BASIC EVALUATION OF
FUEL TREATMENT PRODUCTS

GENERAL OVERVIEW

This document describes the basic properties of the products, their mechanism and their interaction with fuels, and the end benefits created.

How the product is described:

Fuel conditioner: This is a non-specific common usage term within the industry. Industry standard term would Classify the products as additives.

What the product is in general terms:

A unique, proprietary blend of ingredients specifically designed to improve flow, lubrication, stability and combustion characteristics of petroleum fuels.

What the primary active ingredients are:

They are active agents and/or stabilizers, in that they are highly available and more likely to bond, attract and/or interact with a wide range of stable and unstable elements typically found in fuel. This may also in some cases be reactive agents, or act to create reactive agents, with the ability to disrupt and/or re-combine its elements into other structures.

What the products does:

When properly mixed with the fuel, the products create changes within the general chemical environment of the fuel which:

- Neutralise acids and other damaging, unstable elements.
- Allows the dense clusters of heavier, more densely packed molecules (heavy aromatics, napthenes, paraffin's and their oxidized by-products) to be broken down into smaller molecules of the same type.
- Inhibits or prevents these large, clumped molecules from recombining and re-bonding.

How the product does this:

The general chemical mechanisms of the products are both highly effective and unique within the industry. When combined with fuels, the ingredients of the products act on or in conjunction with the more damaging and unstable
elements in fuel (sulphates, nitrates, the acids derived from them, and the oxygen component of water) to create a secondary active agent, which, while not naturally occurring in fuel, is wholly beneficial and 100% compatible with the fuel itself.
This second generation active agent is unstable acting as a solvent and seeking stability, acts to break down the large densely packed, densely bonded cluster molecules of the heavier weight aromatic, napthene, and paraffin components of fuel into similar but smaller molecules and reduce their ability to recombine. This method of action is the same type as that of breaking down sludge, varnish, gums and lacquers which are the final state of these elements after extended oxidation.

Why is this valuable?

In fuels, the heavier, more densely packed molecules are the most problematic, despite the fact that they carry the greatest amount of potential energy. The general properties of these more densely bonded molecules are responsible for creating the majority of problems in fuel stability,

flow, atomization, combustion, and lubricity.
However, their dense structure is essential to fuel because it carries the highest concentration of energy value.

Breaking down these molecules into smaller molecules of the same type improves the performance of treated fuels in two ways:
The force of attraction between molecules increases geometrically as the size increases. Reducing the overall mass of some types of fuel molecules without changing their structure or composition would significantly reduce their intermolecular force. This reduction in the force of attraction between the molecules has a direct effect on the fuels internal resistance to flow, atomize, mix with air, and combust.

BASIC TECHNICAL EVALUATION OF FUEL TREATMENT PRODUCTS

2. The larger, more densely packed molecules within the fuel, because of their density, are the least likely to burn thoroughly in combustion. Reducing them to a smaller size makes them more available to burn completely, releasing a larger proportion of their stored energy value in combustion. (Both of these effects are discussed more thoroughly when relating to their individual benefits).

Additionally, the method of interaction the product uses to achieve this is valuable. When added to diesel fuel, the product absorbs and reuses many, if not all of the acids and unstable elements naturally found in fuels, making the treated fuel more stable and less available to oxidation and other problems than untreated fuel. Neutralizing the many unstable elements typically present in fuel, including water, and preventing them from destabilizing other elements is, in itself, extremely valuable.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

FUEL FLOW

Claimed benefit:
Improved fuel flow

Comments:
Reducing the size of the larger fuel molecules reduces the force of attraction between these molecules, which in turn increases their ability to slide past other molecules as a fluid flows, reducing its rate of shear. A fluids internal resistance to flow, absolute viscosity, is a direct function of its rate of shear, (absolute viscosity = shear rate / shear stress).

What makes the benefit created by the products extremely valuable in this particular method of improving viscosity of the fuel is that they do it without changing any of their other characteristics, in particular their overall density or energy carrying ability. They change the fuel's kinetic density (absolute viscosity / density) as well as their absolute viscosity, which is extremely meaningful in fuel chemistry. This change, or effect of the products when introduced to fuel, is at the heart of the many benefits they are able to demonstrate.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

LUBRICITY

Claimed benefit: Improved fuel lubricity.

Comments:

General

When the products are present in fuels they demonstrate a significant improvement in fuel lubricity in treated vs. untreated fuel. This improvement in lubricity has the effect of reducing machine part wear. An improvement in general lubricity in fuel is a direct result of an improvement in kinetic viscosity, i.e. the same density of protection is able to flow, slip, and coat more readily.

Coating

The highly refined carrier oil present in the products, or "top oil", in interaction with fuel is capable of creating a secondary lubricating benefit in that it increases hydrocarbon penetration of metal surfaces, giving the fuel an improved coating ability and a more effective surface interface between metal parts and fuel. Also, as relates to coating, heavier weight molecules of a smaller more useful size would generally be more useful in machine part coating than larger clumps.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

COMBUSTION

Claimed benefit:

Improved combustion - Better starting - Reduced harmful emissions - Improved fuel economy – Increased power - Higher BTU output.

Comments:

Vaporisation

Where the products are present in fuels there is a meaningful improvement in fuel vaporisation at working (cylinder) temperatures in treated vs. untreated fuel. The heaviest, most densely clumped elements are the slowest, least likely, and last to evaporate and mix with air in **atomization**. Breaking them down into smaller parts has a direct impact on the fuels ability to vaporise and mix with air for combustion.

Atomization

Improved atomization is a direct result of improved flow and reduced intermolecular attraction.

Fuel-to-air mixture In treated vs. untreated fuel there is a significant improvement in fuel-to-air mixture. Improved fuel-to-air mixture is a direst function of improved atomization and improved working temperature vaporization.

Improved ignition - Higher Cetane Rating

Improved ignition is a direct function of an improved fuel-to-air mixture. Separate from improvements in ignition related to improved fuel-to-air mixture, treated fuel in itself, demonstrates a higher cetane rating when compared to untreated fuel.

An improvement of basic ignition properties in treated fuel is consistent with the breaking down of larger, clumped molecules since the larger structures are the most difficult to ignite.

More complete combustion

Significant reduction in both particulate and unburned hydrocarbon emissions in treated vs. untreated fuel demonstrates a more complete combustion.
This is a function of improved ignition, improved atomization, and the increase in heavier weight molecules available for combustion as smaller, more readily combustible elements.

Shorter combustion time or Burn Rate

There is significantly reduced burn duration for treated vs. untreated fuel. This is a function of improved ignition.
Improved atomisation, and an increase in heavier-weight molecules available for combustion as smaller, more easily combustible elements.

More Homogenous Combustion

The presence of a more complete combustion, as well as shorter burn duration, together with improved atomisation. higher vaporisation, and improved fuel-to-air mixture in treated fuel.

Greater BTU Conversion

In treated fuel a more complete combustion as well as a shorter burn rate produces a greater BTU conversion Increased power per stroke/rpm and improved fuel economy results.

More Power per Stroke/RPM

There is a significant difference in torque developed per rpm for treated vs untreated fuel. A faster burn rate and more complete combustion are conducive to increased power.

Improved Fuel Economy

Improved fuel economy is a direct result of greater BTU conversion per litre resulting from a more complete and efficient combustion.

Reduced Harmful Emissions

A more complete combustion is one factor. A particularly good reduction in unburned hydrocarbon and particulate emissions indicates that more of the heavier-weight hydrocarbons, the most difficult to burn completely and burned in combustion.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

Reduced Harmful emissions cont/.....

Reduced emissions of nitrogen oxides, sulphur oxides, and carbon oxides are the result of a more complete combustion; leaving less unused oxygen available to bond and form gas during combustion.
A reduction in particulate emissions is also due, in some part, to a reduction of inorganic material bonded to or embedded within the larger more dense molecules. Breaking these down would free

some or all of the material to be trapped by the fuel filter prior to combustion.

Lower combustion and exhaust temperatures
A more complete and thorough combustion, a shorter burn rate, improved power per stroke, and better BTU conversion ensures higher temperatures within the combustion chamber. Lower exhaust temperatures follow the reduction in unburned hydrocarbons in the exhaust cycle.

Less Violent Ignition Onset
A less violent ignition onset is a function of a more complete and homogenous combustion.

Reduced peak pressure
A reduction in cylinder peak pressure is a function of improved ignition, reduced burn rate and a more complete and homogenous combustion.

Reduced Mechanical Stress
A reduction of mechanical stress on pistons, rods, and other moving parts is an effect of reduced peak pressure and a less violent ignition onset.

REVIEW AND EVALUATION OF CLAIMED BENEFITS
FUEL STABILITY
Claimed benefit:
Retards fuel oxidation.
Comments:
Oxidation, colour, Sediment Formation
Treated fuel significantly increases the resistance to oxidation. This is as a direct result of the products unique mechanism of absorbing free radicals and other destabilising elements and converting them to a more stable and beneficial function.

Storage and Evaporation
The products demonstrate an ability to significantly increase the resistance to evaporation at storage temperatures for treated vs untreated fuel. This is a direct result of the products unique mechanism for absorbing free radicals and other destabilising elements and converting them to a more stable and beneficial function.

Moisture and water contamination
The products demonstrate an ability to significantly reduce the amount of water retained (suspended) in fuel. This is a direct result of the products ability to modify the absolute and kinetic viscosity of fuel, thereby reducing the size of trapped colloidal water (a function of viscosity). There is also a relationship with the products unique ability to absorb destabilising elements, including the oxygen component of water, and convert them to a more stable and beneficial function.
Acid Formation / Acid Reduction
This is an extremely valuable central benefit brought about by the general chemical mechanism of the products. The products ability to absorb and reuse many of the acids and unstable elements

naturally found in fuels and the management of water and the oxygen elements provide for a reduction in the ability of acids to form.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

CLEANING

Claimed benefit:

Cleans and keeps clean fuel system components.

Comments:

The products mechanism for cleaning and maintaining internal machine parts occurs in he following areas:

a) It acts as a "solvent" to break down, remove and reabsorb the dense heavily oxidised fuel molecules which create varnishes, lacquers, and gums attached to machine parts.
b) It acts in a similar way with respect to carbon deposits, and burned and unburned fuel build-ups on injectors, valves, pistons etc.
c) Its coating action provides a protective coating on machine parts to prevent future, recurring build-up.

d) Its function in maintaining the general health and stability of fuel removes the opportunity for further oxidation and build-up caused by unstable elements.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

ACID WEAR AND CORROSION

Claimed benefit:

Inhibits acid formation and corrosion

Comments:

The products interaction with fuel helps in increasing the effectiveness of standard anti-corrosion agents blended at the refinery. Corrosion and acid wear are the result of unstable or destabilising elements, such as sulphur, nitrogen, and water in fuel. The natural chemical interaction of the treated fuel, in absorbing and re-using these elements, reduces or mitigates both of these problems. Additionally the coating and bonding action achieved through the interaction of the "top oil" carrier which, further protects engine parts.

REVIEW AND EVALUATION OF CLAIMED BENEFITS

BACTERIAL AND MICROBIAL CONTROL

Claimed benefit
Eliminates bacterial and microblal contamination (diesel bug)
Comments:

The products are highly effective in eliminating bacterial and microbial growth following treatment of contaminated fuels.
The ability of the product to achieve this results from two factors:
Reducing both the size and absolute amount of colloidal water trapped in fuel.
2. Changing the nature of the chemical interface between fuel and water in a way which inhibits microbial activity.

REVIEW AND EVALUATION OF CLAIMED BENEFITS
MAINTENANCE
Benefit claimed
Reduced maintenance costs.

Comments:
Use of the products provides a natural out come of increased lubricity, reduced deposits and gums, reduced corrosion, and improved engine part coating which is one of reduced maintenance costs and machine down time.

The natures of the chemical interaction created by the products when mixed with fuels are extremely effective in creating a wide range of very meaningful benefits without any negative side effects. The products are true multifunction and address all of the major areas affecting fuel performance and efficiency in a thoroughly integrated way that incorporates and is fully homogenous with the natural chemical interactions inherent within the
fuels themselves.

GLOSSARY OF TERMS

Absolute Viscosity	A term used interchangeably with viscosity to distinguish it from either kinematic viscosity or commercial viscosity. Absolute viscosity is the ratio of shear stress to shear rate. It is the fluid's internal resistance to flow. Absolute viscosity divided by fluid density equals kinematic viscosity, sometimes referred to as dynamic viscosity.
Additive	A chemical substance added to petroleum products to impart or improve certain properties.
Absorption	Adhesion of molecules of gasses, liquids, or dissolved substances to a solid surface, resulting in relatively high concentration of the molecules at the place of contact e.g. the plating out of an anti wear additive on metal surfaces.
Cetane Number	a measure of the ignition of a diesel engine fuel by comparison with various mixtures in which the alpha form of methyinaphthalene is given a standard value of 0 and cetane is given a standard number of 100.
Corrosion Inhibitor	Additive for protecting lubricated metal surfaces against chemical attack by water or other contaminants.
Detergent	in lubrication, either an additive or a compounded lubricant having the property of keeping insoluble matter in suspension thus preventing its deposition where it would be harmful. A detergent may also re-disperse deposits already formed.
Drag	The resistance to movement caused by oil viscosity.
Fluid friction	friction due to the viscosity of fluids.
Interfacial tension	the energy per unit area present at the boundary of two immiscible liquids.
Lubricity	ability of an oil or grease to lubricate; also called film strength.
Oxidation	Occurs when oxygen attacks petroleum fluids. The process is accelerated by heat, light, metal catalysts and the presence of water acids, or solid contamination. It leads to increased viscosity and deposit formation.
Paraffin	Any hydrocarbon identified by saturation straight (normal) or branched (iso) carbon chains; also called alkane. Paraffin's are relatively non-reactive and have excellent oxidation stability. They have a relatively high wax content and pour point, and generally have a high viscosity index.

GLOSSARY OF TERMS

Shear rate	rate at which adjacent layers of fluid move with respect to each other.
Shear Stress	frictional forces overcome in sliding one layer of fluid along another, as in any fluid flow. The shear stress of petroleum oil at a given temperature varies directly with the shear rate (velocity). The ration between shear stress and shear rate is constant.
Surface tension	the contractile surface force of a liquid by which it tends to assume a spherical form and to present the least possible surface.
Surfactant	surface-active agent that reduces interfacial tension of a liquid. A surfactant used in a petroleum oil may increase the oil's affinity for metals and other materials.
Suspension	a system consisting of small particles kept dispersed by agitation (mechanical suspension) or by the molecular motion in the surrounding medium (colloidal suspension).
Viscosity	the measure of a liquid's internal friction or its resistance to flow. Low viscosity fluids flow easily. High viscosity viscosity fluids pour esily