Research Paper Engineering

Performance Investigation of Hydraulic & Electronic Power Steering System of Four Stroke Four Cylinder Petrol Engine

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ABSTRACT

Hydraulic power steering is parasite of engine and it is continuously consumes the power from the engine on the other hand Electronic power steering consumes power from battery and saves valuable power from engine. In these research paper power consumption identification methods developed for both hydraulic and electronic power steering system and then comparision between both system is done.

KEYWORDS Hydraulic power steering, Column mounted electronic power steering (CEPS)

INTRODUCTION

Any mode of transportation used by people must have some means of control. For the automobile, two primary control systems are at the driver's disposal:

(1) The steering system, and
(2) The braking system.

Many vehicles incorporate a power steering system, the purpose of which is to reduce the driver's effort to turn the steering wheel. The system usually is hydraulically operated, with hydraulic pressure provided by a pump driven by a belt from the crankshaft. A drive system that is an older V-belt type. These systems used multiple V-belts to drive the various accessories on the front of the engine. Most new vehicles use a single, ribbed belt (serpentine belt) to drive all of the accessories.

Electrically powered steering uses an electric motor to drive either the power steering hydraulic pump or the steering linkage directly. The power steering function is therefore independent of engine speed, resulting in significant energy savings. A "steering sensor" is located on the input shaft where it enters the gearbox housing. The steering sensor is actually two sensors in one: a "torque sensor" that converts steering torque input and its direction into voltage signals, and a "rotation sensor" that converts the rotation speed and direction into voltage signals.

LITERATURE REVIEW

Naseem Daher & Monica Ivantysynova (2014)[1] experimentally studied that that DC steering results in 14.5% fuel savings, 22.6% productivity gain, and a grand total of 43.5% fuel usage efficiency increase than conventional steering system.

K. Izutani & Y.Shimizu (2010)[2] developed a technique to measure power consumption by electronic power steering and concluded that by improving the axial force estimation method for low-speed driving, a method has been developed for estimating EPS energy consumption from parked state steering to high speed driving more quickly and performing vehicle operation testing. As a result EPS energy consumption can now be predicted in the planning stage of vehicle development. This development method is utilized during the stage of EPS design to study battery power consumption and system efficiency optimization.

Fumihide Kozuma et al. (2005)[3] energy saving power steering system, which was named as KEEPS (Kayaba Electronic Controlled Energy Saving Power Steering). In a conventional hydraulic power steering system, the hydraulic pump always supplies enough quantity of oil to the hydraulic circuit. This extra oil flow increases driving torque of the pump, thus the hydraulic power steering system wastes energy. On the other hand, KEEPS can control oil flow electrically in accordance with the condition of a vehicle. In the measurement test for energy consumption of the power steering system with the actual vehicle on test courses, KEEPS got 48% less at city mode, 41% less at highway mode and 39% less at country mode compared with the conventional hydraulic steering system.

EXPERIMENTAL SETUP

The experiments were conducted on a single-cylinder, 4-Stroke, four cylinder santro engine because it is possible to mount both electronic power steering easily(CEPS & PEPS). Power consumption in case of electronic power steering system is measured on vehicle under different road condition (Rough, Concrete & Bitumen road at different speed (from 0 to 80km/hr, at the range of 10). Figure shows a experimental setup for power consumption measurement in case of electroni power steering system.

Figure 1 Experimental setup showing connection of measuring instrument with steering system

Figure 2 Experimental setup & instruments connection with electronic power steering system

Power consumption in case of hydraulic power steering is almost similar for all the speed because it continuously draw a power from vehicle engine even required or not. (Steering pump is parasite for the engine). It is not possible to measure power consumption by hydraulic power steering so a separate test rig is developed to measue a power consumption. In test rig the hydraulic steering pump is driven by an electric motor and power consumption by a electric motor is measured. Power consumption is measured for under different three road condition (i.e Rough, concrete & Bitumen Road).

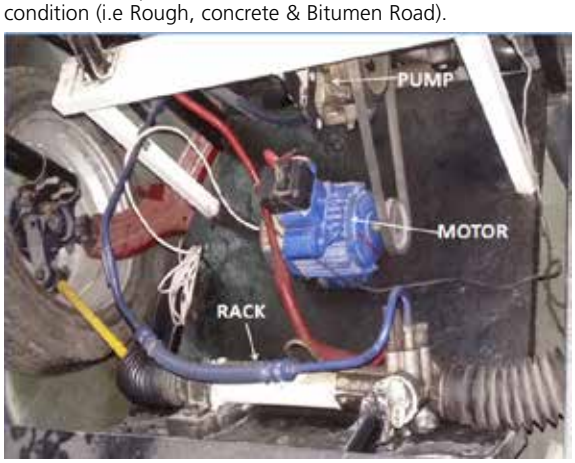

Figure 3 Experimental setup for measurement of power consumption by hydraulic power steering.

RESEARCH METHODOLOGY

For the experimental investigation we carried out following steps:

Research methodology for pinion mounted electronic power steering

In this experiment hydraulic power steering system was replaced by the electronic power steering

Then take the reading for the power consumption by the steering system under different vehicle speed at different steering angle under different road condition.

Research methodology for hydraulic power steering system

To measure the power consumption on running and installed in car condition is difficult to measure so we removed hydraulic power steering from the vehicle.

We have prepare separate test bench and then take the reading for the power consumption for the hydraulic power steering by providing external supply by putting external load similar to load on the front axle.

RESULTS AND DISCUSION

Power consumption by different steering systems

Power consumption for different steering system (i.e. CEPS, PEPS & HPS) on different road condition (i.e. Rough, Concrete & Bitumen) has been measured at different road speed (i.e. 0, 10, 20, 30, 40, 50, 60, 70, 80 Km/hr).

Here graph shows power consumption by different steering system on different road conditions in case of hydraulic power steering system, it consumes power continuously from the engine and is almost remain same for different road speed and for all the road condition so it is said that hydraulic power steering consumes power from the engine even not required but in case of electronic power steering system power consumption by electronic power it consumes high power during parked condition and low speed region but for high speed region power consumption by both electronic power steering (i.e. column and pinion mounted) is lower and beyond 50 km/hr power consumption by both electronic power steering

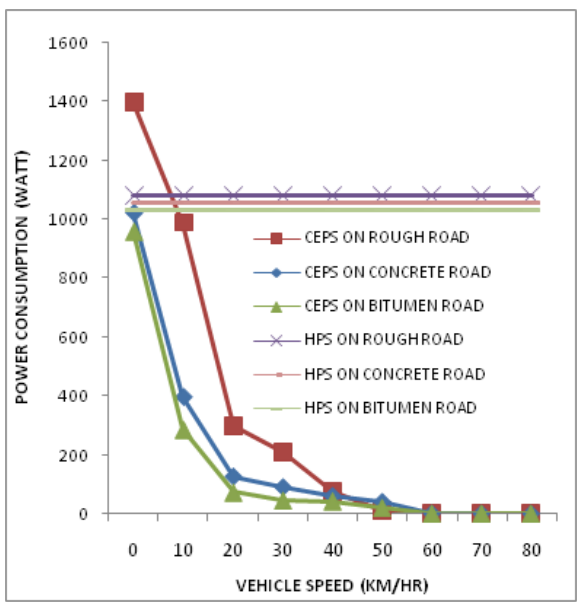

Figure 4 Graph showing power consumption by different steering system on different road condition.

system is almost negligible because a beyond this range power cutoff is provided in case of both EPS. When comparing column mounted electronic power steering and pinion mounted electronic power steering power consumption by PEPS is slightly lesser than that of CEPS. In case of EPS road condition has influence on power consumption. On rough road power consumption by is much higher than the other to road condition i.e. concrete road and bitumen road and on concrete road power consumption is almost similar to bitumen road but for higher speed region the power consumption by electronic power steering is almost similar.

CONCLUSION

- From the experimental following parameters may be concluded
- Power consumption by hydraulic power steering is almost constant at every speed and does not affected by road condition.
- Power consumption by electronic power steering is decreases as the vehicle speed increases.
- Power consumption by electronic power steering is depending on the road conditions. On rough road power consumption increases due to higher road and tire friction. On concrete and bitumen road power consumption by the electronic power steering is almost similar.
- Power consumption by electronic power after the speed of 50Km/hr is almost negligible because in electronic power steering motor cutoff is provided after that speed.

- When comparing power consumption by hydraulic power steering and electronic power steering hydraulic power steering consumes more power than another system
- When comparing two different electronic power steering systems (i.e. column mounted and pinion mounted) pinion mounted steering system consumes less power compared to another system.

FUTURE SCOPE

There are power losses in the case of electric circuit so one may determine power losses in case of electronic power steering system. Work may be carried out to minimize the hysteresis losses in the electronic power steering system.

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