

Performance Testing of Single Plate Automatic Clutch

Nilkanth Badhe¹, S.V.Patil²P.G. Student, Dept. of Mechanical Engineering, RMD Sinhgad School of Engineering, Pune, Maharashtra, India¹Associate Professor, Dept. of Mechanical Engineering, RMD Sinhgad School of Engineering, Pune, Maharashtra, India²

ABSTRACT: Single plate automatic clutch can be used for light weight or medium weight vehicle which operates due to centrifugal force on bobweight of clutch. Performance of clutch is based on efficiency, torque variation according to load and clutching/declutching as per speed. This paper includes testing set up of single plate automatic clutch, testing method, performance representation at various speeds as per loads on clutch. Load variation is done by adding or subtracting loads on clutch with rope and pulley arrangement it causes speed variation of single plate automatic clutch. this single plate clutch is fully automatic which eliminates human efforts for gear shifting while riding, performance of such clutch help us to implement it in automobile.

KEYWORDS: Bobweight, Centrifugal force, Performance, Testing method, Efficiency, Torque

I. INTRODUCTION

Clutch is device used for torque/power transmission from engine shaft to transmission box for gear changing purpose. The foot-pedal operated clutch so widely used with the orthodox gear-boxes is dispensed with in semi-automatic and fully automatic transmission systems and in its place is used one or other of the alternative devices for disconnecting the engine drive to the transmission unit, automatically, at lower engine speeds in the idling to fast idling range. This clutch operation as ordinary friction plate clutch, with its friction and presser plates (and springs), but instead of using a foot pedal actuated mechanism to operate the clutch withdrawal gear, use is made of the force. When engine is accelerated the centrifugal force on the bob-weights slowly increases and the clutch plate at first begins to slip and then gradually to engage with the flywheel and pressure plate until at some speed, usually between 700 to 800 rpm, the clutch is fully engaged and the power is transmitted from engine to the transmission input shaft. This clutch is not only eliminating human effort for gear shifting but give smooth engagement during clutching or declutching. Due to smooth engagement, jerk, vibrations, life limitation is eliminated and transmission efficiency is high for single plate automatic clutch.

Karl Friedrich Benz is a first person who invented clutch system and use for first commercial gas powered automobile, the famous Tri-Cycle in 1885. Exedy Corporation is one of the major players for clutch technology, which has manufactured clutches under the brand name of Exedy. Daikin was reported to produce rigid type disc clutch since 1918, which was a clutch disc with the plate and sp-line hub secured by rivets until now, clutch manufactures has come out with new and efficient technologies for clutch system to compensate higher torque produced by bigger engine created especially for heavy vehicles. Samir Safarni proved that after gear shift and during the clutch re-engagement the clutch disc allows the transmission of progressive torque through its Axial Stiffness. Tripathi proved, the friction clutch must be design for minimum axial force between the pressure plate and clutch plate. he suggested that for optimum design of friction disc the ratio of inner radius to outer radius should be kept 0.577. Nitinchandra Patel stated, utilizing the centrifugal clutch enables the selection of normal torque motors for running loads rather than the selection of high torque motors for starting loads. The torque carrying capacity can be calculated at different speed which is using in transmitting power. The entire work based on conventional design with ferodo lining, driving shaft, spring, shoe, spider, cover plate, driven shaft.

The work is divided in two stages. 1) Testing set up and procedure 2) Result plotting.

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II. RELATED WORK

Testing set up is done with single plate automatic clutch. This is demo model to show the working of clutch at various loads and speeds. Performance graphs are plotted by readings and those are compared. In order to demonstrate the functionality of the clutch the test rig set up is developed where in the input shaft or driver shaft of clutch is driven by a variable speed motor of AC type, speed control achieved by means of a continuously variable rheostat. The output shaft is having a dyno brake pulley. Test rig set up has shown in fig 1. It is consist of 4500RPM capacity motor, Belt drive arrangement with pulley as shown in fig. 1. Input and output shaft is mounted with housing and ball bearings of 02 numbers. Single plate clutch assembly is transmitted torque and power from drive shaft to the driven shaft.

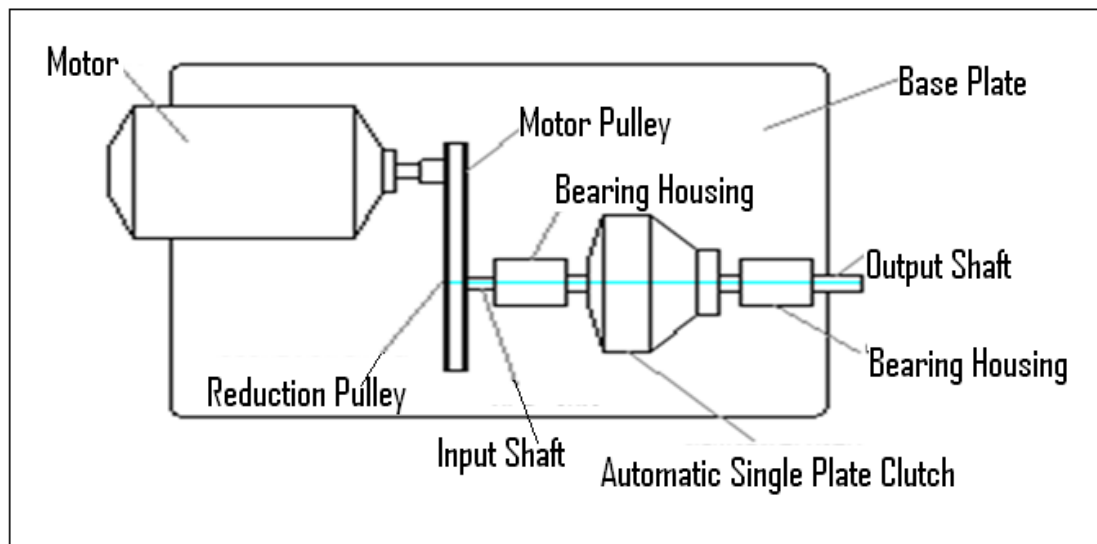


Fig. 1 Test rig for single plate automatic clutch

Several trials need to be taken for calculation of performance testing by adding or subtracting weight in pan. Pan is attached to rope and rope is wound over the dyno pulley simultaneously change in RPM is also measured with help of tachometer. Pulley diameter is 25 mm. due to load on pulley it transverse to clutch via shaft. load on clutch resist rotary motion .following procedure is used for testing,

Procedure

1. Start motor by applying electric connection.
2. Let the mechanism run and stable at a certain rpm (say 800-900 RPM).
3. Place the pulley cord on dyno pulley and put a 100 gm weight into pan then note the speed with help of tachometer.
4. Add 100gm weight to pan and note the speed, take at least 5 sets of readings.
5. Apply thruster brake
6. Take similar reading while unloading pan.
7. Plot
 - a) Brake power absorb V/s Speed
 - b) Torque V/s Speed characteristic.
 - c) Power V/s Speed characteristic.

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III. EXPERIMENTATION

Experimentation has done as per fig-1, weight is added in pan and changes in speed are noted. Same procedure is followed during subtracting weight and speed is noted. It is observed during loading the weight in pan, speed at output shaft of clutch is reduced and during unloading the weight in pan speed of output shaft is increased. When weight is low 200gm speed is noted as 1300RPM and as soon as weight is increased speed of output shaft starts decreasing, at 1000 gm of weight speed is noted as 735 RPM. Below table 1 is observed during loading and unloading,

TABLE 1 OBSERVATION OF SPEED DURING LOADING AND UNLOADING

| SR NO | LOADING | | UNLOADING | |
|-------|-------------|-----------|-------------|-----------|
| | WEIGHT (gm) | SPEED RPM | WEIGHT (gm) | SPEED RPM |
| 1 | 200 | 1300 | 200 | 800 |
| 2 | 400 | 1140 | 400 | 960 |
| 3 | 600 | 990 | 600 | 1020 |
| 4 | 800 | 860 | 800 | 1120 |
| 5 | 1000 | 735 | 1000 | 1310 |

IV. ANALYTICAL APPROACH

Efficiency of single plate automatic clutch is calculated with help of speed and torque. Input data is taken from table-1. One sample calculation is done by considering weight 0.6 Kg as per table-1,

Sample Calculation,

1 Output Torque:-

$$T_o = \text{Weight in pan} \times \text{Radius of Dynobrake Pulley}$$

$$= (0.6 \times 9.81) \times 13$$

$$= 76.51 \text{ N-mm}$$

$$T_o = 0.0765 \text{ N-m}$$

2 Input Power:-

$$P_{i/p} = \frac{2\pi NT(i/n)}{60}$$

$$= \frac{2\pi \times 990 \times 0.11}{60}$$

$$(P_{i/p}) = 10.36 \text{ Watt}$$

3 Output Power:-

$$P_{o/p} = \frac{2\pi NT(o/p)}{60}$$

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$$(P_{o/p}) = \frac{2\pi \times 990 \times 0.076}{60} = 7.87 \text{ Watt}$$

4 Efficiency:-

$$\eta = \frac{\text{Output Power}}{\text{Input Power}}$$

$$\eta = \frac{7.87}{10.36} (100)$$

$$\eta = 76.05 \%$$

Usually, the efficiency of Power Transmission through clutch always lies between 70-78 %.

V. EXPERIMENTATION RESULT

Total five readings are taken during experimentation testing. With the help of procedure for sample reading, following calculation is done for torque and power for respective speed and load. The Torque, Power and Speed for 200, 600, 800, 1000 gm load as per below table 2.

TABLE 2 SPEED VS TORQUE VS POWER AT VARIOUS SPEEDS

| SR NO | LOAD (gm) | SPEED (RPM) | TORQUE (O/P) (N-M) | POWER (O/P) (Watt) |
|-------|-----------|-------------|--------------------|--------------------|
| 1 | 200 | 1300 | 0.0255 | 3.28 |
| 2 | 400 | 1140 | 0.0510 | 5.98 |
| 3 | 600 | 990 | 0.0765 | 7.87 |
| 4 | 800 | 860 | 0.0892 | 8.4 |
| 5 | 1000 | 735 | 0.0914 | 9.2 |

It is observed that as load on clutch increases speed of clutch decreases but, torque and power gradually increases. the rate of power and torque increment is high up to 0.6 Kg load but after 0.6 Kg load rate of torque and power increment is less due to load on clutch. It means load, torque and power give us linear relation. Power 9.2 Watt is maximum at maximum load 1 Kg but speed decreases up to 735 RPM. Whereas speed is high 1300RPM when load is 0.2 Kg and power shows 3.25 watt at this speed.

Graph is plotted for Speed Vs Torque Vs Power as per fig. 2. It is clearly shown load and speed give us non linear relation. Values for torque and power are too small so it lies on X-Axis. Graph shows, initially load is very low 200 gm at that time speed is about 1300 RPM but speed decreases according to increment in load which is shown by inversely relationship. But a Torque and Power value rises because Torque and Power is proportion to applied load.

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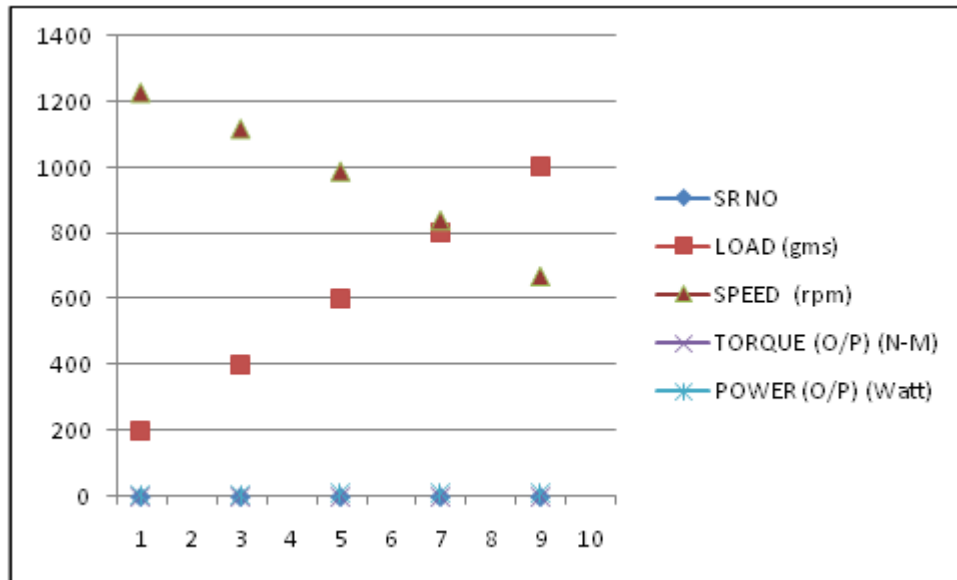


Fig. 2 Speed Vs Torque Vs Power

The above graph plays fundamental roll for performance calculation. The summary of graph is same as that of conventional clutches. But we get such characteristics by automatically operated automatic single plate clutch. The slope of graph is gradual which indicates gradual relationship and it is so sophisticated for life of clutch.

VI. CONCLUSION

We have conducted experimentation for single plate automatic clutch for performance testing. Our results meet to standard torque and power limit. We achieved efficiency of single plate automatic clutch is 76.05% which is within range of normal efficiency for clutch that is 70% to 78%. Also performance graph itself explains smooth nature between load and speed. So this clutch can be used for automobile for automatic power and torque transmission purpose. We conducted several trials and we got satisfied results for efficiency of clutch. This clutch is successfully take loads and gives power, torque output with higher efficiency.

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