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Written by Peter Wolter

Frontpage headline:

Smart-Diesel for UL’s
The Efficiency Wonder In test

Article headline:

SMART CDI DIESEL VON FLYECO
Fuel DESPISER

Since 14 years the Smart- Motor flies in ULs.
Now the Diesel Version could achieve the break through –
with unbeatably low operational costs

It is about 10 years ago, that I have flown Ecofly’s Smart motor in a FK9, it was a petrol engine. At that time it seemed the highly modern Suprex M 160 could make life hard on a long term base for the Rotax 912. It was not only the convincing technical standard, furthermore Ecofly was managed by two leading people from the aviation and automotive branch: Otto Funk and Eberhard Rau, who constructed the smart motor at Daimler Benz. About 60 smart gas motors are used in small aircrafts until now. Actually there is offered a version with 101 PS. But this number is extremely small regarding more than 45,000 produced Rotax 912 and 912 S. There have been smart diesel engines in aircrafts as well: Ecofly sold 300 engines to Northrop Gramman to be used in the UAV type Hunter. For manned aircrafts the diesel engine only was used twice: for an FK9 and a Silcence Twister. Otto Funk stopped the diesel engine development, because he could not find an convincing advantage for light-planes: the diesel engine was heavy and the advantage in consumption was not attractive enough for clients prepared spending more than 50,000 € for an UL. Furthermore the performance with 65 PS was clear under the standard Rotax has set up with its 80 and 90 PS power units. In meanwhile something had happened.

The FK9 standing on the airfield in Höxter-Holzminden is driven by a smart diesel engine.” 80 PS, seven litre per hour with 170 km/h” says Patrick Rudolph, pilot and owner of the UL. Together with Arnim Wegener and Jennifer Hasslinger, he is keen on establishing the smart diesel in the UL scene. Therefore, they founded a company named FlyEco. Patrick Rudolph passion for diesel motors has the roots in familiy history: his father – a physician – once founded a company called Eoil. The purpose was the development of engines driven by vegetable oil. After winning the “**German Founder-Award 2007**” (in the category Visionary Startup-initiative of the Sparkassen, McKinsey, stern and ZDF) and selling more than 8,000 engines the company was closed down (due to changed political decisions). Nowadays nobody is talking about vegetable oil as fuel for combustion engines. Remaining is Patrick’s enthusiasm for diesel engines. “First at all is was only on emotions that I made plans to fly a diesel engine” we were told by Patrick. “I wanted to do something very different from the others, only for the joy of playing/gambling. But soon I realized the advantages.”

Thinking about a smart engine started, when Patrick in 2008 saw a FK9 driven by a small patrol- engine. This was the one he wanted to fly. Three years ago he had passed through the UL licence. The first season he made 800 hours, since 2010 he is flight instructor. “I dig for smart “ admits Patrick “for me it is the most modern and best engine on the market.” Meeting Otto Funk in Speyer attracted his attention to the diesel motor with an exhaust gas turbocharger. It needs to be noticed that the diesel motor is using a commonrail- and the petrol motor a multipoint injection.

For his further developed engine Patrick is using the Ecofly gearbox but with changes in the gear- ratio. This is caused by the fact that the propeller was not working in the speed range UL propellers are build for. It is turning too slow. While smart petrol engines during cruising makes more than 4,000 revolutions per minute at the crankshaft (max Power at 5600 rpm), the diesel engine only reaches 3,300 as its best (the ECU limits at 3,800 rpm). Considering the original step down ratio 2.1:1, there was left not enough revolutions at the propeller. Actually the step down ration is 1,79:1 and the propeller is revolving with 1700 to 1900 turns, that fits.

New as well is the (own developed) Electronic Control Unit (ECU). I does control the volume of the injected fuel, injection pressure and opening of the injectors, all in dependence of charging pressure as well as fuel- and the charge-air -temperature. Programming of the ECU is extremely different to them, used in cars. IF something is wrong during operating – temperature too high, oil pressure too low, a control lamp lights up. The engine continues with lower performance. To slow down is acceptable, damage of the engine would be worse. In the aircraft the pilot has to make a decisions whether he wants to allow a short term load for the engine even he knows for sure that something is wrong. This can be a life safer for example by take-off, even when the engine will become damaged. In the aircraft the control lamp delivers only the information about the distress, without gearing the mapping of the ECU. The Pilot is in a position to check what had happened and make his decision. If all important parameters are well – there might be the option one sensor is missing in action – pilot has not to interrupt the flight.

A distress program exists for the situation, performance can not be influenced by the throttle. This one is formed by a potentiometer, means there exist no mechanical connection between throttle and the ECU. In case of a defect potentiometer, pilot gets out a protective sleeve from the switchboard and switches in one of three positions: top high speed, middle idle thrust; down cruising thrust. This allows him to make his way home and arrange a save landing and this more comfortable than in a situation with broken throttle cable used for traditional engines. This cause that the spring pushest he thottle to maximum. Than you only have two options, between high speed or switching the engine off.

Is there a break down of the generator, a red lamp lights up at the swithboard. A 10 ampere lithium iron-phosphate batterie is going to deliver energy for the Electronic Control Unit and the fuel pump. This grants five hours more to go. Futhermore a backup battery makes sure, you can go for 30 minutes extra. At this point latest the pilot should have managed to find a aoerodrome.

When entering into the D-MXUV, I was not only interested in hard facts like performance or consumption but also in the sound of the diesel engine. Referring to this aspect I am pleased that it is not revolving that high than a smart petrol engine

does. But it is a gear- motor, would it be possible to hear the frequency? I was informed that neither switch on nor switch off would create the same awful sound like Rotax 912 with its gear drive. The smart is build with a tooth-belt gear.

Turn the key to the right side, main switch on, glow with the red touch switch for 10 seconds (it is cold, on a warmer day 5 seconds would have been enouch), press the start button and – “nothing happens”. Well, the engine is running, but the propeller does not move. *All right, centrifugal clutch!* I step carefully on the gas and at 1700 revolutions per minute the propeller starts revolving. At 1900 complete force locking is reached. Safety aspects of this technique - no revolving knifes with idle thrust - are only a side affect. Primarily the clutch has the function to avoid vibrations. Those would happen with a fixation between propeller and engine and stepping on the gas under 1700 rpm. This effect is caused by the extremely reduced flywheel of the small 800 ccm engine.

Irritations are coming on the taxiway, when I have to find out that rolling speed is not adjustable with the throttle when speed is very low. I step on the gas until the prop starts shovelling and pull the breaks when it is going too fast.

For the take off the breaks are very important, if rolling distance is requested to be as short as possible. When setting on the gas, the engine is speeding up slowly. This is due to the mapping of the ECU, which prevent oscillations. This means pulling the break (middle console) throttle ahead, wait a second until maximum engine-speed, loosen the breaks und than speed up with full power.

Climbing with 110 km/h we have at 3400 rpm almost 76 PS. Patrick and I have a weight of something about 70 kg each, we have 42 litres diesel fuel. This are 35 kg. The aircraft weighs 280 kg, this is an amount of 455 kg. With 17 kg below MTOW, the variometer shows a climbing rate between 800 and 900 feet per minute. (4 – 4,5 meter per second). This is comparable with the 70 PS smart petrol engine performance. 10 years ago I red 4,5 m per second, but on a warmer day. That we have started today from an aerodrome positioned 622 feet higher is of no interest for the Turbodiesel.

At full throttle the Taildragger FK9 did not make more than 180 km/h. Probably Propeller-Pitch was too small, the engine exceeded the nominal speed. Patricks diesel engine in a nose wheel Fk9 achieves 190 – 200 km/h. Impressing is the consumption: 12,2 litres per hour at maximum indicated speed of the FK9 at a engine speed of 3690 rpm. I reduce to 3300 rpm and read180 km/h…. and 8,6 litres. Again slowing down and 170 km/h with 7 litres. When we are cruising very comfortable with 130 km/h over the Weser mountains region, consumption is down to 4 litres/h. With a tank volume of 60 litres we could spend 15 hours in the air, going for 2000 km and spent only 83 € for fuel when calculating with 1,39 € per litre. More realistic is a cruising speed of 170 km/h. This enables to go for 1400 km (without spare). Just to compare: the 70 PS petrol engine, which once offered a 20 % consumption advantage versus Rotax 80 PS, was in the need of 8 litres per hour by 140 – 150 km/h. This is double to the actual diesel engine when flying 130 km/h. The low consumption helps solving the loading problem: for cruising 500 km with 170 km/h only 18 kilo fuel are needed in the tank. This allows more weight for passengers and baggage.

And this thing is not supposed to have a cloven hoof/ catch?

What about vibrations? It is a three and not a four cylinder. No, nothing to tell about this. The sound? Very good, very deep, in deed you hear nothing than the propeller. Performance? Good enough and due to the charger, the engine is not going to weaken when climbing. Licensing? An UL engine is not in the need of this. For the advanced ultralight type certification of the FK9 with the FlyEco Diesel Motor, the flight test phase has been sucessfully completed. The high wing plane can be ordered with the smart diesel. Adaptations to other types of aircrafts are not carried out by FlyEco, but they are offering a consulting service to the aircraft type support organization in charge. And the price? 19,000 € brutto. These are about 3.000 – 4.000 € more than a Rotax 912, depending on the equipment. (This engine has to be taken as reference all the time, because it dominates the market) “Eight years ago, Daimer did charge 1,900 € for the motor in complete, today this are 5,800 € without charger and injectors” am I told from Patrick Rudolph. This might be a point for the high pricing of the engine, but is it not too expensive at all? Patrick’s and his partners intention is to convince flight schools. For those clients the high investment could be a good deal by a good booking capacity.

Difficult is the future of FlyEco. When flying the D-MVWW in the mid of April only one engine was complete. Will they manage to get a series production? Will the company come in a position to offer the engine on industrial level? Will the company still exist in 10 or 20 years?

Regarding the base engine nobody needs to be worried, this one is used by Daimler for the Smart, all parts are available. Thinking about the numbers in automotive there are no changes to expect even years after the termination of production.

All by itself, FlyEco Diesel is a “wow”. But spreading will not be dependant on its quality as an engine, it will be dependant on its placement in the market. Money, Inquiry, Support, Staying Power, means business will make the decision for the future.