



NEW

EPX-Hydraulic Energy Recovery

System for recovering hydraulic energy through Meter-out compensation technology



EPX HYDRAULIC ENERGY RECOVERY

The modern mobile machinery market demands a constant increase in productivity and performance, together with lower operating costs, greater efficiency and reduced emissions in favor of sustainability and social responsibility.

Hydraulic systems have evolved to maximize the predictability of actuation speed. Flow compensation is a well-known technology that mechanically corrects the actuator speed if it exceeds the operator's demand due to inertial load. This is achieved through a mechanical device introducing a pressure drop to limit the flow when necessary.

EPX innovates beyond the industry standard with a three-way device that not only limits actuation speed but also recovers stored gravitational and kinetic energy.

ADVANTAGES

- Synergistic set of components for the recovery of hydraulic energy
- Traditional Flow Sharing architecture
- Energy recovery options based on OEM's choice
- Prolonged autonomy and reduced battery capacity on electrified machines.

CONCEPT DESIGN



EPX APPROACH

The most common advanced hydraulic systems do include in the main control valve an hydraulic compensator. This 2 ways mechanical device allows through a restriction to limit the flow rate to the actuator. Typically, this compensator is placed in the delivery line that connects the pump to the actuator inlet.

Two technologies are present now on the market: when the compensator is placed upstream the spools the technology is known as "pre-compensated" systems, vice versa when the compensator is placed "downstream" to the spool, that technology is called "post compensated" and allows Flow Sharing operation. This feature is very useful when the flow request by the operator is more than the pump possibilities: in this condition, the directional control valve maintains the flow repartition between sections. The hydraulic system is then typically completed with counterbalance valves to improve further the actuation precision.

EPX's novel approach combines two key innovations.

Meter-Out compensation

This design improves the control of unbalanced loads. Meter-Out compensation provides extra flow restriction when the load is unbalanced, preventing unwanted velocities due to the load on the cylinders or motors. This innovation also simplifies the load control valves: in a Meter-Out system the meter compensator protects against load drifting. The secondary valves are used in this case only as safety equipment. These safety valves, typically flanged on the cylinder, are designed to have minimal pressure drop and minimal impact on regular valve operation. Example of simplified safety valves are pilot-operated check valve or an electric on/off valve.

Three-way compensation

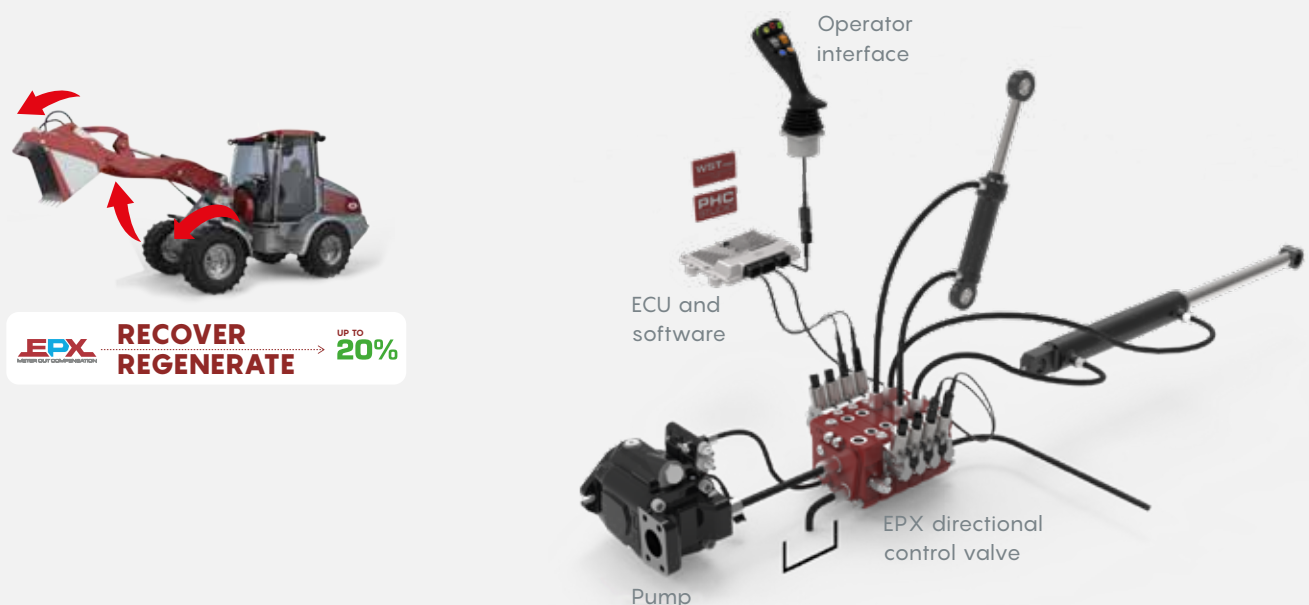
This patented design introduces an extra flow path to the meter-out compensator. During operation, the compensator measures the fluid pressure: if the pressure exceeds a determined threshold, an extra path is opened, pressurizing the recovery line with the stored energy in the actuator.

The combination of these two innovations provides a Flow-Sharing solution that can recover stored energy in the machine.

EPX technologies are evolving to minimize the environmental impact and stabilize the power consumption of the next generation of hydraulic systems.

Testing activities on wheel loaders have demonstrated a 20% of energy saving combining recoverable energy and reduction of compensation losses.

A typical system with EPX is made of a EPX Flow Sharing directional control valve, an electronic joystick, a Load Sensing pump and an electronic control unit with customizable modular software developed by Walvoil (PHC STUDIO).



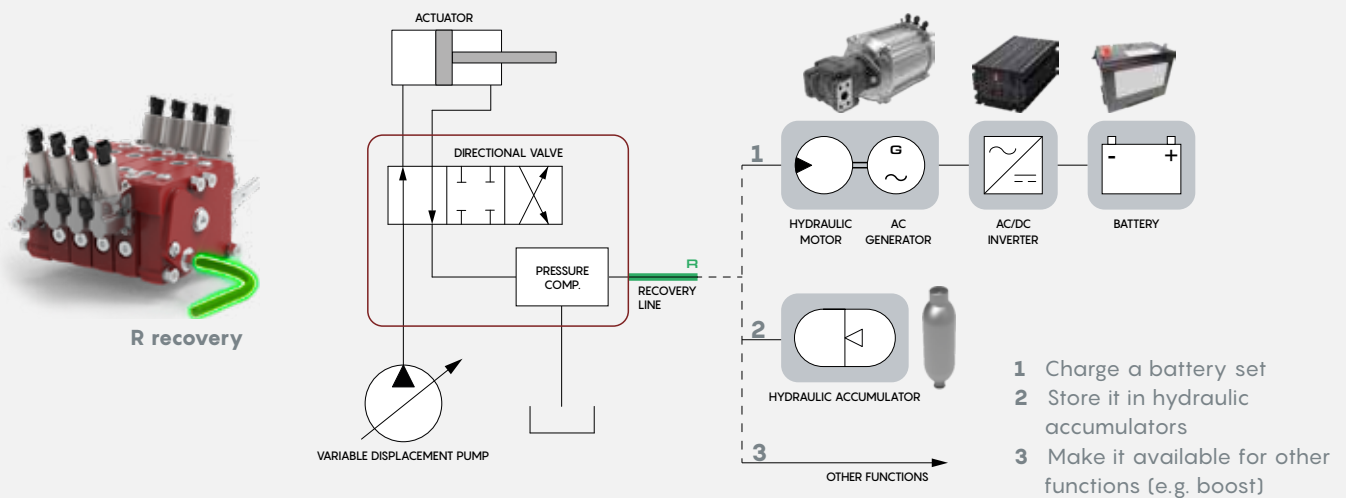
ENERGY RECOVERY STRATEGY: MULTIPLE OPTIONS OF RECOVERY WITH R LINE

EPX technology is based on new compensator's function with a recovery line R powered by flow in pressure (Power).

This principle is at the basis of the recovery, which occurs in contemporary movements, in dependant sections at lower loads, and also in single movements with overrunning loads, thanks to a low pressure pilot source X feeding LS line.

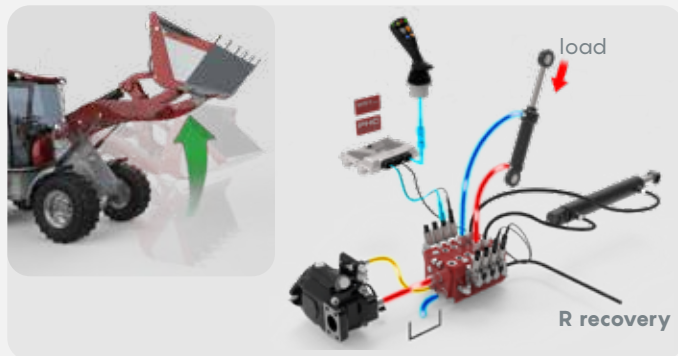
The downstream compensator keeps independent from the pressure the flow to the actuators and allows recovering energy during simultaneous movements in the sections at lower load and in presence of gravitational loads.

Once the recovered flow is available in the line R, its management depends on the choices of the equipment manufacturer. It is possible to regenerate the recovered flow into the system directly, to store it in a hydraulic accumulator, or to transform it in electrical energy and store it in a battery.

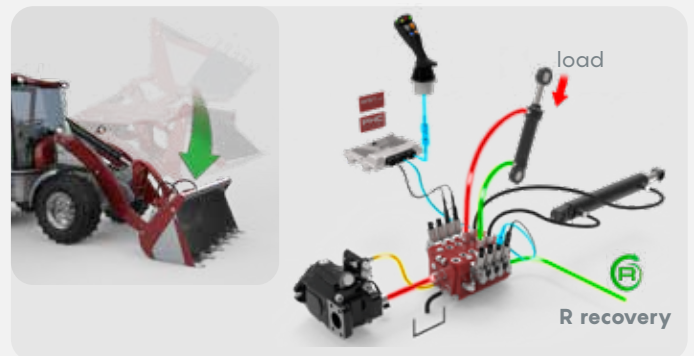


HOW DOES IT WORK ?

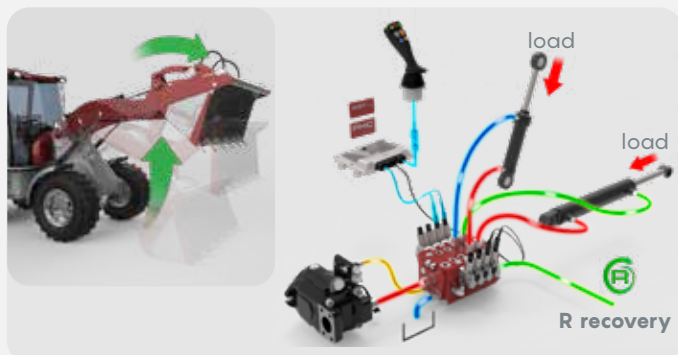
• Single resistive load (traditional L.S. Flow Sharing Valve)



• Recovery of gravitational loads



• Recovery during simultaneous functions



TESTING ACTIVITY

EPX valve has been installed in a hybrid front end loader for tractors, powered by the primary ICE engine and by a secondary boost electric system composed by:

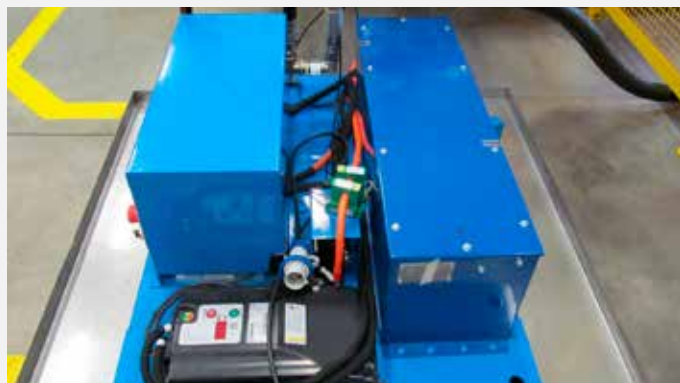
- ICE equipped with primary hydraulic pump
- Electrical Motor (19 kW) equipped with boost
- 600 A Inverter
- Battery charger control panel (CAN-Bus protocol)
- 48 VDC kWh lithium-Ion battery.



TEST OUTCOME

- 10% energy recharged to battery
- 8% saved with booster overcharge
- 16% energy saved with internal regeneration

Same working cycle performed using only 66% of energy normally consumed.



TEST ON FIELD

COMPACT WHEEL LOADER

- Operative weight 2.2 t
- 100% Electric Engine 7+12 Kw

Equipped with:

- HJW joystick + MTH handle
- EPX valve

