

# Veggie Oil and Common Rail Engines

German engineer Alexander Noack spent a few days in Perth in June 2013 and WARFA members had several opportunities to meet with him and learn from his experience. The following is a summary of his presentation.



Alexander was chief engineer at Elsbett Technology in Germany who were leaders in veggie oil technology from the late 1980's when they developed a multi fuel capable engine that eventually formed the basis of the Volkswagen Golf TDI. Elsbett intended for this engine to go into wide production, but Volkswagen declined to develop the dual fuel capacity so Elsbett continued the development of their engine alone.

They bought new vehicles, Volkswagen and Mercedes sedans, and replaced the new OEM engine with their multi fuel motor. Many examples of this engine are still functioning in Europe.

The company developed technology to enable veggie oil to be used in a wider range of engines with modifications such as refined nozzles, in addition to heat exchangers, filters, Magnetic valves, and ancillary equipment such as electronic changeover controllers. This allowed a wide range of direct and indirect injection engines to be modified to run effectively on veggie oil, both new and used.

Germany also developed their oil seeds supply chain to include the availability of new canola at regular service station outlets.

As computer controlled then common rail technologies became popular, the company faced the same challenges that we have as veggie users and asked questions like what are we dealing with? It looks really complicated and we don't want to muck things up!

Having the advantage of two decades of R&D experience, competent professionals, money and time, they realised common rail was worth exploring; it wasn't going away.

The result has been spectacular in that being able to access the Engine Control Unit (ECU or computer) directly has resulted in far greater control over the combustion process than was ever possible with mechanical systems. Alexander has just decommissioned his personal common rail diesel after 400,000km of travel. The engine is fine, the body has rusted from the salt on the roads. His vehicle is not alone, and the company provides kits and ECU re-mapping for a wide variety of vehicles. The most developed have been Bosch ECU systems that allow easy flashing. Toyota and Nissan in Australia tend to use Denso ECU which are more difficult to flash.

During Alexander's visit, I introduced him to Graeme Bentink of GTurbo fame.

[www.gturbo.com.au](http://www.gturbo.com.au) Graeme re-engineers Toyota and Nissan turbochargers and is revolutionising the driving experience for these vehicles worldwide. In computer-controlled vehicles, Graeme uses a Unichip, which has potential for Alexander to develop into an effective tool for many common rail Australian 4WD owners. This is something to watch.

Three years ago the German government introduced taxes on new veggie oil users that raised the price of new oil to be similar to diesel. Elsbett's backers walked away. The company closed. Alexander has taken on the further development of kits under his own company name ANC and sells them under the Greasenergy name.

### **Indirect, Direct and Common Rail - what does it mean for veggie use?**

Indirect Injection refers to the style of head in the diesel engines that contain a pre-combustion chamber. As the piston rises, it compresses the air inside this small chamber, creating super-hot air under high pressure. The injector spurts fuel into the chamber, and the expanding air rushes out of the chamber and onto the flat top of the piston - pushing it down. IDI engines are well suited to veggie oil as any small amounts of unburnt fuel stay in the pre-combustion chamber to be burnt next time, or expelled as smoke. The injector tip is a self clearing pintle type nozzle that physically opens and closes each firing stroke, clearing any coking from the nozzle that may change the spray pattern. The fuel pump adjusts the amount of fuel simply by volume, the supply pressure remains the same.

Elsbett's redesigned nozzles are simply smoother inside and contain a better design to match the characteristics of veggie oil.

One disadvantage of IDI, is the energy lost in the transfer of gasses from the pre-combustion chamber on to the top of the piston. Direct injection was developed to resolve this.

### **Direct Injection.**

The injector on a direct injection motor protrudes down into a cup that is machined out of the top of the piston. As the piston rises, all the pressure builds inside this cup, the injector spurts a mist of fuel and the fuel burns quickly right into the best spot to force the piston down. Much more power is produced, they start easier, often without the need for glow plugs, and it is a more efficient system.

The down side of DI for veggie use is that should any fuel remain unburnt, it may make it's way to the walls of the cylinder, contaminate and foul the piston rings, and excessive quantities will make their way into the sump where it turns to a jelly, starving the engine of oil and quickly leading to a catastrophic failure.

In addition, the injector nozzles contain multiple (five) small holes that mist the fuel at injection time. There is also often a small gallery inside the tiny tip and all these places can suffer from the buildup of the products of combustion, coking. This happens particularly at low and medium load as the nozzles are sized to provide



maximum power, and under low and medium load conditions the injection pump only pushes smaller quantities of fuel through so coking - carbon buildup - is a common occurrence. We all know the benefits of a long run at high speed to our engines - it's because this coking has been blown away.

In the late 1990's and early 2000's, direct injection engines started to have computers controlling basic functions such as timing advancement, and maintained their mechanical injectors. This provided increased performance and economy, but the real advancements were made when the injectors themselves became able to be controlled electronically and finely tuned control of the combustion process was possible.

This was the start of common rail technology.

In these systems, a high pressure fuel pump replaces the injection pump. It is much simpler and therefore cheaper to manufacture. They are strong devices that provide a regulated fuel supply of 30,000 psi (2000 bar). IDI and DI injection pumps provide much less pressure, with injector cracking pressures more like 3,000 psi (200 bar). The high pressure pump provides a small reservoir of fuel ready for the injectors to release. This fuel is in a rail or pipe that runs across the top of all the injectors, hence the term common rail.

With the advent of high speed computers and the electronic injectors, precise amounts of fuel can be released from the rail multiple times per firing stroke. This is often 7 times per firing stroke, which gives incredible control over the combustion process, increasing power and economy, decreasing emissions and noisy engine knock and increasing the acceptance of diesel as a fuel to the regular consumer.

### **So what does this mean for veggie oil?**

Alexander was confident in saying that an IDI could not be damaged internally by veggie oil. Direct injection is another matter, and coking of injector tips and rings can easily lead to engine failure if the injectors are not purged. The damage is done on cold starts when the fuel does not spray correctly and there is a high risk of unburnt fuel remaining in the combustion chamber.

Common rail engines are also Direct Injection, so how come it can be okay to run a common rail on a single tank system? This was perplexing.

For Alex, the introduction of common rail technology has opened the door for much greater control than ever before. With sensors on the air intake pressure from the turbocharger, the crank angle, the fuel pressure and temperature, air intake temperature, coolant temperature and other inputs, he can re-map - or finely tune - the way the engine runs. The map is simply the set of parameters and instructions that tell the injector to open, and for how long at any particular time. This set of software data can be overwritten in a process called 'Flashing', which is commonly used on many consumer electronics to upgrade systems.



Once Alexander has the ECU, he installs the revised veggie map to suit the vehicle and returns the ECU to the owner for reinstallation. Owners can also re-flash their own vehicle if they have the equipment and the map is simply emailed to them. With a UniChip, it is feasible to change engine map settings and load them to the ECU with the vehicle running - a marvelous opportunity for real world optimisation.

Alexander was not specific in what settings are used for cold starting a DI common rail engine on veggie oil, but he did say that precise control to avoid any excess fuel is the critical factor. Without excess fuel in the combustion chamber, coking is minimised. Coking is the enemy.

The computer can be mapped to provide low volume and high pressure for a short time, creating a strong blast that will surely burn completely, but may need to be altered once the engine reaches operating temperature. The ECU re-mapping allows for all of this. His kits do include an all alloy heat exchanger, so the fuel is heated to aid flow through the systems, particularly the filters and ensures the high pressure pump receives good volumes of oil. There are many high pressure pumps that have been destroyed with inadequate fuel supply on diesel. They seem to be more robust on veggie due to the increased lubricity, another advantage of veggie over diesel!!

In short, common rail technology is suited to single tank veggie oil conversions - as long as the ECU can be modified. If the ECU cannot be modified, it MAY be feasible to run a two tank system, but he expressed caution and there are no universal recommendations. Some IP's, ECU, nozzles and high pressure systems are not suited to veggie use, some are. The ones with Bosch systems are much easier for Alexander to supply a new map and a kit for, Denso is less easy for the time being. This article is not meant to be a promo for GreasEnergy, so if you have a common rail engine you want to run on veggie oil, check his site and take it from there. If your engine is not listed on his site, contact him and ask. [www.anc.me/us/](http://www.anc.me/us/)

If he says your engine is not suited, do not take this as a challenge to prove him wrong, he knows what he is talking about! If he says he does not know, then assess the level of risk you are prepared to take and step ahead with informed caution. If he says yes, he has experience with successful conversion of your engine, you can assume the best. The market for veggie oil in Europe is far in excess of what we do here in Australia. The number of long haul trucks running on new oil is substantial, in the hundreds. The number of converted cars runs into the thousands. There is a legitimate confidence that comes from this experience.

The issues we had previously been concerned about with common rail were all addressed in his talks. They all became minor in the end, but one thing rose to the top of the most important critical thing to achieve - fuel quality.

This means that if you are looking at running veggie in a common rail, and these criteria are not bad to adopt for all conversions, then the fuel must be filtered to 1 micron and have no free water.

Alex stated that the main fuel filter should not be required to do any work on final



filtration of our fuels. If there is any sediment that settles out of a sample of your fuel, then it has not been adequately filtered. If you have to replace your fuel filter at any regular interval, on any vegetable oil powered diesel engine, then your home filtering is not up to scratch and must be improved.

Obviously, if there is any free water, it must be removed. He urged caution about observing free water at ambient temperatures and reminded us that free water is released from oil when the temperature rises.

Interestingly, oxidation of fuel was not a common problem he had to overcome. It is possible that the high quality of the new and used oils may protect users somewhat to the scourge of oxidation, but like many things about oxidation, we're not always sure.

Alexander appreciated the opportunity to see first hand the mix of our vehicle fleet and to see the types of injection systems commonly installed. This will all aid his ongoing R&D and eventually more Aussie common rail ECU's will become able to be re-flashed.

Whether or not you are in the market for a common rail vehicle, the increased awareness and knowledge imparted by Alexander was very valuable for all those who were able to attend.

For comment, please contact

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