

EcoActive Technologies

◁ C.L.E.A.N. Diesel Power Pack ▷



Bombardier Transportation sets new standards in environmentally friendly propulsion systems: The C.L.E.A.N. Diesel Power Pack already meets the new, strict EU toxic substance guidelines for 2012 today.

Within the C.L.E.A.N. (Catalyst based Low Emission ApplicationN) research project, the propulsion with the worldwide lowest emissions for diesel-driven vehicles in the 500 kW class was developed at Bombardier Transportation in Hennigsdorf, Germany.

The new propulsion is based on a 560 kW strong eight-cylinder diesel motor with an SCR catalytic converter, which is connected with a power shift transmission. When calibrating the components, it was possible to optimize weight, construction and fuel consumption of the propulsion unit – while simultaneously reducing the required maintenance.

Maximum efficiency

The C.L.E.A.N. Diesel can be used in coasting or cruise mode. Both forms of operation are equally fuel-efficient and low on emissions. The active reduction of the auxiliary operating load offers additional savings potential.

With the C.L.E.A.N. Diesel, Bombardier Transportation, as the global market leader, is already equipped for rail traffic engineering with production-ready technology which meets the current, vastly stricter, EU emissions guidelines (EU Guideline 2004/26, Stage IIIB).

Passenger Vehicles

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Emission level	Valid for rail cars from	NO _x (g/kWh)	HC (g/kWh)	CO (g/kWh)	Particulates (g/kWh)
Euro II	Not applicable	7.0	1.1	4.0	0.15
Euro III	Not applicable	5.0	0.66	2.1	0.1
Stage III A EU 2004/26	2006	4.0 (combined)		3.5	0.2
Stage III B EU 2004/26	2012	2.0	0.19	3.5	0.025

C.L.E.A.N. Diesel Power Packs drastically reduce exhaust emissions

The research project

The preparations for the research project began in August 2006 with the technical clarification of the components and their specifications, simulation calculations, the development of the type test program, the construction of the Power Pack and the material procurement. Simultaneously, the test bed construction was planned and scheduled.

Operation of the test bed started in August 2007. The C.L.E.A.N Diesel Power Pack and its peripheral components were subjected to comprehensive type testing. After successful completion of the test phase, the C.L.E.A.N. Diesel was presented to the public on 8 April 2008.

With greater vehicle performance and considerably lower fuel consumption than its predecessor, as well as up to 83% lower exhaust emissions, the C.L.E.A.N. Diesel is the most environmentally friendly diesel propulsion worldwide with superior performance!

The results

Less propulsion mass

The mass to be accelerated has an enormous impact on fuel consumption. Particularly vehicles in regional traffic, which frequently accelerate and brake, benefit from reduced vehicle mass. The trend towards higher equipment comfort, however, leads to an increase in mass. It can ultimately be balanced out by minimizing the propulsion mass. With C.L.E.A.N. Diesel, the mass of the Power Pack and the exhaust system were reduced by 20% compared to the predecessor model.

Lower maintenance requirements

An important goal of the research project was to minimize the maintenance and repair times. C.L.E.A.N. Diesel achieves this goal through a combination of innovative ideas.

For improved maintenance:

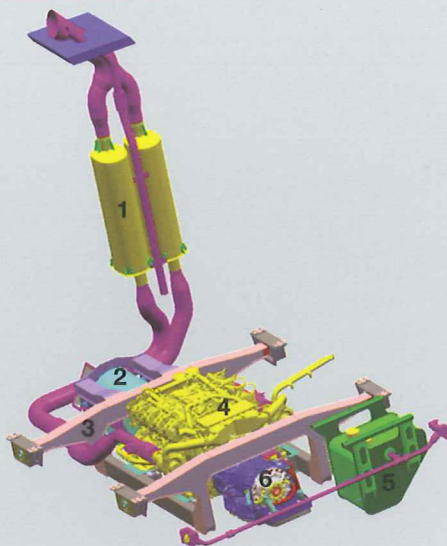
- Fuel and oil filters are electronically monitored for contamination
- Propulsion of all ancillary components is achieved mechanically without fan belts
- No particulate filter – no cleaning and disposal of oil ashes
- Longer maintenance intervals after the introductory phase
- Reduced number of motor components
- Electronic oil level monitoring for the motor oil

For improved repairs:

- Disassembly of the power shift transmission without disassembly of the Power Pack
- Easier handling of the transmission due to considerably reduced mass
- Disassembly of the 400-V board power generator without disassembly of the Power Pack
- Side access to the air compressor
- Good access to the fuel and high-pressure injection system
- Disassembly of the oil pan is possible and thus good access to the driving gear and the oil pump of the motor

Selective catalyst reduction	Exhaust gas recirculation + Diesel particulate filter + if applicable, multiple turbocharging
<ul style="list-style-type: none"> • Requires carbamide as a reducing agent 	<ul style="list-style-type: none"> • DPF is required and thus a risk of blockage of the filter exists <ul style="list-style-type: none"> - In service, higher idle portions for the diesel motor - It is necessary to use special low-ash motor oils - It is necessary to clean the particulate filter • Motor oil contamination due to EGR
<ul style="list-style-type: none"> • Lower fuel consumption • Lower demands on the cooling system and thus: <ul style="list-style-type: none"> - Minimized energy requirements for propulsion - Minimized tendency towards contamination - Reduced noise • Large series components from the on-highway sector can be used 	

Comparison of approaches to achieve reduced emission values



- 1 SCR analytic converters
- 2 Auxiliary generator
- 3 Single-part supporting frame
- 4 Diesel motor
- 5 Carbamide tank with 150 l usable volume
- 6 Power shift transmission

Power Pack including exhaust gas post-treatment system

Less complexity

Several components were eliminated from C.L.E.A.N. Diesel for the purpose of cost and volume reduction:

- No heat exchanger external to the transmission – no external oil circulation and thus the omission of components and considerably reduced risk of oil leakage
- All components of the charge air system and the cooling are directly constructed onto the motor – no charge air pipes which are external to the motor
- No electrical water pump which is external to the motor
- Reduction of the cooling water lines and their connecting elements
- Integration of the torsional vibration damper in the transmission – thus no torsional elastic coupling between diesel motor and transmission (gear box)

The components

A 400-V three-phase current generator is integrated in the Power Pack, which, together with a converter, assumes the entire auxiliary operating power supply and thus also the energy for the propulsion of the cooling system, with these essential advantages:

- Reduced idling fuel consumption
- No hydrostatic oil circulation is required, hence the elimination of components and maintenance requirements as well as no risk of pollution due to leaking oil

Convincing propulsion concept

The torque created in the diesel motor is adjusted in a power shift transmission. From here, it is forwarded to the wheel set transmission via the power train, where it is further converted and deflected. The master wheel set transmission is equipped with a reversal switch to reverse the rotation.

Powerful motor

The FPT diesel motor is elastically fitted in the support framing. The motor block is linked to the power shift transmission via the flywheel housing. The 400-V generator is connected to the board network power supply behind the 560-kW eight-cylinder motor and is connected to the auxiliary output via a rotational damper as well as a torsionally flexible shaft. The exhaust discharge of the turbo charger is flexibly docked to the catalytic converter. The exhaust gases are fed through the roof using a shared line.

Intelligent transmission

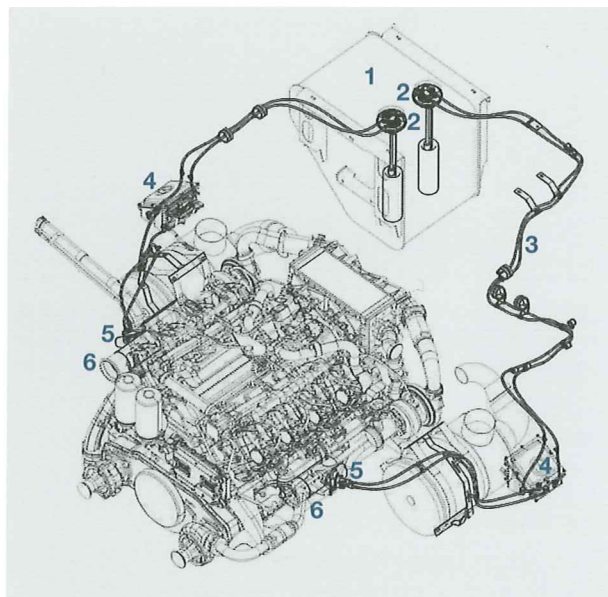
The ZF power shift transmission is equipped with three bevel-toothed planetary sets which can be switched to six gears using five switching elements. After a short start-up, the converter is circumvented by means of a bypass coupling. Thus a mechanical connection exists with high efficiency from the motor to the wheel set. It causes an enormous efficiency increase of the propulsion system.

C.L.E.A.N. Diesel Power Pack

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Considerable exhaust reduction

A catalytic converter with selective catalytic reduction technology (SCR) reduces the emissions with the injection of an urea-water solution into the exhaust system. The heart of the after-treatment system is the supply module with the electronic control unit DCU and the AdBlue pump module. The DCU records process values of the motor, the exhaust system and vehicle control data. It computes the injection quantity of the reducing agent AdBlue (carbamide-water solution according to DIN 70070) and controls it by means of pressure regulations.



- 1 AdBlue tank
- 2 WEMA units (intake, heating, fill level check)
- 3 Cable laying
- 4 Supply modules (compute injection quantity, apply suction, create pressure)
- 5 AdBlue injection module
- 6 Mixer

ECO4 – Energy, Efficiency, Economy and Ecology
C.L.E.A.N. Diesel forms part of Bombardier's ECO4* environmentally friendly technologies. Addressing the growing challenges among operators to reduce Energy consumption, improve Efficiency, protect the Ecology while making sense Economically, ECO4 is the concrete validation of Bombardier's declaration – *The Climate is Right for Trains**.



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