Ultra-High Molecular Weight Polymer
X-1R Fuel Additive for Diesel Emissions Reductions

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Certified By The Space Foundation

Overview

Clean Fuel Additive technology consisting of very high molecular weight pure hydrocarbon (PIB) polymer

- Patented technology – US Patent.
- Polymer: Non-toxic, odorless, used for food grade applications.
- Initially developed for military application.
- Environmentally Safe.

History

- Initially fuel additive developed for US military, served as an anti-misting agent to moderate the size, heat, volatility, and smoke emanating from jet fuel explosions.
- Original tests conducted at China Lake Missile Sites in the deserts of California dramatically indicated that the polymer did exactly what it was developed for.

China Lake Testing

Naval Research Center, China Lake, Testing

Detonation of Untreated JP-5 Aviation Fuel. Notice the size of the smoke cloud.

Detonation of treated JP-5 aviation fuel. Notice the much smaller smoke cloud.

X-1R Fuel Additive

- The current fuel additive is a hybrid of the original ultra high molecular weight polymer, modified to optimally enhance fuel combustion and cause emissions reduction.
- Current version of fuel additive can be used in diesel (and other middle distillates fuels), gasoline, heavy fuel oils (HFOs) to reduce PM, HC, CO, and NOx; as well as improve fuel economy.

How it Works

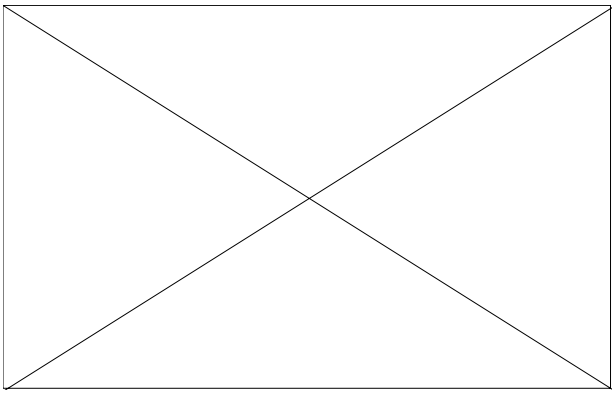
- Modifies rheological properties of fuel: extensional viscosity
- Improves air/fuel mixture by modifying fuel's physical properties – making fuel Viscoelastic
- A more uniform distribution of droplet size across the cross section of the diesel spray cone
- A reduction of the mean volume diameter (Sauter Mean Diameter) of the diesel injector spray

How it Works

- A more even distribution of the fuel distributed across the cross section of the spray cone
- The elimination of superfine satellite droplets, which cause early ignition
- An improved spray jet penetration
- Reduced wall wetting

How it Works

X-1R Fuel Additive – How it works animation

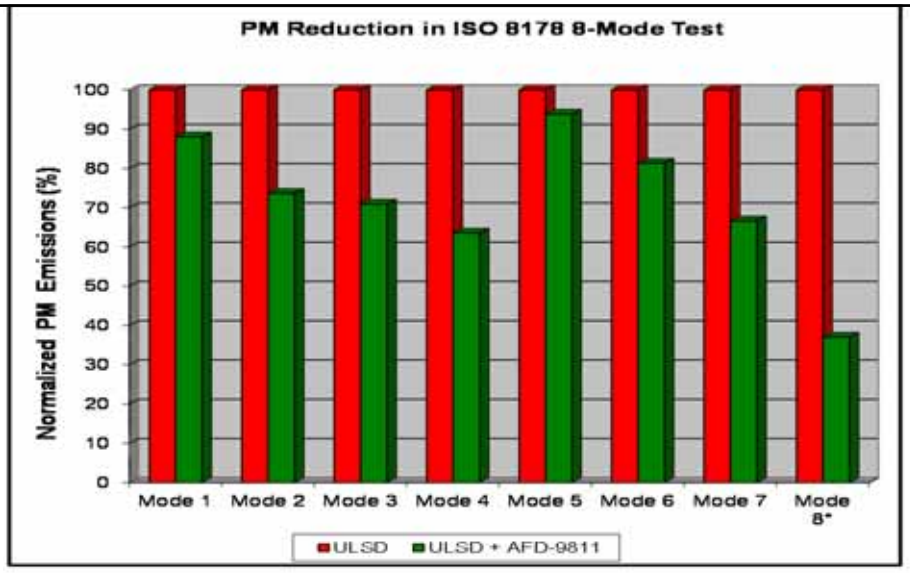


Effect of X-1R Additive

The net effect of adding X-1R fuel additive in diesel fuel (in new engines and engines with deposits) is reduction combustion gas temperatures, reduction in emissions of unburned hydrocarbons, CO and NOx, reduction in fuel consumption and increase in engine power.

Testing and Approvals

- UHMW polymer technology tested at Olson-ecologic Engine Test Laboratories.
- One of the additive technology approved by state of Texas for TxLED program.
- Additive technology approved by CARB for emissions reduction (PM and NOx) for off-road diesel heavy duty engines.
- Technology acknowledged by R20 global body
- Will not void OEM warranty



EACH DATA POINT IS THE AVERAGE OF NINE (9) MEASUREMENTS
AVERAGE PM REDUCTION IN MODES 1-7 WAS 31.2%
PM REDUCTION IN MODE 8 (IDLE) WAS 63.0%

Lab Test Data

Summary – Emission Reduction at Idle

Emission Reductions At Idle Grams Per Horsepower Per Hour		
	NOx	**PM**
Diesel	**157.333**	**25.764**
Diesel+AFD9811	**141.00**	**9.542**
% Difference	**-10.5**	**-63**

Lab Test Data

Summary – Emission Reduction

Steady-State – Post 1,000 Hour Durability Grams Per Horsepower Per Hour				
	HC	CO	NOx	PM
Diesel	1.290	2.56	7.09	0.308
Diesel+AFD9811	0.940	1.59	5.290	0.159
% Difference	-26.8	-37.9	-25.4	-48.4

Lab Test Data

Summary – Using 5% Biodiesel Blend

Steady-State – Post 1,000 Hour Durability 5% Biodiesel Grams Per Horsepower Per Hour				
	HC	CO	NOx	PM
Diesel	1.290	2.560	7.09	0.308
Diesel+AFD9811 +5% Biodiesel	0.934	1.468	5.36	0.168
% Difference	-27.6	-42.0	-24.3	-45.4

Lab Test Data

Summary – Using 20% Biodiesel Blend

Steady-State – Post 1,000 Hour Durability 20% Biodiesel

Grams Per Horsepower Per Hour

	HC	CO	NOx	PM
Diesel	**1.290**	**2.560**	**7.09**	**0.308**
Diesel+AFD9811 +20% Biodiesel	**0.770**	**1.297**	**5.94**	**0.163**
% Difference	**-40.3**	**-49.3**	**-16.2**	**-47.2**

Field Test Data

Summary – Emissions Reduction

Test Period: October 2012 – March 2013
Testing Company: Algoritmos, Santiago, Chile
Engine: Sultzer **Model:** ZA40s **Fuel:** Diesel
Avg. MW: 8-9 MW

Diesel Fuel Results

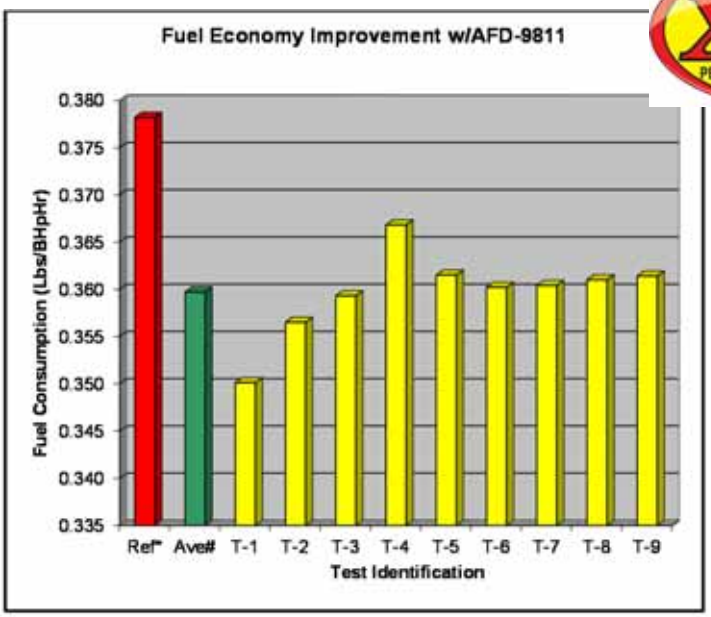
	2012(Baseline)	2013(AFD-9811)	Reduction
NOx kg/h	**109.95**	**109.58**	**0.3%**
SO_2 ppm	**6.5**	**1.52**	**76.62%**
PM mg/m³N	**154.525**	**50.67**	**67.21%**

Additional Benefits

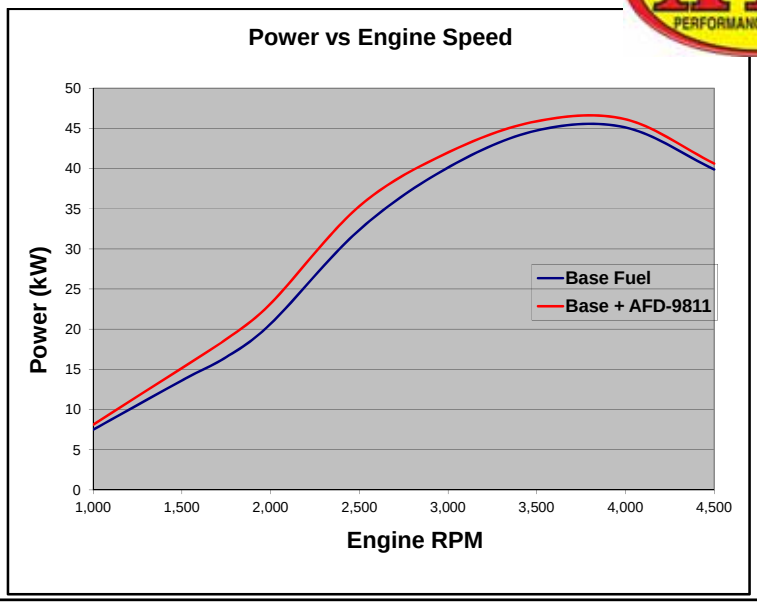
UHMW Technology

- **Fuel Economy Improvement** for diesel engines (technology's savings, pays for the cost of the additive in multiples.)
- **Safety**- Anti-misting properties of UHMW Polymer technology drastically reduces potential explositivity & flammability, for diesel fuel (and other fuels) rail-car transport and storage on site.
- **Increase in Engine Horsepower and Torque**

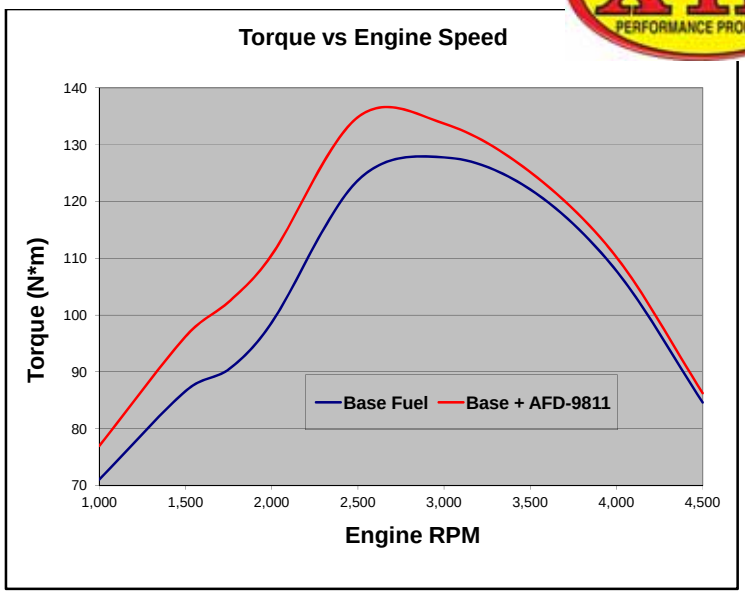
Fuel Economy Improvement



Diesel Power Increase



Diesel Torque Increase



China Lake Testing

SAFETY for transportation of fuel- reduces explosivity and fire.

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Thank You!

www.x1r.com

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