PERFORMANCE INVESTIGATION OF A CONTROLLED DIFFERENTIAL CONTINUOUSLY VARIABLE DRIVE

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ABSTRACT

Now a day's development trends in car industry and mobile machines are driven by universal concerns on energy limitations and greenhouse gases reduction, more energy efficient and environmentally friendly vehicles will be needed. As the increasing concerns in the impact of vehicle emissions of carbon dioxides and Nitrogen oxides on the biosphere combined with today's shortage fuel, hence need to find alternate fuel solutions or develop the transmission system in such a way that lower consumption and lower emission should takes place.
Continuously variable drive is the type of automatic transmission that allows selection of infinite number of transmission ratios within the finite range i.e. between minimum and maximum value. Continuously variable drive is 34.91% more efficient than that of manual transmission. In order to achieve emission reduction and fuel economy needs to improve fuel efficiency. Continuously variable drive can be improved by coupling differential gear assembly to one of variable speed drives; we can increase the speed variation range at the expense of the horse power range. Numerous combinations of the variables are possible.

KEY WORDS- Differential gear assembly, continuously variable drive, Power, Torque, Ratio Control, Torque Control, CVD input pulley Dia.-D1 and CVD output pulley Dia.-D2

INTRODUCTION

It was reported that the 50% improvement of fuel efficiency contributes to 33% reduction of CO_2 gas. CVT allow the engine always to operate in its optimum revolutions per minute whatever the vehicle's speed, which leads to improve the fuel economy. Continuously variable transmission is 35% more efficient than that of manual transmission.

The existing inventions of CVT are based on friction type, hydrostatic type, ratcheting type which are all mechanical systems having diverse limitations, (compared to traditional transmissions).Actually CVT can be seen as an actuator applying load to the engine where as CVT is a system dedicated to converting the torque delivered by the engine to the wheels. Performance of friction type CVT depends upon way of traction forces are generated & controlled. As CVTs are not new technology, limited torque capabilities, poor reliability and the poor control schemes have inhibited their growth.

Controlled differential continuously variable drive helps to improve drive capacity, efficiency & durability. Differential gear assembly coupled to one of variable speed drives so as to improve performance of continuously variable drive. We can increase the speed variation range by compromising the horse power range.

The acting forces within the drive can be precisely calculated, assuring a sound drive design which is especially important for heavy-duty applications. This system also offers compactness, low weight and its low cost.

PROBLEM DEFINITION

After carrying out literature survey it is found that present continuously variable drive units have inherent limitations relating to speed variation range, power loss, control systems etc. The performance of continuously variable units depends upon its control systems and power split function. Now our aim is to design power split type continuously variable drive unit for better performance. So it is decided to design, development, testing of controlled differential continuously variable drive unit to improve the Speed variation range as well as performance of continuously variable drive unit.

FEATURES OF CONTROLLED DIFFERENTIAL CONTINUOUSLY VARIABLE DRIVE

- Improved speed variation range can be obtained by Controlled differential continuously variable drive.
- The developed system offers high horse Power Capacity & hence efficiency.
- High torque transmission capacity with simpler & effortless operation.
- Greater drive accuracy offers eco-friendly drive.

Experimental Set-Up

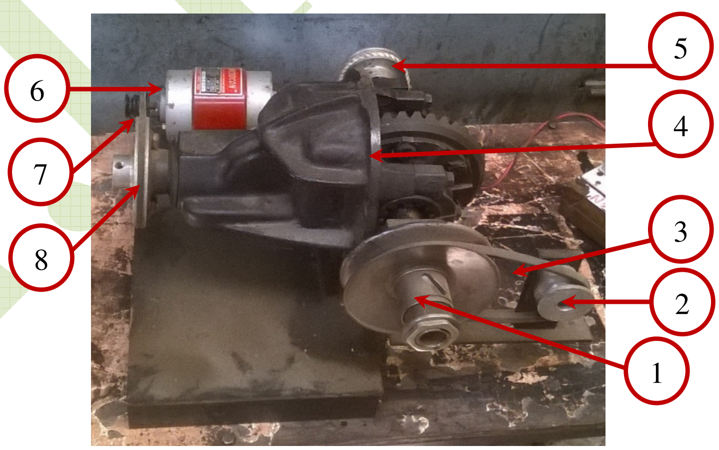

Fig.1.-Photograph of Schematic Experimental Set-Up

Table No.1. –Nomenclature for Experimental Set-Up

1	Continuously Variable Drive input pulley.	5	Brake Dynamometer and cord provided for applying load
2	Continuously Variable Drive output pulley.	6	Variable speed drives motor.
3	Continuously Variable Drive belt.	7	Belt
4	Differential gear assembly.	8	Input pulley for Differential gear assembly.

In Experimental set up as shown in figure.1. Variable speed drive motor is used to give power to the input shaft of differential gear assembly through belt and pulley drive. At the left hand side shaft of differential gear assembly brake dynamometer is provided with cord and pan for applying step wise load in the pan in order to improve speed variation range. L.H.S. and R.H.S. shaft of differential gear assembly supported in two bearing housings.

At the right hand side shaft of differential gear assembly continuously variable drive is connected as shown in fig.1. Input pulley and output pulley of continuously variable drive is connected by using belt drive. At the output pulley of continuously variable drive we can apply the stepwise load so as to measure the output torque and at the output pulley of continuously variable drive speed can be measured by using tachometer. Number of combinations of the drive systems is possible. The type of differential system depends on the combination that we developed. Such a system can be possible to develop using bevel gear or planetary gear set. Both single and double differential configurations are possible. Differential gear assembly allows the driving wheels to transmit twisting force or torque, at different turning rates in an automobile's drive-train. Thus one wheel can follow the longer curve around the outside of a turning road while the other wheel tracks the shorter inside of curve of turning road without skidding on the road surface.

Such a combination will add up the advantages of continuously variable transmission with the robustness, accuracy and high efficiency of the differential gear. Differential gear assembly coupled to one of variable speed drives so as to improve performance of continuously variable drive. We can increase the speed variation range by compromising the horse power range.

PERFORMANCE TESTING

Testing of drive has carried out by using following procedure:

1) Start motor by turning electronic speed aviator’s knob.
2) Now the mechanism should run & stabilize at certain speed (say 2750rpm)
3) Keep zero loading condition at brake dynamometer pulley for experiment 01 and full loading condition at brake dynamometer pulley for experiment 02. By selecting any of the loading condition between zero to full loading condition we can conduct following experiment. Here we are selecting zero loading condition at brake dynamometer pulley for the following experiment.
4) Select First profile Gear ratio 1:2 at Continuously Variable Drive. (i.e. Input Pulley Dia. = 120 mm and Output Pulley Dia. = 60 mm)
5) Note down the Output speed at zero loading condition by tachometer.

6) Place the pulley cord on continuously variable drive output pulley and add 02 Kg weight into the pan, note down the output speed for this load by means of tachometer.
7) Added another 02 Kg load into the pan & took the reading.
8) In this way 12 readings have taken for 24 Kg.
9) Now the readings should be tabulate in the observation table.
10) For second observation table Select Second profile Gear ratio 3:5 at Continuously Variable Drive. (i.e. Input Pulley Dia. = 100 mm and Output Pulley Dia. = 60 mm) and repeated the procedure.
11) For third observation table Select Third profile Gear ratio 3:4 at Continuously Variable Drive. (i.e. Input Pulley Dia. = 83 mm and Output Pulley Dia. = 60 mm) and repeated the procedure.
12) In this way we can select infinite gear ratios within finite range and repeat the procedure for precise change in speed ratio.
13) Finally Plotted Following performance characteristics Curves
a) Torque Vs speed characteristic.

b) Power Vs speed characteristic

c) Efficiency Vs speed characteristic.

DISCUSSION ON EXPERIMENTAL RESULTS

1) Torque Vs Speed:

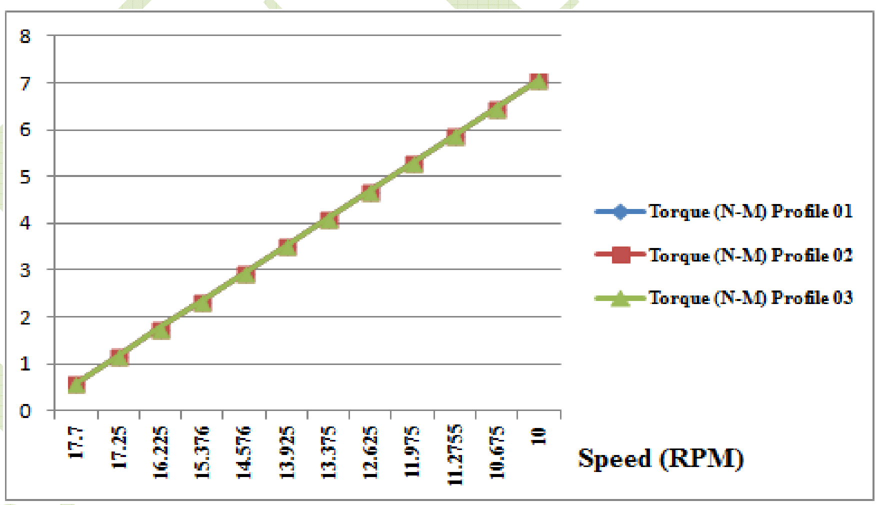

Fig.2. Graph- Torque Vs Speed (Profile-01, Profile-02 and Profile-03)

Characteristics curve Torque Vs Speed have drawn for Profile 01 (D1=120 AND D2=60), Profile 02 (D1=100 AND D2=60), and Profile 03 (D1=83 AND D2=60). From the graph it is observed that as profile changes (Gear ratio increases 1:2-3:5-3:4) speed increase for the same torque. For each profile, as torque increases, speed decreases slowly up to 7.0632 N-M torque. Above 7.0632 N-M torque, speed decreases at faster rate.

2) Power Vs Speed:

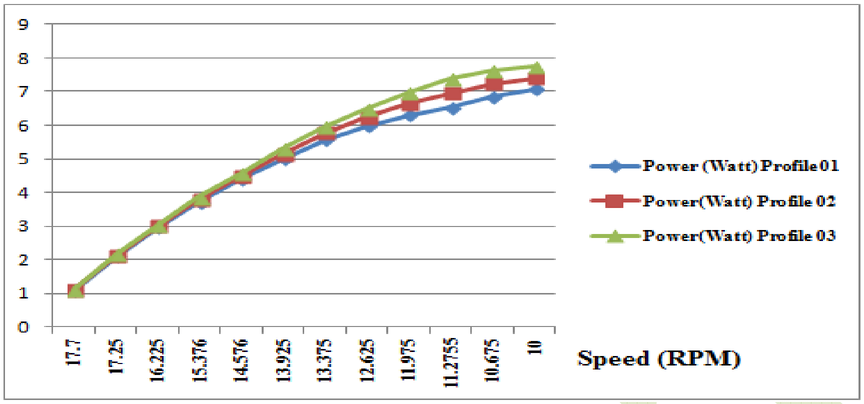

Fig.3. Graph - Power Vs Speed (Profile-01, Profile-02 and Profile-03)

Characteristics curve Power Vs Speed have drawn for Profile 01 (D1=120 AND D2=60), Profile 02 (D1=100 AND D2=60) and Profile 03 (D1=83 AND D2=60). From the graph it is observed that as profile changes (Gear ratio increases 1:2-3:5-3:4) speed increase for the same Power. For each profile, as power increases, speed decreases slowly up to 7.730413 Watt power. Above 7.730413 Watt power, speed decreases at faster rate and again speed is constant.

3) Efficiency Vs Speed:

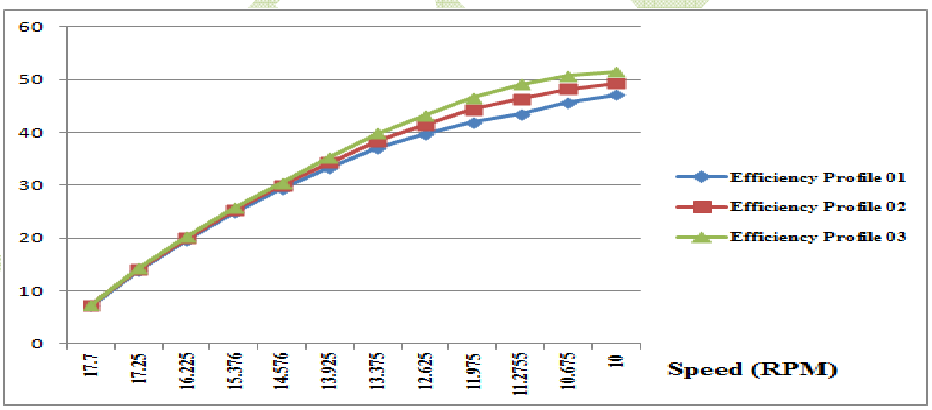

Fig.4. Graph- Efficiency Vs Speed (Profile-01, Profile-02 and Profile-03)

Characteristics curve Efficiency Vs Speed have drawn for Profile 01 (D1=120 AND D2=60); Profile 02(D1=100 AND D2=60) and Profile 03 (D1=83 AND D2=60). From the graph it is observed that as profile changes (Gear ratio increases 1:2-3:5-3:4) speed increase for the same Efficiency. For each profile, as Efficiency increases, speed decreases slowly up to 51.53609 Efficiency. Above 51.53609 Efficiency, speed decreases at faster rate and again speed is constant.

CONCLUSIONS

From the experimental setup of Controlled Differential Continuously Variable drive, the following results were obtained

- This paper describes the controlled differential continuously variable drive mainly emphasizing on improvement of performance of drive in the sense of two concepts mainly speed variation range and efficiency.
- Speed variation range for the controlled differential continuously variable drive improved considerably approximately 46 % to 50 %
- As profile changes (Gear ratio increases 1:2-3:5-3:4) speed increase for the same Efficiency.
- Torque transmitted by the drive drops with increase in speed marginally.
- Continuum ratio control and torque control concept achieved so that developed system does not act as actuator applying load to the engine.
- The developed system enables for eco- friendly drive by minimizing emission of Cox and Nox gasses.
- The acting forces within the developed system can be calculated precisely, assuring a sound drive design which is especially important for heavy duty applications. So these merits are useful in some applications such as in Automobile transmission, dehydration oven and textile spinning machinery, paper printing machines and automatic transfer lines used for industrial applications.

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