

2nd VegOil

Demonstration of 2nd Generation Vegetable Oil Fuels in Advanced Engines

Workpackage 5 Engine Demonstration

Deliverable N° 5.3: One stage 3B compliant demonstration vehicle

Publishable Summary

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prepared by:

IBDI, WWP

Alois Dotzer (WWP), Stefan Innerhofer (IBDI), Tino Wunderlich (IBDI)

Regineering (IBDI), Alemannenstr.25, D-85095 Denkendorf, Germany

Tel.: +49 (8466) 90414-0

Fax: +49 (8466) 90414-29

Email: s.innerhofer@regineering.com

Partner website : www.regineering.com

Project website : www.2ndVegOil.eu



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List of acronyms

DOC	Diesel Oxidation Catalyst
DPF	Diesel Particle Filter
ECU	Engine Control Unit
FLRS	Full load rated speed
HCI	Hydro Carbon Injection
JD	John Deere
S/N	Serial number of tractor
RO, RS	Rapeseed Oil
SCRi®	Selective Catalytic Reduction integrated
VWP	Vereinigte Werkstätten für Pflanzenöltechnologie
2G-PVO-RS	2 nd Generation – Pure Vegetable Oil – based on Rape Seed oil





1 Summary

Up to now, only Euro stage 3A engines were field tested. As a first step, four of these tractors were equipped with an SCRi (Selective Catalytic Reduction integrated) **retrofit** system to test the possibility to meet the Euro stage 3B standard. (see deliverable D5.2 update report)

According to the project plan, the vegetable oil capability of Euro stage 3B John Deere Tractors shall be demonstrated not only retrofitted but also as original John Deere engine. Therefore tractor n°17, a John Deere pre-series tractor, was converted in cooperation with VWP to run on 2nd generation vegetable oil (2ndVegOil). Finally power curves were measured at John Deere test stands to check the engine performance.

Compared with the Euro stage 3A engines, the 3B version uses a DOC (Diesel oxidation catalyst) and a DPF system (Diesel particle filter). The DPF system is regenerated by injecting fuel into the exhaust system prior the DOC. The exhaust temperatures will rise to combust the DPF residuals.

Furthermore the preheating system for the use of 2ndVegOil differs from the 3A Engine version due to modifications.

As a final step, the 3B version will be equipped with an SCR system additionally, to reach Euro stage 4 level.

The tractor will be operated exclusively by John Deere in Mannheim.



2 Conversion of the tractor

The tractor was converted by VWP at the John Deere Werke Mannheim. Several non standard units had to be implemented or changed, like preheating system, ECU software, fuel lines, fuel filters and fuel pressure pumps.



Figure 1: converted Euro stage 3B tractor, JD 6210R

2.1 Preheating system

A new preheating control unit was developed for the 3B engine conversion. Now the complete fuel preheating system is integrated in only one device. Hence benefits results of having less wiring efforts with less sources of error.



Figure 2: left side - prototype of new fuel preheating control unit, right side - old module only with preheating controller

preheating
activate
button with
control
lamp



Figure 3: cockpit of the 3B tractor, steering wheel panel

The functional principle of the whole preheating system can be seen below. Finally the conversion measures are shown in an explosion assembly drawing and a picture of the real engine. A bill of materials is attached as well.

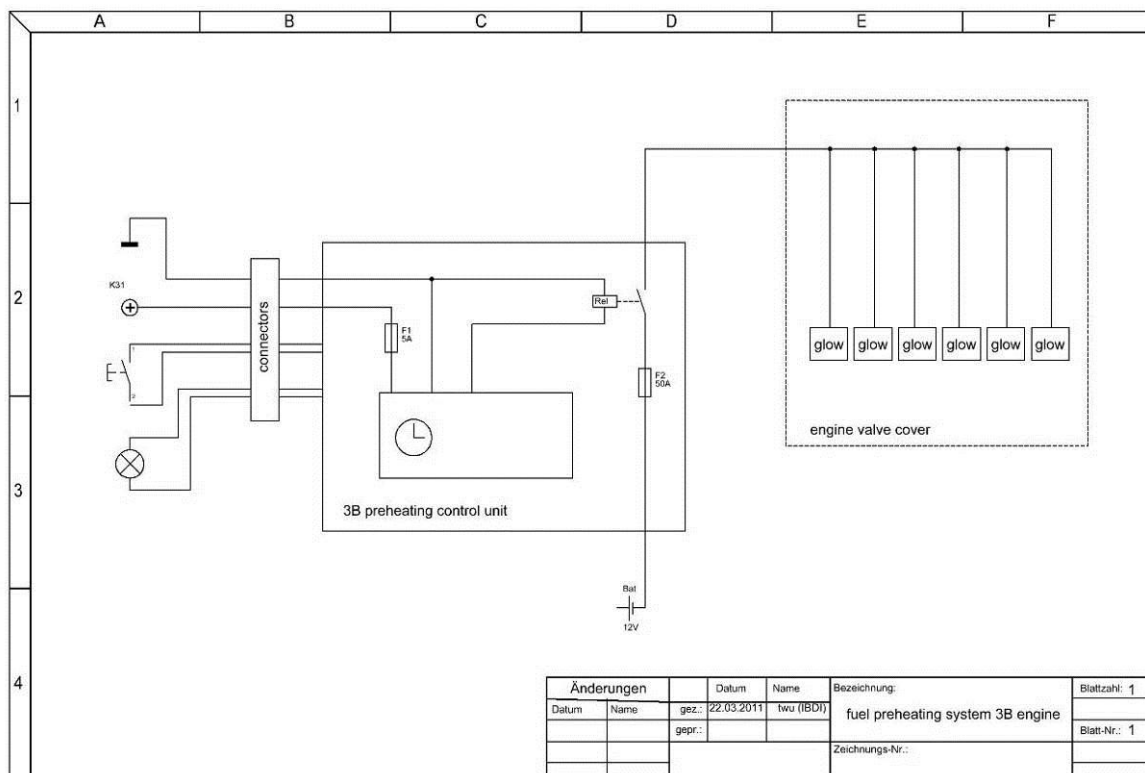


Figure 4: scheme of the electrical circuit of the fuel preheating system

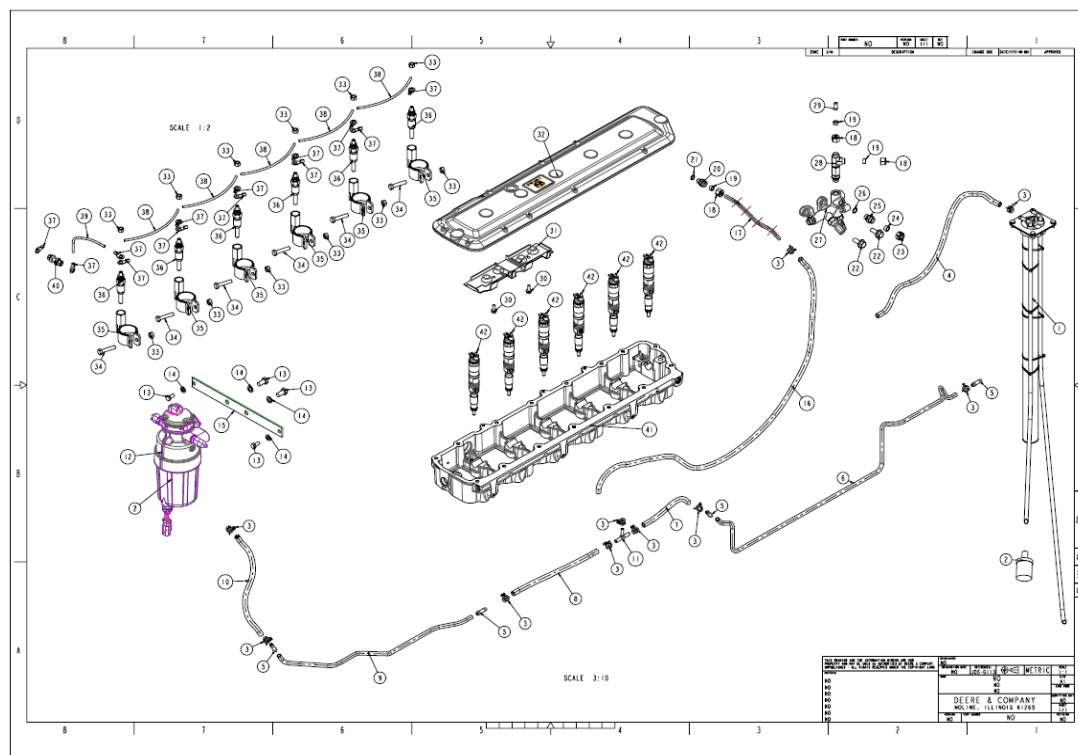


Figure 5: exploded assembly drawing of the preheating system (source: JD)

2.2 Engine control software

One of the main functions of the engine control unit (ECU) is to control the fuel injection in terms of timing and amount. To perform on high power levels and modern emission levels it is indispensably to modify the engine software too.



Figure 6: multi functional display and control panel, right side of driver seat

2.3 Fuel lines

Due to its physical characteristics, pure plant oils (PPO) as 2ndVegOil need partly fuel lines of enlarged diameters compared to diesel fuel lines. Additionally the 3B engine needs fuel for the regeneration of the DPF. Due to the complexity and interactions between the 3B engine

and DPF system, initially only diesel fuel will be injected for DPF regeneration purposes (HCl unit). Hence an additional fuel tank was installed on the converted 3B tractor. So the engine can be tested either with diesel or 2ndVegOil during the DPF regeneration.

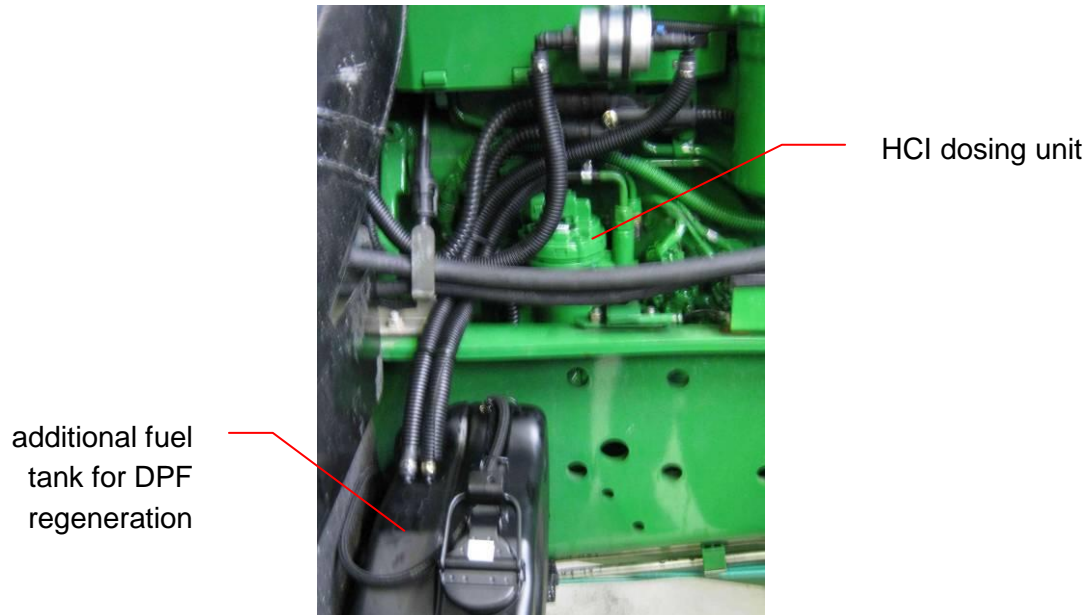


Figure 7: additional fuel tank, right side of the tractor

The engine fuel supply was separated from the DPF regeneration fuel supply. The tubes for the fuel supply and fuel return for the regeneration unit were cut off and sealed engine sided. Further on the engine injectors' leakage fuel was diverted to the inlet of the pre pressurization fuel pump. So the hot return fuel is not cooled by the fuel cooler any more. But it will heat up the inlet fuel temperature coming from the fuel tank. The remaining connection to the fuel cooler was closed engine sided, as it was done in the 3B conversion of the test stand engine (see deliverable D2.4).

2.4 Fuel filters

There are two fuel filter elements. The low pressure fuel pump contains a fuel filter element, which is not appropriate for the use of 2G-PVOs. It had to be removed and displaced by a filter with a wider mesh size. Therefore an adapter was soldered to the fuel pump. The main parts of the fuel pump are an electric motor with fuel pump, a filter mesh and its housing.



Figure 8: JD series fuel pump with small filter element, disassembled



Figure 9: fuel pump with new components for 3B conversion, disassembled



Figure 10: new filter connected to the fuel pump, assembled



Figure 11: pre pressurization pump with pre fuel filter, mounted in front of the engine air cooler (concerted 3B tractor)



Figure 12: main fuel filter, mounted left side of the tractor

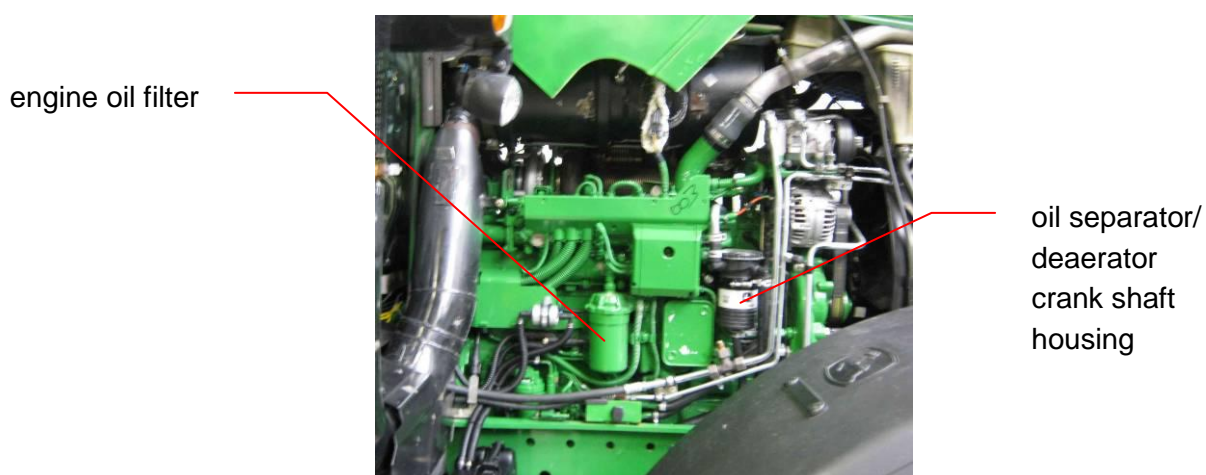


Figure 13: tractor engine oil filters



3 Validation and verification

Emission tests were conducted on the engine test stand at the TU Kaiserslautern to prove the stage 3B exhaust gas targets. After the conversion the functionality and performance of tractor n°17 was evaluated and proven at the JD power take off (PTO) dynamometer.

3.1 Power and torque measurements

The measured full load curves are displayed below. The converted 3B engine satisfied in terms of power performance using 2nd VegOils. In standard mode the maximum power was 136,0kW at 1800rpm. In boost mode the maximum power was 153,3kW at 1900rpm.

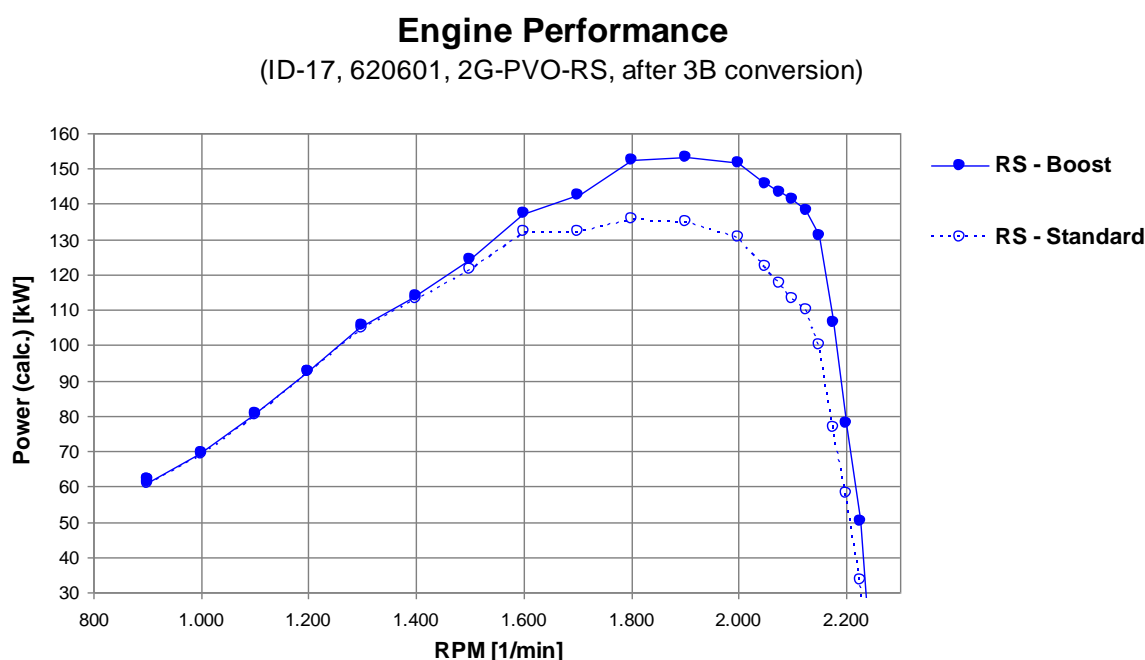


Figure 14: Dyno performance results with 2G-PVO-RS fuel, Stage3B converted tractor ID-17, S/N 620601.

3.2 Emission tests

The emissions of the Euro stage 3B converted engine were measured on the engine test bench. An 8-mode test was conducted according to ISO 8178, 97/68/EC and 2004/26/EC as well with diesel as with 2nd Generation pure vegetable rapeseed oil (2G-PVO-RS).

Due to achieving the needed exhaust gas targets at the engine test bench, the Euro stage 3B converted tractor had not been measured again. The measuring results of the Stage 3B test stand engine can be found in the following reports: deliverable D2.5.

