Oxytane Technical Data sheet

All liquid hydrocarbon based fuels suffer from entrained gases (air and fuel vapor) dissolved in the fuel. The problem is further magnified when these same fuels are agitated from vibration and pumping thru modern day fuel systems and their component parts fuel filters, fuel pumps and fuel injectors ect. The condition is identified as fuel aeration, cavitation and/or nucleation in *flowing fuel*. It is also known that naturally occurring static electricity generated in the flowing fuel further contributes to the condition increasing the surface tension of the flowing fuel. This reduces the fuels ability to release the entrained air and vapor gases in a timely manor increasing the air contamination in the flowing fuel.

The problem is identified by universally by recognized US Research Laboratories (see link below) and Major Engine Manufacturers (see attached)

For the record they do not know how to mitigate or control it.

The common name **air** is given to the atmospheric gases used in breathing and photosynthesis. By volume, dry air contains 78.09% nitrogen, 20.95% oxygen,[1] 0.93% argon, 0.039% carbon dioxide, and small amounts of other gases. Air also contains a variable amount of water vapor, on average around 1% at sea level, and 0.4% over the entire atmosphere. Air content and atmospheric pressure vary at different layers, and air suitable for the survival of terrestrial plants and terrestrial animals is found only in Earth's troposphere and artificial atmospheres.

There are a couple of sources that entrained air/vapor is introduced into diesel fuel. The first is agitation: As you travel down the road or operate the engine the fuel is agitated, the longer you run the more air gets in the fuel. This in most cases is where the majority of air is developed. Also, the return fuel pouring in the top of the fuel tank is introducing more air and agitation, simply, agitation occurs as you are operating the engine. In a little over an hour, the amount of entrained air present in the fuel is equal to the amount of vapor being produced when fuel is subjected to 11 1/2" of vacuum. In turn, creating even more of an air issue, this brings us to the 2nd source of entrained air/vapor – "VAPOR." With some exception most brand new filters "Clean," are rated at about 5" of restriction. As a fuel filter restricts, the amount of vacuum increases causing what we know as fuel starvation. Fuel starvation is "VAPOR" being produced from the fuel equating to less fuel and more air replacing where fuel should have been. Food for thought – remove the dirty fuel filter from your engine and replace it with a new fuel filter, engine performs much better. Yes, this is due to less restriction; now imagine even cleaning the new filter to where there is "NO" restriction, i.e. like in the manufactures test cell!! Research from both Cat and Cummins both confirm that diesel fuel itself contain as much as 3-10% air. One easy place to identify that air/vapor is in the fuel, and many engine owners ask themselves this, why is my suction side fuel filter almost

never full of fuel when it is removed? This tells you that you always have entrained air/vapor entering your engine.
Physics are also at work. Diesel fuel loses viscosity and lubricity as it heats up causing the fuel to expand and become "thinner." The thinner a liquid, the more air/vapor is created but the less air it entrains. With thicker or cooler liquids, less air vapor is created but more is entrained. Vacuum and pressure also affect this equation, pressure to fuel raises the boiling point and vacuum lowers it. Boiling Point - You may be asking yourself?? Restriction on fuel lowers the boiling point, i.e. more vapors. Pressure/less restriction on fuel increases the boiling point, i.e. less vapors. A plugging fuel filter will create more air/vapor, as the vacuum increases to the fuel pump. The fuel pump is not working as efficiently.

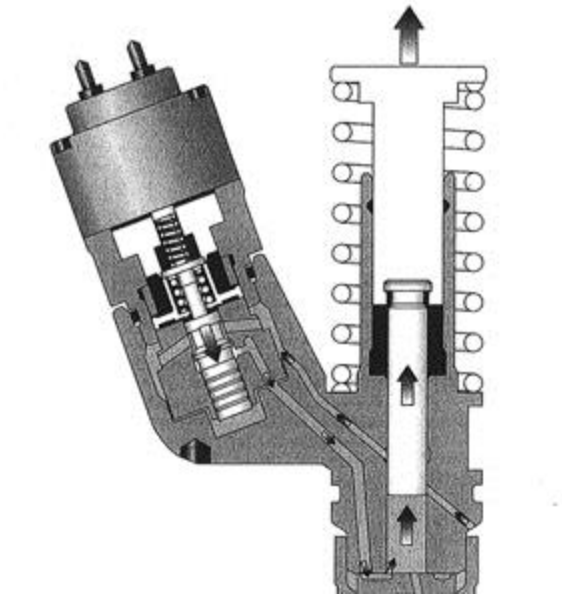
Why are air vapors a problem? Air vapors entrained in the fuel can create a degree of fuel starvation for your engine. Have you ever heard your engine "miss or idle rough" while idling? This is air entering your injector and throwing the timing off of when the fuel actually enters the combustion chamber, causing an inefficient burn or "miss." The symptoms you may experience maybe more engine noise, less power, laboring to pull a load as well as it did earlier in it's life. The engine is experiencing a loss of performance, which equates to lost horsepower and a loss of fuel mileage. Another by-product is increased emissions – i.e. smoking. There are mechanical ramifications as well. Research by Caterpillar has shown that air can cause up to 50% greater force of the plunger on the injector tip, occasionally causing the injector tip to blow off. The air/vapor in the fuel will also cause excess cavitation to the injector nozzle that can lead to premature injector failure. A degree of “implosion” is also created within the injector housing, adding to wear. The additional loss of lubricity caused by the air/vapor will also create gaulding and scoring of the injectors. The air/vapor problem in diesel fuel is for the most part off the OEM radar screen. A controlled environment during the testing process is the culprit. Most OEM test facilities test the engine itself in a lab. Ambient temperatures are stabile, and the fuel is gravity fed from a tank mounted on the roof or well above ground that contains thousands of gallons of fuel. Since the engine is stationary, agitation in the fuel tanks is a nonissue (unless the fuel is being recirculated from the engine). Variations in fuel pressure and vacuum are also eliminated. Here are a couple of things to try with your own engine: •Pay attention the next time you fill your fuel tank. You may be able to notice increased performance with a full tank of cooler fuel. As the fuel level in the tank depletes and the fuel entrains more air, you will experience a reduction in performance. •While filling up fill up your primary fuel filter with fuel (section side). Pay attention to the engine’s performance and experience how it will perform better for about the next hour. After about 1 – 2 hours after that you’ll notice the performance falling off. If possible, stop and pull the filter off and see how much “empty” headspace is in it. Refill with fuel and see your performance improve. Entrained air/vapors are an inherent problem for all diesel engines, including Class 8 trucks, pick-up trucks, marine engines, generators & etc.

Today's diesel fuel presents many challenges to a truck owner besides the "High Price." While cetane levels, lubricity, water, dirt particles and waxing have all been discussed in detail, entrained air/vapors in the fuel have not. Although comprehensive data is available through such companies as Cummins, Detroit, Caterpillar, Racor, MSOE (Milwaukee School of Engineering the foremost school of hydraulic engineering) and other fortune 500 companies, this data is hard to discover in public articles.

How does entrained air/vapor affect a diesel engine mechanically? The most damaging area affected by entrained air/vapors is the engine's fuel injectors. One of the functions of diesel fuel is to lubricate the injectors as they are working. As the entrained air/vapor passes through the injector it is not providing complete lubricity. This lack of lubrication for the injector's barrel ad plunger becomes even more critical with the tight tolerances and high fuel pressures used in today's injectors. The entrained air/vapor creates a metal on metal situation. Over time the plunger can start to stick and as it wears, factory tolerances are lost. This causes fuel blowby in the injector. According to Caterpillar's handbook, entrained air/vapor can create up to 50% greater forces by the plunger on the injector tip. As the fuel comes out the injector tip under high pressure the entrained air/vapor can also act much like an acetylene torch, eroding the injector tip. These two things in combination can lead to the injector tip breaking off. Entrained air/vapor also causes a degree of implosion in the injector tip, loosening microscopic metal particles from the tip's interior. The gear pump will also experience a degree of gaulding and scoring due to entrained air/vapors. The engine will have a gradual loss of fuel pressure and eventual gear pump failure.

What are some performance issues caused by entrained air/vapors? Fuel injection is the process of injecting a predetermined amount of fuel at a predetermined time for a controlled combustion event. Since solid fuel is not compressible but air/vapor is, any air in the fuel is throwing off and retarding the engine timing. The majority of technical manuals for diesel engines point out that the following problems can be caused by fuel and air restrictions: low horsepower, low fuel mileage, inconsistent performance, hard starts, rough idle, excessive smoking and etc. Simply put, entrained air/vapors do not allow the engine to perform in the working environment as well as they do in the factory. The truck/engine may seem "sluggish" while pulling hills or under load, especially after the fuel in partially filled tanks has time to slosh around and heat up thus entraining air/vapors. You may experience more engine and cab noise than normal and the engine may be a little rough when idling. The entrained air/vapor problem is one that OEMs are not prepared to deal with. Since the amount of air and vapor that is entrained is changing constantly, there is no way to adjust ECMs to compensate for it nor does the problem show up in the R&D lab. Fuel sources at test facilities are usually above ground-mounted tanks that gravity feed fuel to the pump and eventually to the engine.

In a truck/engine's real world working environment, every fuel system's challenge is working against gravity to draw the fuel uphill and forward nearly 8-12 feet to the injectors. Entrained air/vapors are an inherent problem for all diesel engines, including Class 8 trucks, pick-up trucks, marine engines, generators & etc. On most EUI injectors, the tappet and tappet spring lift the plunger and pull supply back into the plunger cavity. Low fuel supply pressure from plugged fuel filters can cause cavitation damage to injector poppet valve during injector fill. Fluid trapped between the tip and check at the end of injection acts as a shock absorber, minimizing check impact. An air bubble in the tip provides no fluid damping, allowing the check to impact the tip with up to 50% greater force.



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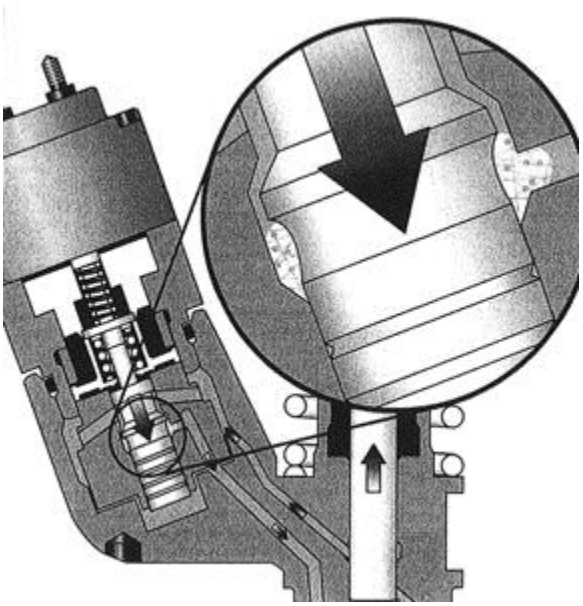
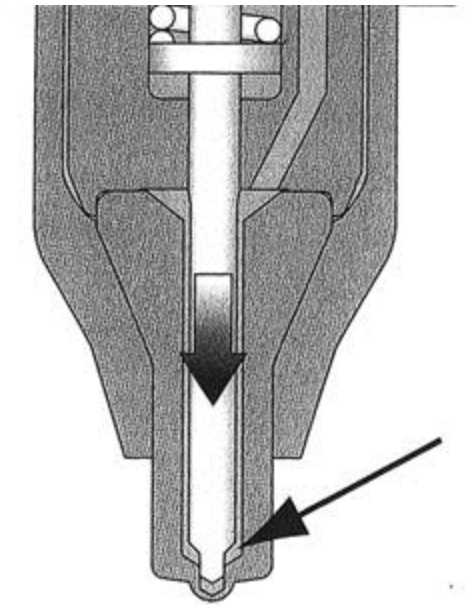


Low fuel supply pressure from plugged fuel filters can cause cavitation damage to injector poppet valve during injector fill.



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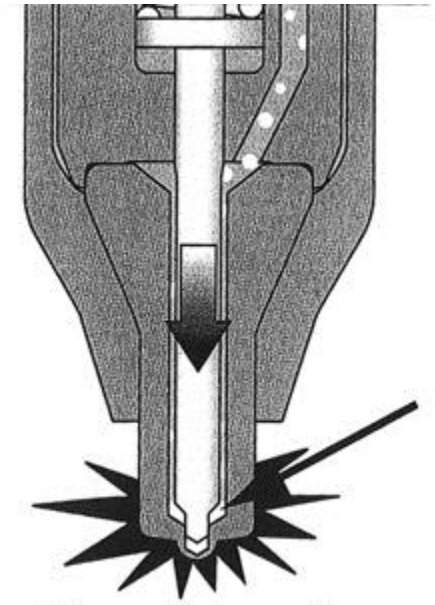

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Argonne National Labs
http://www.anl.gov/energy-systems/project/fuel-spray-modeling

https://www1.aps.anl.gov/Sector-7/7-ID/Techniques-and-Facilities/7ID-B

https://www.youtube.com/watch?v=VDLYEvU_Tng

https://www.youtube.com/watch?v=Bun2fkww4dE

https://www.youtube.com/watch?v=7Y1rCU3kUm0

Oakridge National Labs
http://www.greencarcongress.com/2014/09/20140922-ornl.html

http://neutrons-old.ornl.gov/imaging/

https://www.ornl.gov/news/imaging-fuel-injectors-neutrons

Fuel cavitation is one of the most well documented

and least understood phenomena today.
It has only been researched seriously since the late nineties. (see attached)

Oxytane works this way:

Static electricity/high voltage generated in flowing fuel increases surface tension of the flowing fuel.
Which is further magnified by cavitation/aeration of imploding and exploding microscopic bubbles that further increase the voltage generation in the flowing fuel.
The increased surface tension entrains/traps the bubbles in the flowing fuel.
While the fuel flow contributes significantly to this problem,
The fuel system design and components also play a big role in the charge separation/voltage generation problem.
This leads to over-fueling the engine (to compensate for this not very well understood problem) which over time, contributes to carbon deposits and as a result reduced fuel efficiency.
Fuel that is contaminated by air and vapor and is less energy dense than fuel without air contamination

This is a problem in all liquid hydrocarbon based fuels

All hydrocarbon based fuels have a Dr.Jekyl and Mr.Hyde personalities.
When they are at rest (not moving) they are Dr.Jekyl
When they are at flow (moving) they are Mr. Hyde
Please also see attached documents for more on cavitation in flowing diesel fuel

The unique Oxytane hydrogen bonded chemistry reduces the voltage generated in flowing fuel. The result is a significant reduction in the surface tension
of the flowing fuel, Improving the air release properties of the flowing fuel providing a more pure fuel with less air contamination.
Fuel with less air contamination stays wetter longer This also improves the fuels own natural solvation/cleaning properties
which helps reduce and clean up carbon deposits that reduce fuel efficiency.
Lower surface tension also reduces fuel cavitation and improves fuel droplet dispersion of the injected fuel.

Oxytane is not a fuel additive as it adds nothing to the fuel

Oxytane is undetectable in diesel fuel, kerosene or gasoline/petrol

Oxytane D-975 and EN590 tests show zero change in fuel specs (see attached Intertek EN590 test)
Oxytane is registered with USEPA and considered substantially similar (a pure fuel)
Oxytane treat rate is usually 1 ml per gallon of fuel in it's concentrated form (requires a syringe)
Oxytane is a Anti-Cavitation fluid that improves the release of microscopic air and vapor bubbles in the fuel.
Oxytane lowers the voltage which reduces the surface tension and allows the microscopic bubbles to escape. (see attached Static test)
The result is a more pure, more energy dense liquid fuel for use in the engine