A Review on Clutch used in Heavy Duty Vehicles
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Abstract—Clutch is the key element of the transmission system use in any vehicle. Its main function is to transmit torque effectively to transmission system from the engine. Apart from this, secondary objective of the clutch is to supply and disconnect power at the wheels according to will of driver. Compare to clutch used for two wheeler vehicles, construction of clutches used for heavy duty vehicle is more complex.

Key words: Heavy Duty Vehicles, Clutch system

I. INTRODUCTION
Clutch system is among the main systems inside a vehicle. Clutch is a mechanical device located between a vehicle engine and its transmission and provides mechanical coupling between the engine and transmission input shaft. Clutch system comprise of flywheel, clutch disc plate and friction material, pressure plate, clutch cover, diaphragm spring, lever and the linkage necessary to operate the clutch.

II. MECHANICAL MODEL
Two inertia’s I1 and I2 and traveling at the respective angular velocities ω1 and ω2, and one of which may be zero, are to be brought to the same speed by engaging. Slippage occurs because the two elements are running at different speeds and energy is dissipated during actuation, resulting in temperature rise.

A. Based On Contact
1) Positive contact clutch
2) Friction clutch
Positive contact clutch transmit power from the driving shaft to the driven shaft by means of jaws or teeth, whereas friction clutches works on the principle of friction caused between the two rotating members viz. discs, plates or cones. Compared to positive contact clutches, friction clutches can be used for high speed engagement applications.

The aim of friction clutches is to attach a moving member to another that is moving different speed or stationary, typically to synchronize the speeds, or to transmit power. As friction clutches slip relative to each other, there is very little shock during engagement. Friction clutches are further classified as dry and wet sort friction clutches. Most of the vehicles rely on dry sort clutch instead of wet sort clutch as wet clutch has lower coefficient of friction. Thus, different clutches are elite for use on the premise of speed, material and torque of the rotating members [6].

B. Based On Application of Force
1) Push Type Clutch
In a push type clutch, release bearing is pressed and disengagement is taken place so it’s called push type clutch, in this clutch fulcrum is inside of the pressure plate contact.
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2) Pull Type Clutch
In this type of clutch, release bearing is pulled and as a result of it disengagement of clutch is taken place and that’s why it is called pull type clutch. Here, fulcrum is outside of the pressure plate contact.

C. Based On No of Friction Plate
1) Single plate clutch
2) Multi-plate clutch
In a single plate clutch, there are only two friction discs that transmit power. However, for many high-performance vehicle applications, the high torque at the engine could lead to the clutch plate slipping and turning on its own, without transmitting power to the transmission, because of the friction coefficient being too small for any one plate.

A multiple-plate clutch is used in such situations, because it essentially functions as one much larger plate would, or as a similar sized plate with a much higher friction coefficient. The pressure plate used in the multiple plate clutch generally compresses multiple steel discs that separate every set of two friction discs. Here's another simple video of a multiple disc clutch. The same principle of a multiple disc clutch applies to a dual disc clutch [4].

D. Based On Use of Oil
1) dry clutch
2) wet clutch
A wet clutch is immersed in a cooling lubricating fluid that also keeps surfaces clean and provides smoother performance and longer life. Wet clutches, however, tend to lose some energy to the liquid. Since the surfaces of a wet clutch can be slippery (as with a motorcycle clutch bathed in engine oil), stacking multiple clutch discs can compensate for the lower coefficient of friction and so eliminate slippage under power when fully engaged.

The Hele-Shaw clutch was a wet clutch that relied entirely on viscous effects, rather than on friction. A dry clutch, as the name implies, is not bathed in liquid and uses friction to engage [4].

E. Other Types of Clutch
1) Centrifugal Clutch
A centrifugal clutch is used in some vehicles (e.g., mopeds) and also in other applications where the speed of the engine defines the state of the clutch. This clutch system employs centrifugal force to automatically engage the clutch when the engine rpm rises above a threshold and to automatically disengage the clutch when the engine rpm falls low enough. The system involves a clutch shoe or shoes attached to the driven shaft, rotating inside a clutch bell attached to the output shaft. The shoe(s) are held inwards by springs until centrifugal force overcomes the spring tension and the shoe(s) make contact with the bell, driving the output [4].

IV. TYPES OF THEORY USED FOR CLUTCH PLATE
1) Uniform wear
2) Uniform pressure

Reasons behind its classification:-
A. Uniform Wear
When the pressure plate is old or wear out, pressure is changed as the plate get wear out. So the pressure don’t remain uniform because of the axial wear.

B. Uniform Pressure
When the clutch plate is new because of axial thrust applied by the group of spring pressure remains constant so at that time constant pressure theory is applied [4].

V. SPEED CHANGING DURING ENGAGEMENT AND DISENGAGEMENT PHASE
During engaging the clutch slips, i.e. both parts of the clutch rotate at different speeds with normal force and transmitted torque. During the start-up process as illustrated in Figure, the clutch slips in the “engagement phase”. The clutch transmits torque from the engine to the transmission and thus to the wheels. The vehicle is accelerated and the transmission input speed increases while the engine speed is reduced – assumed the driver does not increase the accelerator.

Fig. 3: Push Type Clutch [2]

Fig. 4: Pull Type Clutch [2]

Fig. 5: Speed Changes During Operation [1]

As soon as transmission input speed and engine speed are identical, the state of the clutch changes from friction to adhesion and the engaging process is completed.

During the engagement phase, friction power loss occurs in the clutch in the form of heat input to the clutch lining. Thus, the clutch heats up considerably. The heating depends on transmitted torque, vehicle mass and starting
gear ratio. For this reason, not all heavy and powerful vehicles can be equipped with dry friction clutches. Wet shift elements or so-called hydrodynamic torque converter are therefore used [1].

VI. TERMINOLOGY USED FOR PERFORMANCE ANALYSIS

A. Clamp Load
Load applied by pressure plate through the group of spring for the engagement of clutch.

B. Release Load
Pressure applied by bearings on diaphragm to disengage the clutch.

C. Pressure Plate Travel (Lift)
At the time of disengagement, travelling of pressure plate.

D. Release Travel
Distance travelled by release bearing at the time of disengagement.

E. Lever Ratio
Clamp load/release load = release travel/lift.

![Fig. 6: Basic Terminology [2]](image)

VII. CONCLUSION

Roll of the clutch is deeply explained. Basic criteria which must be decided before selecting the clutch is described. Clutch is classified well according to different attributes of it. Along with that, how the speed changes during engagement and disengagement of the clutch is described in detail. Certain basic terms which must be known to decide and calculate the design of clutch is explained well over here.

REFERENCES