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A study on of Electromagnetic clutch water pump and compressor engine efficiency-An overview

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***Abstract*:** With the use of an electromagnetic clutch water pump and a pneumatic compressor, an internal combustion engine fuel consumption can be reduced. The water pump in an engine is driven by the crankshaft via a belt and circulates water for cooling. The thermostat valve prevents coolant circulation; when the temperature inside the engine's coolant jacket is below 375 degrees Fahrenheit, the thermostat is closed; when the temperature rises above 375 degrees Fahrenheit, the thermostat opens. When the thermostat is turned off, the water pump continues to run. The purpose of a pneumatic or air compressor in a pneumatic braking system is to compress air and store it in a storage tank for braking operation. When the air pressure in the storage tanks rises above its storage capacity, the governor regulates it by releasing it to the atmosphere. The use of an electromagnetic clutch water pump and air compressor can reduce the amount of unnecessary work performed by this water pump and air compressor. The fuel economy of the engine from the electromagnetic water pump and pneumatic compressor was improved by 8.0 percent when compared to the conventional types, according to the results of many articles. The electromagnetic water pump and pneumatic compressor improve engine performance while lowering vehicle fuel consumption.

***Keywords*-**Electromagnetic clutch; Water pump; Air compressor; Performance

I. INTRODUCTION

The role of the internal combustion engine is to provide tractive power to the driving wheels via drive train. The most commercial fuel used in internal combustion engine are petrol, diesel, CNG, LPG, biodiesel etc. Nowadays, alternate and hybrid technologies are used to reduce the emission from combustion of fossil fuel and also as an alternate source of energy for the internal combustion engine. Normally the combustion efficiency of an internal combustion engine are optimized, approximately 98% of the energy contained by combustion of the diesel fuel and 95-98% of the energy from the gasoline. However it may be, but only less than 40% of energy is transfer to drive the wheels and the fraction of energy are been used by ancillaries such as water pump, alternator, air compressor [4]. The inability to convert all the chemical energy into brake power energy is termed as gross indicated thermal efficiency. From the definition of the engine fuel conversion efficiency is expressed as

Fuel conversion efficiency = combustion efficiency X gross indicated thermal efficiency

For the improvement of the energy efficiency, electric and hybrid techniques, which can enhances the efficiency of the internal combustion engine these technology were been considered as valuable in recent era of development. The advancement in the science and technology, which were been contribute for the improvement in the efficiency in heavy-duty engines. High-efficiency technology like reduction in weight, air resistance, improving thermal efficiency and energy optimization were been used to reduce fuel consumption in the conventional vehicles.

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In most Commercial engines the coolant system consists of water jacket which is the outer cover of engine, thermostat and radiator. Generally water pump are operated in proportional to the engine speed to circulate the coolant throughout the water jacket of the engine block and radiator, in this configuration of direct connection of the engine crankshaft and the water pump results in excessive mass flow rate of coolant at cold start and part load condition the flow is regulated by thermostat. To optimize the coolant pump effect and to meet the efficiency of the coolant, alternative methods have been proposed by electrification of coolant components.

As per the effect, the electromagnetic water pump and intelligent thermostat have been used in vehicle cooling system. The mass flow rate of coolant in heavy duty diesel engine is relatively high at low engine speed [6] which can be optimized by this technique. In current study we have suggest a method for the efficiency improvement technique, which not only can be applied to the water pump but also to the air compressor of the pneumatic brake system. In pneumatic brake system air compressor process is to compression of the air for the brake operation is stored to the storage tank. The air pressure of the storage tank is regulated by the pressure relief valve.

When the brake pedal is pressed, for the application of the braking process the pressurized air from the storage tank is flow through the hose to the brake cylinder which pushes out connecting rod of the brake cylinder to actuate s-cam and pushes the brake shoe outward. The air compressor, purpose is to pressurize the air and stored in the storage tank when the pressure accumulation reaches beyond the capacity of the storage tank, pressure is regulated by pressure relief valve [2]. The electromagnetic clutch type air compressor is used for the energy optimization technique as an alternative of the conventional type.

From our study, we suggest a methodology which improves fuel economy of an internal combustion by using electromagnetic clutch type water pump and air compressor. The performance of these water pump and compressor result in decrease in fuel consumption and co_2 emission were demonstrated by the experimental mean results

Experimental setup

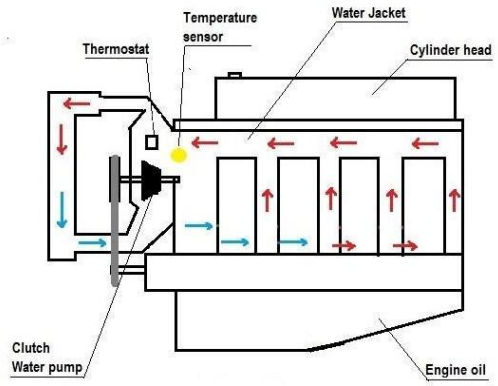

Figure-1. Layout of the coolant system with electromagnetic water pump

The Figure-1 gives the complete layout of the coolant system in an engine and with the electromagnetic water pump. The engine specification is given in the table 1.
From the layout it is clearly illustrated the process of the coolant from the cylinder jacket to the radiator, the red arrows indicates high temperature coolant and blue arrows indicates the low temperature coolant. Figure-2 indicates the complete layout of pneumatic braking system, it consist of an air dryer, storage tanks, dual operated brake valve and brake cylinder. The air dryer purpose is to remove the moisture and water content in the

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compressed air and storage tanks is to store the pressurized into it.

TABLE1: Specification of the Engine

Items	Value
Engine type	Water cooled type
Displacement	796 cc
Bore dia. X stroke length	68.5 X 72.5 mm
Max power	37 KW @5000rpm
Max torque	15 Nm @2500 rpm
Fuel used	Petrol
Fuel system	Solex carburetor

The dual valve used for control the air flow from storage tanks to the brake cylinder. The brake cylinder is to transfer kinetic energy of the pressurized air into mechanical energy by piston, connecting rod which connect the s-cam or wedge type for expanding the brake shoe inside the wheel drum.

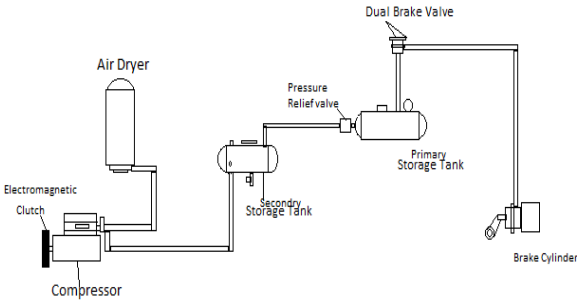

Figure-2. Layout of pneumatic braking system with electromagnetic clutch compressor

Figure-3. The electromagnetic clutch type compressor

The belt connects the pulley of the water pump as well as the air compressor to the crankshaft for transfer of the rotation motion for the necessary operational process. However, with the electromagnetic clutch the rotation speed is controlled by disengage and engage of the clutch and to transfer the crankshaft rotational motion to the water pump and the air compressor. The consumption of the electromagnetic clutch is 20 W under all operating condition. And the temperature sensor is installed near the cylinder water jacket for monitoring the temperature output of coolant. For evaluation of fuel consumption we use the New European Driving Cycle test.

Figure-4. The experimental setup

Figure-5 shows about the schematic layout of the NEDC test process. In NEDC test [1], it consists of constant volume sample, dynamometer, etc. The constant volume purpose is to collect the exhaust for the measuring the emission parameters by gas analyzer method. The figure-3 show the

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electromagnetic clutch type compressor. The figure-4 shows the model of the `experimental setup of the engine with the electromagnetic clutch type water pump and Air compressor and the storage tank with relief valve.

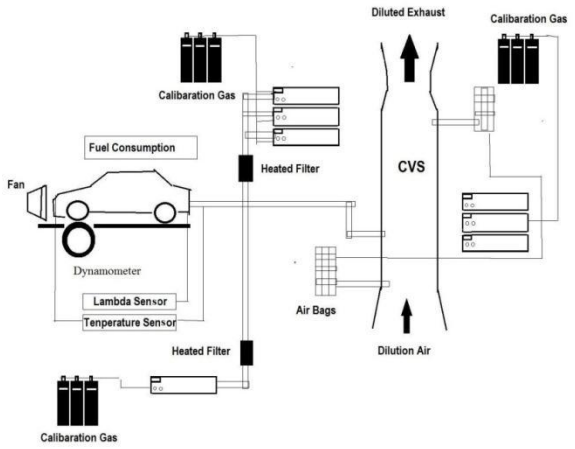

Figure-5. A Schematic layout of testing process

II. Results and discussions:

New European Driving Cycle Test (NEDC),the NEDC is driving cycle designed to access the fuel consumption of the engine. The driving cycle used for emission type-approval of all Euro 3 and later light-duty vehicle models in Europe. The emission limits (expressed as mass of pollutant emitted per kilometer driven) refer to the emissions over NEDC. From the NEDC evaluation test we obtained the results for fuel consumption and emission levels as shown in Figure 6 & Figure 7. We had conducted experiment on medium sized petrol engine ref table-1 to compare the performance of the clutch type water pump and pneumatic compressor with conventional types, the experimental setup consist of dynamometer for performance testing and co_2 emission parameter in the exhaust is determined from constant sampling process and gas analyzer test in NEDC. Figure- shows about the difference between conventional and electromagnetic water pump at cold start phase, the reduction in fuel consumption is due to the optimization of the water pump, the unnecessary work is reduced at this phase. From the figure-5 it is clearly illustrated that reduction in co_2 and fuel consumption level when compared with conventional type. The level of co_2 and fuel consumption has been decreased because at cruising phase the application of the brake is very less due that air pressure is maintained constant inside storage tank.

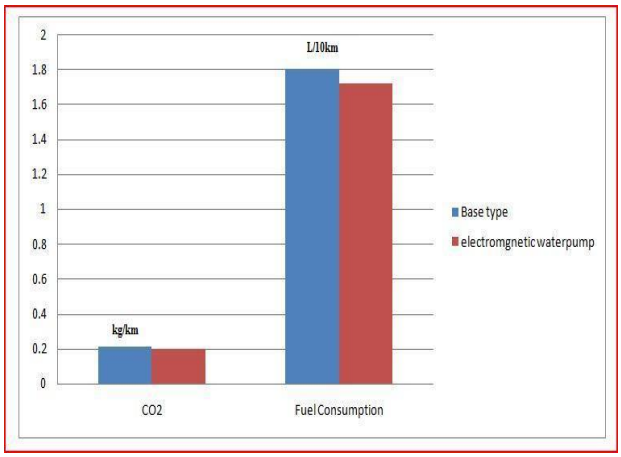

Figure-6. Test result of NEDC at cold start phase.

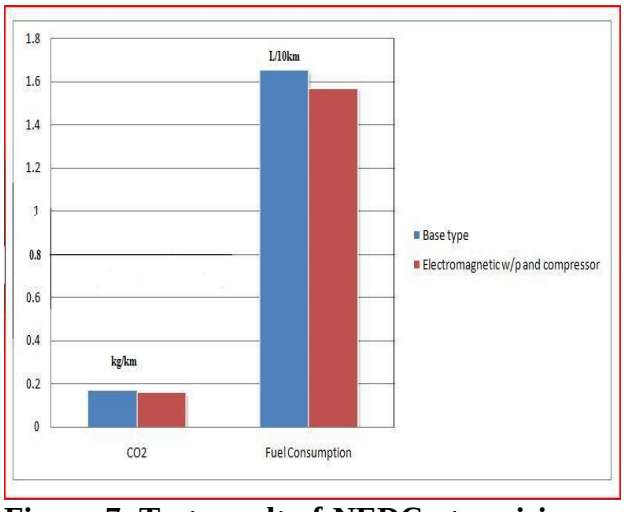

Figure-7. Test result of NEDC at cruising phase

III. CONCLUSION

The paper study is to develop electromagnetic clutch water pump and air compressor to reduce the fuel consumption and co_2emission. The electromagnetic pulleys are installed and performance evaluation test were conducted using NEDC. From the results obtained, we examined the performance improvement and fuel consumption rate have been reduced. The output result from the test Figure-7 clearly Illustrated that the overall reduction of co_2 and fuel consumption about 4.0-6.8% and 6-8% respectively.By this method, the unnecessary work of the water pump and air compressor can be avoided from this we can expect considerable improvement in fuel consumption.

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