanliness level, 18/16/13, as mentioned, is met only occasionally in today's delivered fuels and cleanliness levels much dirtier are routine. Oil companies and fuel distributors acknowledge fuels are routinely in the 22/21/18 range upon delivery (that's about 16X dirtier than allowed by equipment warranty). Yes, there are supplies in the 16/15/13 range but they are not the norm and leave little room for error only taxing the on board filtration to its limits of performance.

Regular Diesel


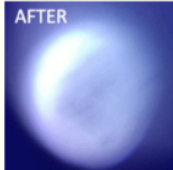
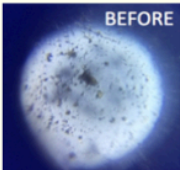

vs.



**150 X Magnified**
Heres a look at a drop of fuel under a microscope set at 150 x

Before HPCD process

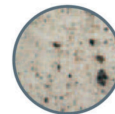
After HPCD Process



Does not meet OEM Fuel quality requirements

Meets ASTM & OEM Fuel quality requirements

Typical cleanliness
of consumer fuels
ISO 22/21/18



Target rating for
engine OEM
ISO 14/13/11



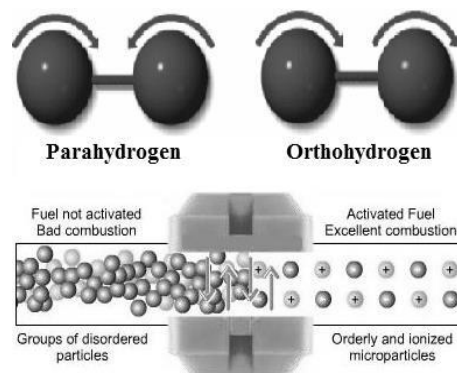
Company	Cleanliness Level
Typical Delivered Fuels	22/21/18
World Wide Fuel Charter	18/16/13
Engine OEM	14/13/11
Fuel Injector OEM	12/9/6

2) FIELDS - Stage 2 of EcoChem's technology operates on the principle of induction, the process of combining kinetic and magnetic energy to influence the behavior of electrons. Our *FuelTron* unit provides a powerful Gauss Field and the flow of fuel provides the kinetic energy. The theory of magnetic diesel fuel treatment states that exposing the diesel fuel to the magnetic field will increase the ratio of orthohydrogen atoms that can be additionally oxygenized to promote more complete combustion, extraction of energy, and a reduction in unburned fuel molecules in the exhaust.

In short, "Magnetization of fuel, breaks down the bonds between hydrocarbon chains which results in decreased density, surface tension and, hence smaller particulars and droplets during atomization or injection within an internal combustion engine. Smaller particles and droplets causes increased evaporation rates, improved mixing of fuel and oxidizer, and improved promotion of oxidation. Increased oxidation of the hydrocarbon fuel causes several effects. Faster and more complete oxidation results in more rapid and more complete combustion of the fuel. Faster and more efficient combustion creates a more concentrated and more forceful driving force on the pistons of an internal combustion engine. The net effect is an increase in the rate of combustion, an increase in power, and reduced pollutants."

An additionally claimed benefit of fuel treatment is the elimination of microbial organisms from the fuel by disrupting the balance between the positive and negative electrical charges found within and immediately surrounding each cell. This results in perforating the cellular membrane and diesel killing the organism.

These reactions stabilize most of the hydrocarbons in addition to polarizing the paired electrons to spin in the same direction changing from a Para-hydrogen to an Ortho-hydrogen molecule. By altering the spin properties of the electron, we can enhance the reactivity of the fuel and related combustion process. This higher spin state shows a high potential reactivity, which attracts additional oxygen. Combustion engineering teaches that additional oxygenation increases combustion efficiency resulting in fuel economy



Note - The compound effect of pretreating fuel prior to precision injection of a multi-functional additive will achieve 3 ends; 1) further improve combustion efficiency 2) accelerate catalysis with immediate fractures of HC chains 3) significantly reducing additive reaction time and recommended treatment ratios.

3) FORMULA - The 3rd and final stage of EcoChem's process operates on the principle of *improved atomization and vaporization through stabilizing and lubricating the fuel to exceed pump and injector OEM recommendations by precisely injecting a proprietary multifunctional catalyst. Note - the process is additive agnostic compatible with standard aftermarket additives.*

Substandard atomization equals a poor quality air/fuel mixture ratio, thus the combustion charge is not as oxygen efficient as possible. Thus unburned fuel exists exhaust, ie: exhaust emissions. Linked HC molecules form a chain known as polymerization. When long hydrocarbon chains are mixed with air at induction

ideal atomization is not achievable. Improved atomization is crucial to thermal efficiency. This formula achieves this through chemical molecular separation breaking longer chains chemically resulting in an oxygen rich combustion atmosphere achieving maximum combustion volumetric efficiency.

Air contains Nitrogen, combined with oxygen produces nitrous oxide. Unburned, a major contributor of smog along with carbon monoxide and carbon dioxide. Thermal efficiency is vastly enhanced by the almost complete burning of the increased molecular surface attachment of nitrogen and oxygen present in the fuel combustion process of our reformulated fuels.

HPCD™ achieves superior atomization and vaporization for maximum combustion efficiency. This will reduce knocking and pinging and will better protect against cold start impact on the upper cylinder, valves, valve seats, and piston rings. Additionally, solvents and micro-lubricants help to keep fuel related components in peak condition and help to protect against Ultra Low Sulfur Diesel (ULSD) lubrication deficit.

The End Product is branded as **HIGH PERFORMANCE CLEAN DIESEL (HPCD™)**



Because Better Fuel Burns Better!

HPCD™ Effectiveness has been proven over millions of miles of on road testing with multiple diesel fleets. A strict test protocol for multiple vehicles is implemented and all data is collected and verified by fleet management. All data is then analyzed and compared to the baseline.

- Exceeds **ASTM / ISO / OEM** fuel requirements
- Verified **AVG 11% MPG Improvement**
- Verified up to **27% less HC Emissions**
- Verified reduction in **NoX Emissions**
- Observed **Lower Maintenance Cost**
- Observed **Extended equipment Life**

Central Ohio Testing Cooperative 2010 between The City of Dublin, Dublin Schools, Washington Township Fire Dept., Resource 100, the Farmers Co-op, Ohio Small Business Development Center and EcoChem was formed for the purpose of testing EcoChem's High performance clean fuel. In this independent field study #2 HPCD Fuel showed a remarkable 16% mpg improvement and 13% reduction in NOX. After 18 months of use, Dublin reports an estimated savings overall of 10.7%. The city said the initiative is one of their more successful efficiency programs.

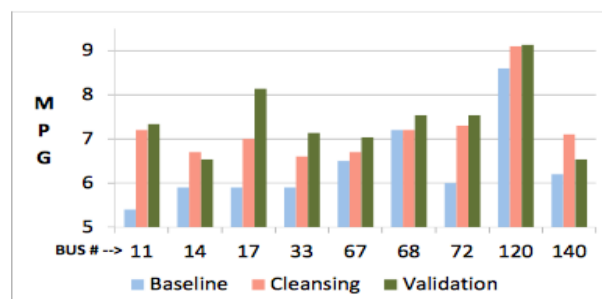


Chart 1 Fuel Economy (MPG) by Bus and Period

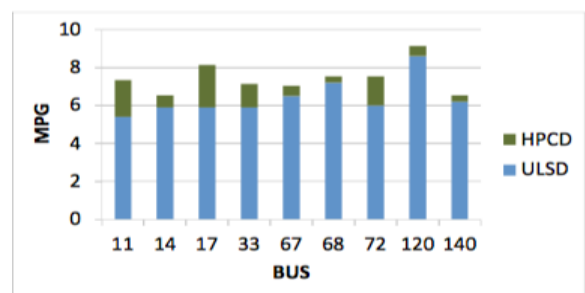


Chart 2 Impact on Fuel Economy of Switch from ULSD to HPCD

Northeast Ohio Testing cooperative 2015 between Cleveland Municipal School District, Twinsburg School Districts for the purpose of evaluation of HPCD Fuel. Results and Conclusion Data from the two recent projects clearly shows a validated average of 12% improvement in MPG for the combined group. Cleveland reported 11% improvement in MPG, and Twinsburg 14% after switching from regular diesel to HPCD.

