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Study on Designing and Operational Analysis of Wet Clutch

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Abstract:
A wet clutch, which is an oil-lubricated friction type device, a torque transmission or torque holding device. It is commonly employed in a planetary gear-based automatic transmission system. Wet clutch is also found as a vehicle launch device. Although the wet clutch technology has been around years. In this paper an automobile clutch plate system is designed and analysis requirement of clutch high torque and high control accuracy and batter design. The paper deal with design friction clutch and analysis. The measurement result show that the torque efficiency and accuracy improve and system is working credibly and stable to improve the engagement quality of clutch plate. The purpose of a clutch is to initiate motion or increase the velocity of body generally by transferring kinetic energy from another motion body. The mass being accelerated is generally a rotating inertial body'

Keywords: Clutch plate, single clutch, Transmission system, Automobile.

1.Introduction

The clutch is a mechanical device which is used to connect or disconnect the source of power from the remaining parts of the power transmission system at the will of the operator. An automotive clutch can permit the engine to run without driving the car. This is desirable when the engine is to be started or stopped or when the gears or to be shifted. [1] With the excellent properties of speed regulation and constant for operation, permanent magnet synchronous AC servo system is very suitable for high precision control and testing of displacement and torque. [2] Clutch is one of the most important part of the automobile vehicle driveline system, which plays an important role in launch and shifting process. The torque feature is an important character which determine the performance of clutch, acquisition of the clutch torque transfer feature would be greatly helpful for automatic clutch control in automated mechanical transmission (AMT). [3] We consider in particular the automatic control of the engagement, which has to be fast enough, but also smooth, in order to avoid disturbing operator, reduce the wearing of friction plates. This smoothness can we implemented by minimizing the jerk. Second derivative of the slip: and measurement of the slip is already quite noisy, and alternative approach, which will used in the following is to maximum and minimum torque dip (torque loss) the torque of the outer shaft. Clutch is open when the initially null, increase to a maximum during engagement, due to peak of angular acceleration: it then decreases after the engagement.[4]

2. FRICTION CLUTCH

The friction clutches work on the fact that friction is caused when two rotating disk into contact with each other. On the other hand, the fluid flywheel works on the transfer of energy from one rotor to other by means of some fluid.

3. WET CLUTCH

The wet clutch plate are always wetted by oil circulation. Many types of wet clutches are used in trucks. The simplest type out of these is the spray type as shown in fig. The oil is sprayed through holes in the clutch plate by a nozzle. This type of clutch is suitable only for small trucks where sufficient torque can be obtained with a single plate unit, since the valve of friction coefficient decreases due to the presence of oil on the friction surfaces. Another type of wet clutch which is suitable for heavy-trucks is shown in fig. [5]

Fig: 1 Clutch plate

Wet clutches are used in a variety of different machines, especially to distribute torque in vehicle drive-trains, the frictional behavior of wet clutch in vehicles drive-trains are of great importance for the vehicles overall behavior and has to be thoroughly investigated when designing new wet clutch system. Depending on the wet clutch application the frictional behavior can vary greatly. Clutches in automatic transmissions normally have rather high engagement speeds and work most of the engagement time in full film lubrication see fig. 1.1 Y. Kato and T. Shibayama [6] have return a good introduction to automatic transmission.

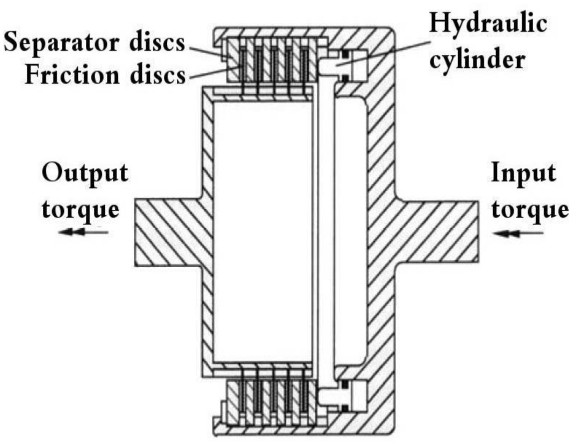


Fig: 2 Schematic wet clutch

3.1 MATERIAL SELECTION

The following materials were selected for finite element analysis:

1) Clutch plate:structural steel.
2) Pressure plate: cast iron GS-70-02
3) Diaphragm spring: spring steel.

The table 1 shows the mechanical properties of the above three selected materials.

TABLE1: The mechanical properties of the three selected materials

S. No.	Material	Poisson Ratio	Coefficient of Thermal Expansion	Elastic Modulus (Pa)	Density Kg/m^3
1.	Structural steel	0.3	1.2 x 10^{-5}/ °C	2.0 x 10^{11}	7850
2.	Cast iron GS-70-02	0.28	1.229 x 10^{-4}/ °C	1.8 x 10^{11}	7400
3.	Spring steel	0.3	3.26 x 10^{-6}/ °C	2.1 x 10^{11}	7850

3.1.2 Development of 3-D model for clutch assembly in Solid Works Software

3.1.3. Clutch Plate

It is an assembly formed from: a Plate, Friction Lining and a Splined Hub.

1) Plate: The features used in Solid Works are Extrude, Cut-Extrude, Circular Pattern and Fillets.
2) Friction lining: The features used in Solid Works are Extrude, Cut-Extrude.
3) Splined Hub: The features used in Solid Works are Extrude, Circular Pattern.

Clutch Plate Assembly: Mate feature in Solid Works was used to join the three components.

3.1.4. Pressure Plate

It is mated with friction lining and the features used in Solid Works are Assembly Mates, Loft (extending over 4 planes), Cut-Loft (extending over 3 planes) Cut-Extrude.

3.1.5. Diaphragm Spring

The features used in Solid Works are Loft (extending over 6 planes), Shell, Cut-Extrude, Circular pattern, Extrude.

The figure 1 shows the model of the clutch assembly

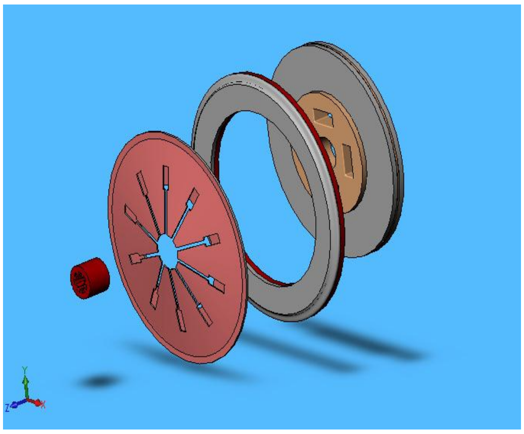


Fig: 3. The model of clutch assembly

3.1.6. CLUTCH PLATE

It is an assembly formed from: a plate, friction lining and a splined hub.

1) Plate: The features used in solid works are extrude, Cut-Extrude, Circular pattern and fillets.
2) Friction linings: The features used in solid works are Extrude, Cut-Extrude.
3) Splined Hub: The features used in solid works are extrude, Circular Pattern.

Clutch plate Assembly: Mate features in solid Works was used to join the three components.

3.1.7. Pressure Plate

It is matted with friction lining and the features used in solid works are Assembly Mates, Loft (Extending over 4 planes), Cut-Loft (Extending over 3 planes) Cut-Extrude. [7]

3.1.8. CLUTCH FETCHING

1) Presence of good binder in it.
2) Cheap and easy to Manufacture.
3) High co-efficient of friction.
4) High resistance to heat. A good clutch facing can withstand temperature are about 330°C [8]

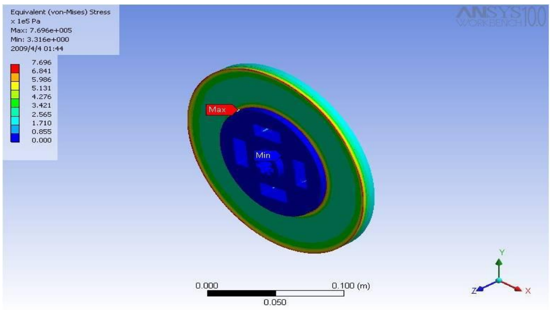


Fig: 4 The equivalent von-Mises stress plot for the pressure plate

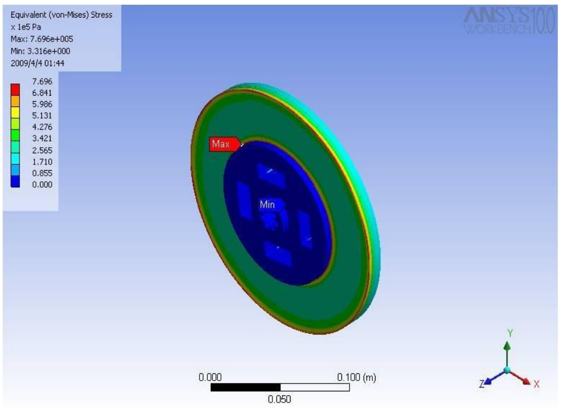
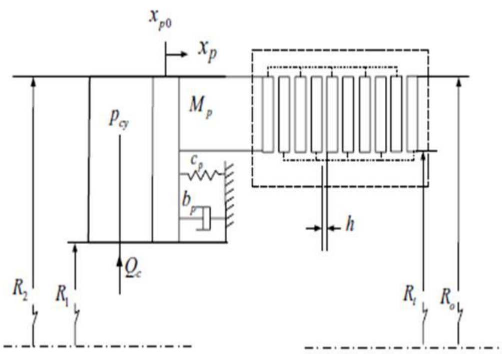


Fig: 5 The total deformation plot the pressure plate

4.DYNAMIC MODEL OF CLUTCH ACTUATOR

wet clutch engagement process can be divided into three stage the gap between the friction plates is to be eliminated. In the second stage, the oil pressure is increased gradually. In the third stage, the engagement process is finished and the pressure maintains a certain value.

Assuming that the distances between the friction plates have the same value h , The model of the clutch Piston during clutch engagement is show in fig. 4



In stage 1, while $x_p < h$, the clutch piston moves towards friction plates under the hydraulic pressure until $x_p = h$. The dynamic model of piston:

$M_p \&_p + c_p \&_p + k_p (x_p + x_{p0}) = F_p$,

where M_p is the sum of the mass of piston and drive disks, x_p is the displacement away the initial position, x_{p0} is the initial displacement compressed on return spring, c_p is the viscous friction co-efficient between the cylinder and piston, k_p is the stiffness of the clutch return spring, F_p is the force on piston the includes static pressure and dynamic pressure caused by centrifugal force.

In stage 2 and stage 3, while x_p achieves the maximum value h the gap between the friction plates is eliminated. So the clutch motion equilibrium equation in those stages is

$$k_p (x_{p0} + h) = F_p - F_{cl} ,$$

where F_{cl} is the clutch reaction force on the piston.

Ignoring oil leakage and oil temperature variation, the clutch cylinder fluid continuity equation [5] in the first stage of wet clutch engagement is

$$Q_c - A_p \&_p = \frac{A_p x_p + V_0}{\beta} \frac{dp_{cy}}{dt}$$

where Q_c is the input flow of the clutch cylinder, β is the effective volume elastic modulus of hydraulic fluid V_0 is the initial volume including clutch cylinder and oil feed lines.[9]

5. CLUTCH OPERATION

Clutch are operated mechanically through a linkage.

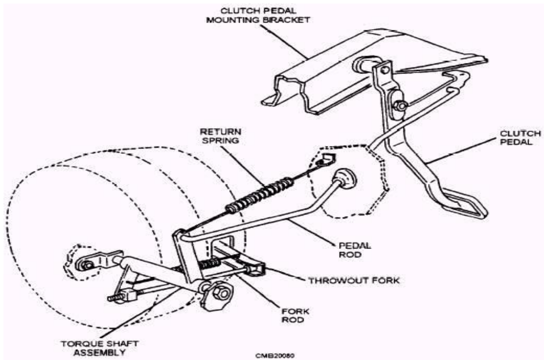


Fig: 6. clutch linkage

However, other means of operation viz., electrical hydraulic or even vacuum, have also been used. All this will be described in the following briefly.

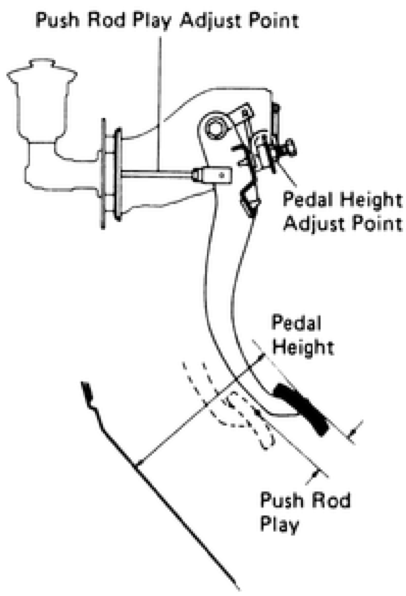


Fig: 6.1. clutch free pedal play

5.1 **MECHANICAL OPERATION**

The clutch linkage for this purpose is show in figure on pressing the clutch pedal, when the clutch pedal is pressed, the thrust bearing is not pressed immediately.[10]

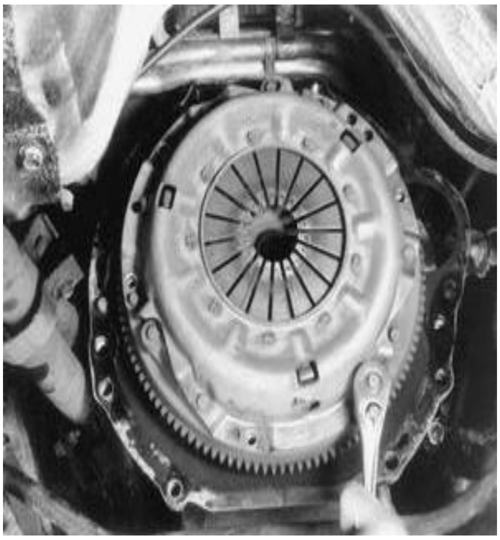


Fig.6.2 mechanical clutch

6. CLUTCH TORQUE TRANSFER FEATURE

The drive and driven plates could be simplified as to concentrated inertia, the torque equilibrium equation in both inertia.

$$T_e - T_c = I_e \acute{\omega}_e$$

$$T_c - T_l = I_v \acute{\omega}_v$$

where I_e and I_v represent inertia of clutch drive plate including engine and flywheel and the inertia of driven plate including the equivalent inertia of the whole vehicle body respectively. ω_e ω_v represent the angular velocity of drive plate and driven plate respectively. T_e , T_c and T_l represent engine output torque clutch actual torque transfer and the torque resistant simplified on clutch driven plate respectively. [10]

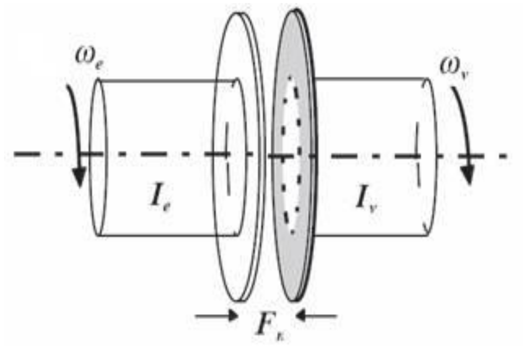


Fig: 7. Diagram of clutch sliding process

The clutch torque transfer features the relation between torque transfer by the clutch friction plates and the displacement of the clutch releasing.

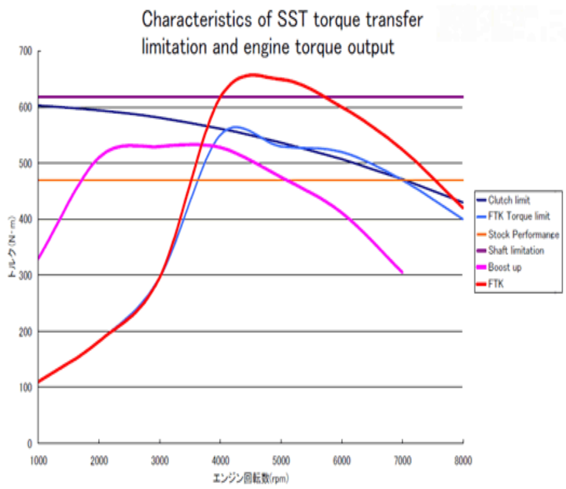


Fig: 7.1.. Clutch torque transfer characteristics

6.1 Approach

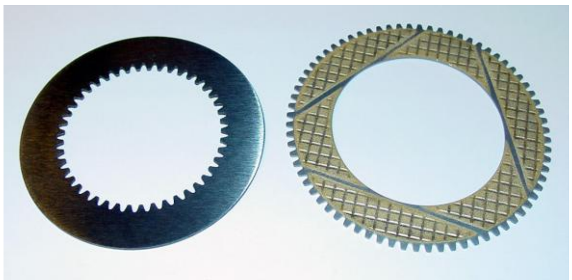


Fig: 7.2 Separator-and friction disk

where Δ ω is a difference in rotational speed between the friction disk ω_{fl} , and separator disk , ω_{sd} respectively.

Figure show resulting torque transmission obtained from a clutch engagement simulation, the respective contribution from full film , computed Reynolds equation, and asperity friction is also displaced.

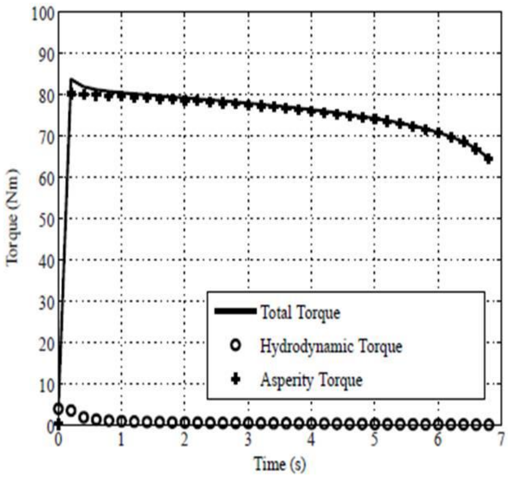


Fig: 7.3 Simulated torque response during engagement from 3000 rpm at 1.25 MPa surface pressure.

7. CONCLUSION

1. The number of disks place the most important role in that aspect and maintaining and a minimum number would help reduce drag torque considerably provide the torque carrying capacity is not compromised.

2. Clutch groove design is better.

3. The clutch plate are also cooling important.

4. Most of the clutch plate conclude surface temperature important.

5. Prediction model, design process it is defined as end of life.

6. A new clutch torque transfer based on a constant engine speed in this paper. The clutch torque transfer feature and the depends on the equipment.

Clutch torque transfer is the most important features. It is found that the temperature in the wet clutch affected friction in the interface. It is possible to accurately determine the transfer torque knowing the current operating conditions and the thermal given boundary friction model taking clutch temperature. The size of the discs can be minimized in order to maximize losses. The improvement gained by reducing the size of discs is not as much when compared to reducing the number of plates. A balance has to be found when considering the geometry of the plates.

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