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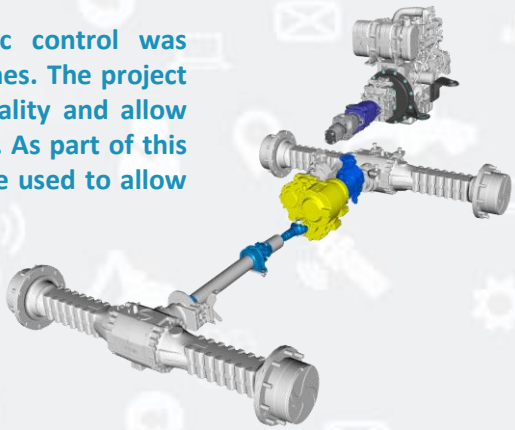
CATERPILLAR®

Closed loop proportional hydrostatic drive system

Alongside the emissions driven project, electronic hydrostatic control was introduced when moving to the most recent K series CWL Machines. The project was undertaken to optimise fuel efficiency, offer more functionality and allow effective power management of the machines to be incorporated. As part of this project, numerous new electronic and hydraulic components were used to allow our goals to be achieved.



Electronic Throttle Pedal:

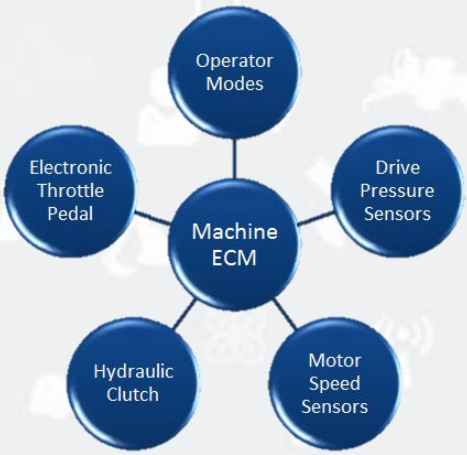
Incorporating an electronic throttle pedal that feeds directly into the main machine ECM allows us to use the pedal position to control various aspects of the hydrostatic system. It allows us to compare the desired engine speed to the actual engine speed (which is fed back from the engine ECM via the CANbus network) and adjust the hydrostatic system performance to maintain peak power output from the engine.

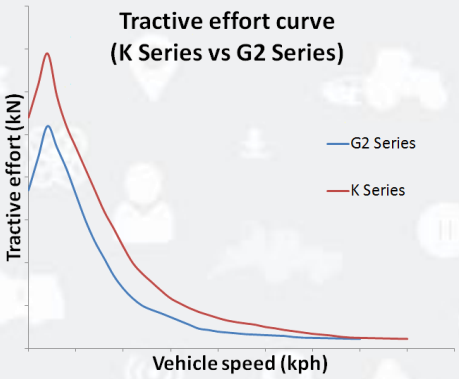
Hydraulic Clutch:

When accelerating if additional tractive effort is no longer required the second motor is de-swashed and clutched out. If the second motor was not clutched out there would be unnecessary parasitic losses in the system, thus reducing its output power and efficiency.

Operator Modes:

The operator can select different modes of hydrostatic aggressiveness and tractive effort. There are four different tractive effort settings and three aggressiveness settings, giving twelve operation modes. Each of these modes are tuned using the parameters in the software to achieve a specific set of operating conditions.





Motor Speed Sensors and Drive Pressure Sensors:

There is a speed sensor on each motor and a forward and reverse drive pressure sensor, which are used to provide feedback from the hydrostatic system that is fed into the ECM. The software within the ECM uses this information to control the pump, motors and clutch command.

ECM Software:

Our ECM supplier and Caterpillar's software integration team developed bespoke software to optimise machine control. Additional features were added into the software throughout the project to allow increased controllability of the machine's hydrostatic drive system.

Benefits of the project:

- Increased fuel efficiency, therefore reduced operating costs for the customer.
- Increased machine performance in terms of peak power, tractive effort and run out speeds.
- Increased component life in pumps and motors.
- The additional control features allow the operator to optimise their machine for the task in hand.
- The new hardware has allowed the introduction of software features such as:
    - ECO Mode: This feature allows the operator to restrict the engine to run within its most efficient speed range whilst still being able to achieve maximum run out speeds, thus reducing fuel consumption.
    - Closed loop proportional speed control: This feature allows the operator to set a maximum speed limit as well as giving the added benefit of extended component life.

Project development:

- This project was carried out alongside our suppliers, customers and a cross functional team within Caterpillar.
- The project began in early 2012, production of the K series commenced in mid 2014.
- We work closely with the National Fluid Power Centre to develop courses and training material to develop young engineers and technicians.

Market:

- As the new K series has the most recent emissions compliant engine it allows us to sell this machine globally.
- These machine are already on the market and have a significant presence in the Japanese, European and North American territories.

Additional information:

- This work has allowed us to develop an electro-hydraulic platform that can be built upon in future projects to add additional features and offer better system control.