TOTAL RUBIA EV FLUID

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TECHNICAL GUIDE

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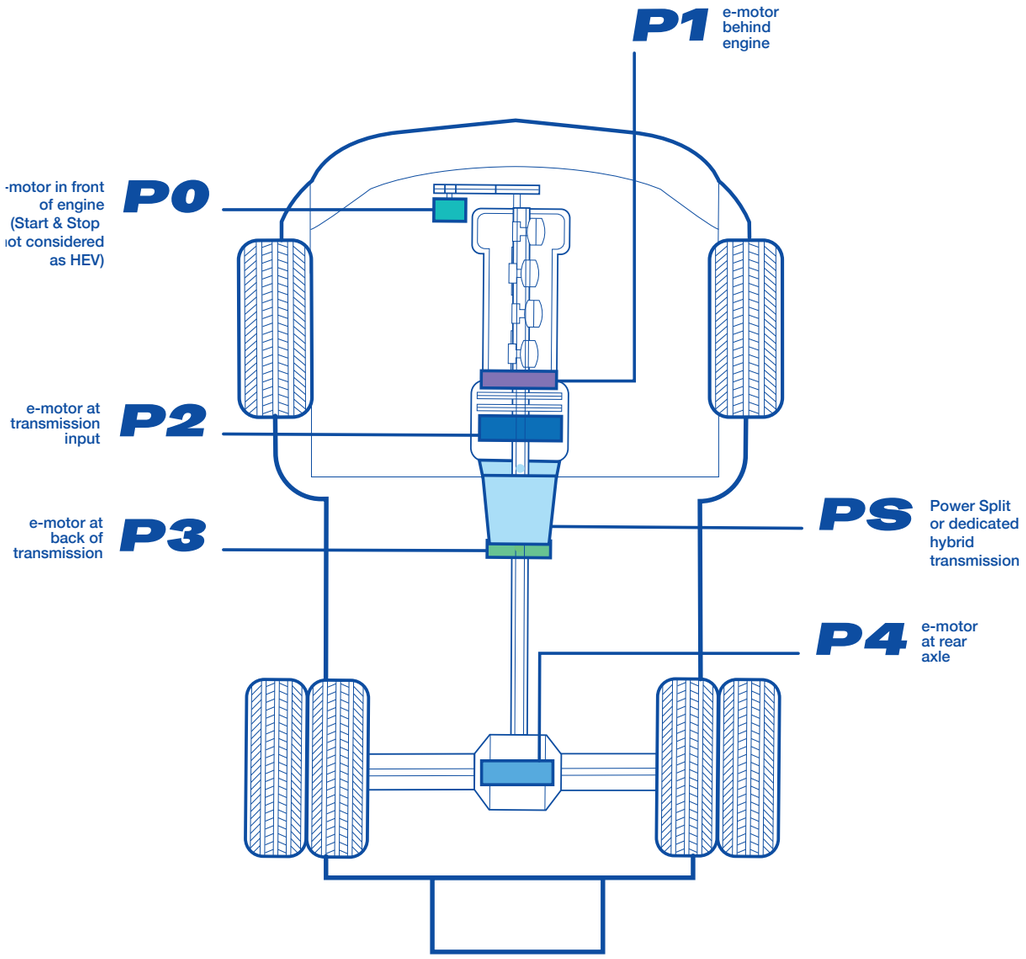
WHAT IS A HEAVY DUTY HYBRID VEHICLE?



A Heavy-Duty Hybrid Vehicle is one of the solutions to reduce fuel consumption, improve efficiency and respond to climate issues for trucks, buses and off-road vehicles. The Heavy-Duty Hybrid Vehicle is equipped with an Internal Combustion Engine (ICE) and one or several electric motor. Two different sources of energy can be used: fuel and/or electricity.

The main differences between Heavy-Duty Hybrid Vehicles and Light Duty Hybrid Electric Vehicles are: weight, driving cycles, torque requirements, energy storage and power density. Truck manufacturers are facing up huge challenges and each application will have a dedicated architecture in the electrification of the powertrain.

Buses and delivery trucks drives in urban traffic, where drive cycle is at lower speed with numerous stop and go. These conditions make suitable the use of a hybrid vehicle with an electric contribution allowing fuel economy and ensuring access to urban zone.

Off-road truck, excavator, bulldozer are heavy machinery used in construction site, where the drive cycle are very short distance. The electrification of the powertrain provide an assistance, reducing fuel consumption.

Long distance trucks are mainly used to operate long distance over land, where drive cycles are mainly on highways at constant speed. The electric engine provide assistance in acceleration and in road slope. These electrification of the powertrain can reduce significantly the fuel consumption.

P1•

The electric motor is connected to the thermal engine and is able to recover energy when the car brakes and uses it to start the vehicle and accelerate.

P2•

The electric motor is located before the gearbox or included in the transmission and is able to recover energy when the car brakes and uses it to start the car.
The electric motor is able to uncouple from the thermal engine for an all-electric drive.

PS power split•

The gearbox uses a set of planetary gears with one or two electric motors and is designed specifically for an electric use.
The electric motor is able to recover energy when the car brakes and uncouple from the thermal engine for an all-electric drive.

P3•

The electric motor is located after the gearbox and is able to recover energy when the car brakes and uses it to start the car. The electric motor is able to uncouple from the thermal engine for an all-electric drive.

P4•

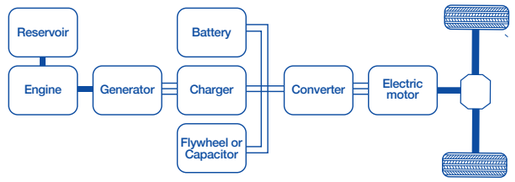
The electric motor is integrated into the rear axle (e-axle), and is able to recover energy when the car brakes and uses it to start the car.

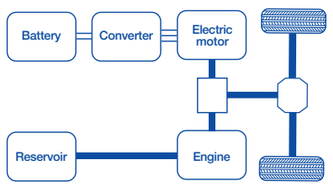
DIFFERENT TYPES OF HYBRID ELECTRIC VEHICLES

Series Hybrid Electric architecture

The Internal Combustion Engine (ICE) is coupled with an electric generator, turning the mechanical output into electricity. Depending on the needs of the electric motor, this electricity is stored in batteries or goes through the electric engine into the drivetrain. The battery can be recharged additionally in braking phases, recovering kinetic energy.

This architecture allows the engine run at its optimum performance with a significant fuel consumption reduction. Electric motor and storage system pack need to have a large power density to give the necessary torque to the wheels.





Parallel Hybrid Electric architecture

Electric motor and ICE are detached, both have a mechanical connections to the drivetrain. Regenerative braking is possible due to the electric motor, which converts kinetic energy into electricity stored in batteries.

		Series	Parallel
Driveline can be powered by	ICE		●
	Electric Engine	●	●
	Energy recovery when braking (generator)	●	●
Electric motor Operation	Stop & Start system	●	●
	Torque booster	●	●

WHAT IS A BATTERY ELECTRIC HEAVY-DUTY VEHICLE?

Battery Electric Heavy-Duty Vehicle

A Battery Electric Heavy-Duty Vehicle uses one or several electric motors powered by electrical energy, stored in battery pack.

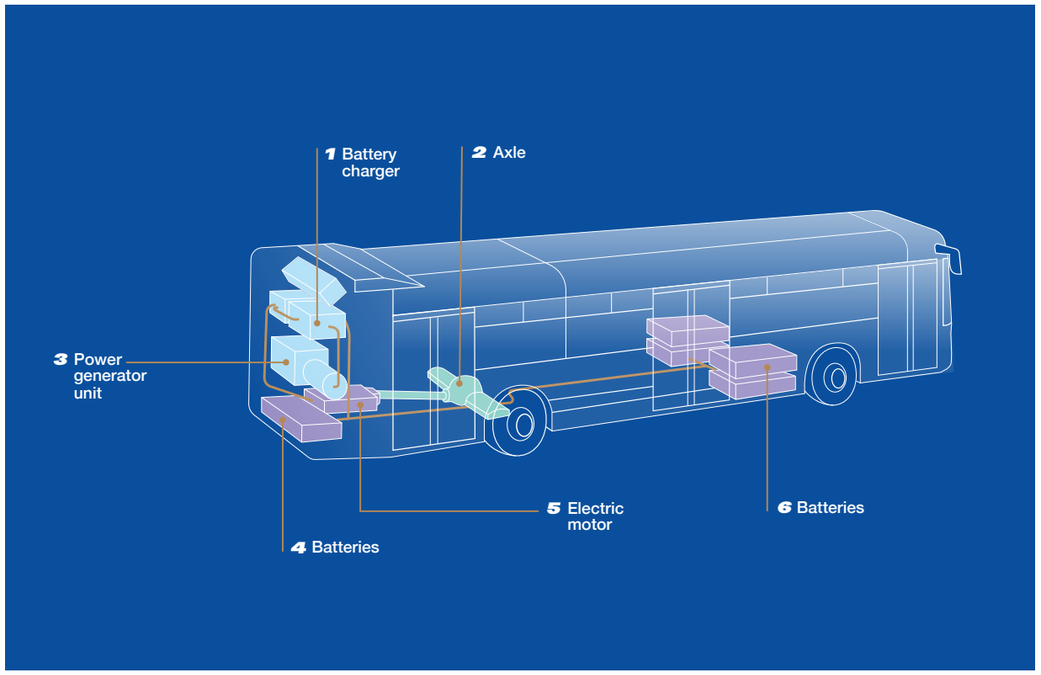
The electric motor converts electrical energy into mechanical energy with an efficiency of around 80%, while Internal Combustion Engine only achieves 35% of efficiency. Batteries are energy accumulators and are the electric heavy-duty's main technological challenge.

Weight of Heavy-Duty trucks are up to 30 times more than a Light Duty vehicles. Those conditions limits the interest of such technology to specific applications: Buses, Urban Delivery trucks and Off-Road vehicles for which access to charging point is easier.

With a high energy storage and high-power density, the system must be protected to ensure the life time of the powertrain.

The electric engine does not require the use of standard complex gearboxes, which are otherwise necessary in today's trucks, buses and off-road. A reducer equipped with one or two speeds is used to transfer the electric motor's mechanical power to the wheels.

Major objectives of a battery are: high power density, reduced charging time, lower cost and extended lifetime.



New technical requirements

New technical constraints for the electrification of vehicles require the development of new fluids. The harsh conditions of the electrification of Heavy-Duty require the use of new fluids. These fluids must meet thefollowing additional properties:

Dielectric properties

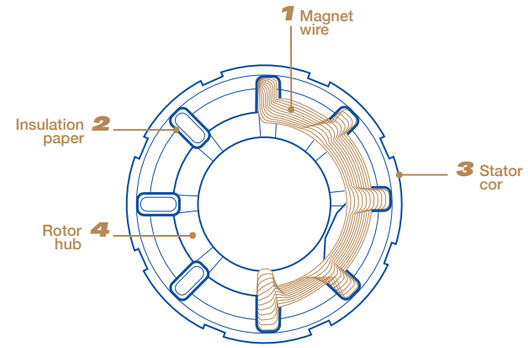
Fluids used in HEV or BEV require electrical insulation properties. The fluid must be insulating to prevent any arcing since it is going to be in close contact with the electrical and/or electronic components of the vehicle.

Dielectric properties must remain stable throughout the time in spite of harsh operating conditions: rising temperatures, oxidation, humidity, particle abrasion.

- **Volume Resistivy** (p): measure of how strongly a material opposes the flow of electric current. A hybrid transmission fluid with high volume resistivity is desired to avoid electrical short-circuits. Unit is Ωm.
- **Electrical Conductivity:** is the reciprocal quantity of volume resistivity, unit is Siemens per meter.
- **Dissipation Factor** (tan ð): indicates the amount of energy dissipated by the insulating material when voltage is applied to the circuit. The worse the insulation is, the more heat is created by the energy dissipation. This parameter is measured with alternating current and is an indication of the energy lost as the molecules in the fluid orient themselves with the changing electrical field.
- **Loss-Factor:** some energy is lost from the transmission system in the form of heat. This lost energy is know as transmission losses.
- **Breakdown Voltage:** minimum voltage that causes a portion of an insulator to become electrically conductive.

Compatibility with materials

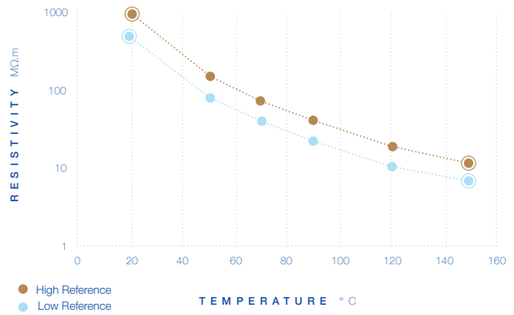
The fluid and new components of HEV and BEV are in direct contact. New challenges must be faced in terms of compatibility with different types of materials in order to avoid the following consequences: swelling, breakage, corrosion etc. Copper is a key material for theseapplications. Its high electrical conductivity makes itthe main critical component used for electrical wiring, windings and organs. It is therefore of the utmostimportance to develop a fluid with excellent copper compatibility.

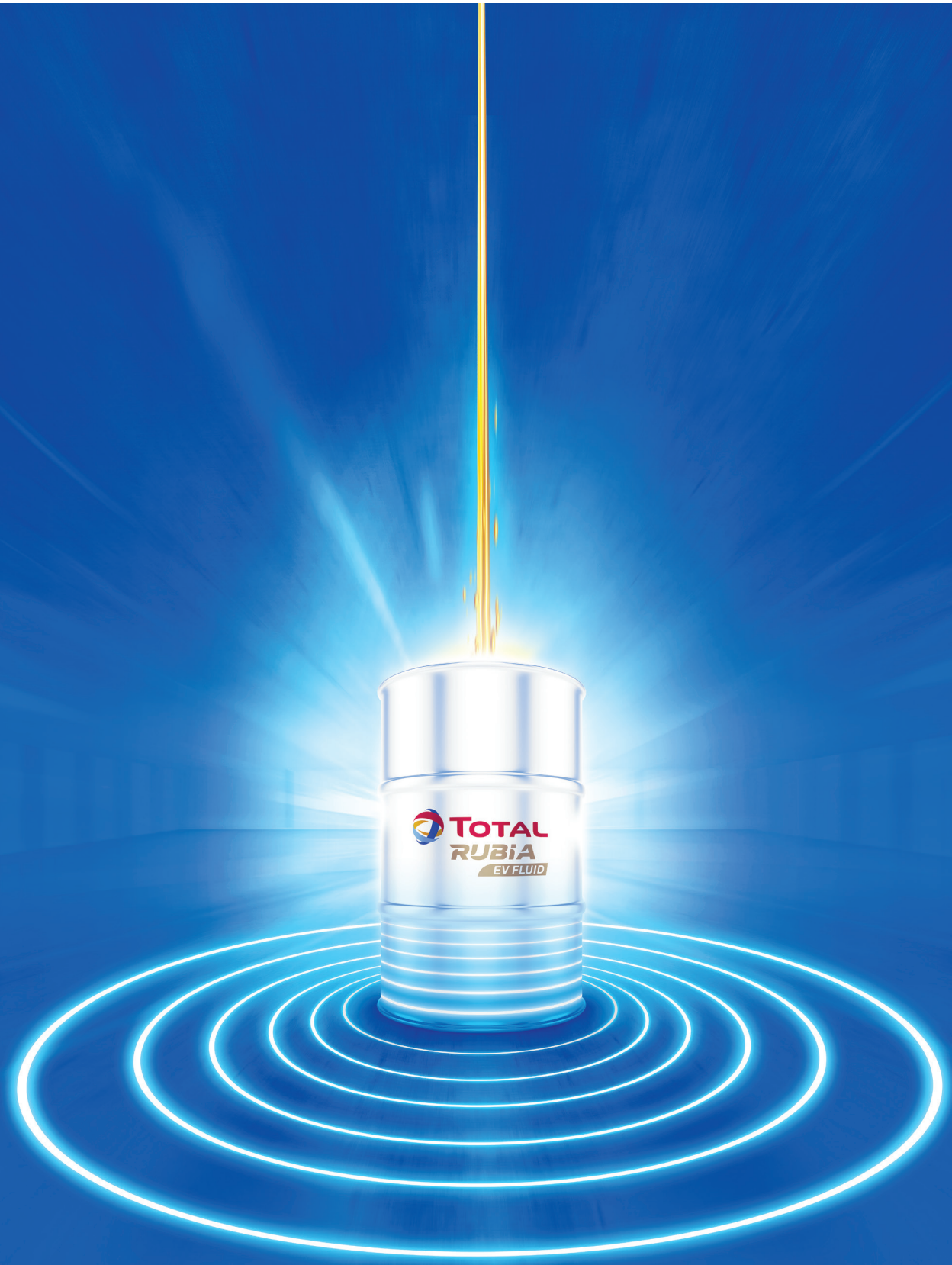


Thermal properties

Power electronics and the electric engine must operate within a defined temperature range. Operating at higher temperature than the desired temperature range inevitably reducesthe vehicles' service life, efficiency and power. The components are subject to the Joule effect, which is the heat dissipation of the electrical energy. A fluid must therefore ensure efficient heat evacuation at temperatures up to 180°C.

Batteries pack in Heavy-Duty are going to accumulate a huge amount of energy, in harsh acceleration and fast charging, the temperature must be managed to guaranty the entire life time of the vehicle.





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Total Lubrifiants - Immeuble Le Spazio - 562 Avenue du Parc de L'Île - 92029 NANTERRE Cedex - France

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