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Design and Analysis of Multi-Plate Clutch Unit

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ABSTRACT:

The clutch is a mechanical device that provides for the transfer of energy (and therefore usually movement) of a component (a member of the address) to another (driven). The other component of brake clutch. Multiple disc clutch can be used when a large torque is moving. It is installed inside the unit to the driven shaft to permit axial movement. And the complexity of the disks and external screws are attached to the housing, which is linked to the drive shaft. Using multiple disc clutches widely in cars cars, motorcycles, machine tools, etc., have not usually from the inside they are usually made of stainless steel and bronze external hard drives. The materials used for coating the friction surfaces are made of cork, rubber, cast iron and metal powder. The project objective is to design a multi-plate clutch using empirical formulas. And drafting and 2D drawing plate clutch multiple accounts and a 3D model is created in 3D modeling software Pro / Engineer. We are carrying out structural design analysis of the above to validate the design. We are in the analysis by changing the surfaces of friction materials. When removing the result we will see which is the best material for covering the roofs of friction. And structural analysis plate multi-use properties of the two materials clutch. The materials used for the coating is Cork, powder metallurgy. And compared to the over all materials check out the best materials for the health of the lining of the multi-plate clutch plate in different circumstances coefficient of friction.

INTRODUCTION:

Clutch is a mechanism for transmitting rotation, which can be engaged and disengaged. Clutches are useful in devices that have two rotating shafts. In these devices, one shaft is typically driven by a motor or pulley, and the other shaft drives another device. Let us take an instance where one shaft is driven by a motor and the other drives a drill chuck.

The clutch connects the two shafts so that they can either be locked together and spin at the same speed (engaged), or be decoupled and spin at different speeds (disengaged). Depending on the orientation, speeds, material, torque produced and finally the use of the whole device, different kinds of clutches are used. The clutch in itself is a mechanism, which employs different configurations and different principles in various models available. In the following lines, we have provided the different kinds of clutches that are available.

Different Kinds Of Clutch

Friction Clutch

Friction clutches are the most commonly used clutch mechanisms. They are used to transmit torque by using the surface friction between two faces of the clutch.

Dog Clutch

A dog clutch couples two rotating shafts or other rotating components not by friction, but by interference. Both the parts of the clutch are designed so that one pushes into the other, causing both to rotate at the same speed, so that they never slip.

Cone Cutch

Cone clutches are nothing, but frictional clutches with conical surfaces. The area of contact differs from normal frictional surfaces. The conical surface provides a taper, which means that while a given amount of actuating force brings the surfaces of the clutch into contact really slowly, the pressure on the mating surfaces increases rapidly.

Overrunning Clutch:Also known as the freewheel mechanisms, this type of clutch disengage the driveshaft from the driven shaft, when the driven shaft rotates faster than the driveshaft. An example of such a situation can be when a cyclist stops peddling and cruises. However, in case of automobiles going down the hill, you cannot take your feet off the gas pedal, as there is no free wheel system. If you do so, the whole engine system can be damaged.

Safety Clutch:Also known as the torque limiter, this device allows a rotating shaft to "slip" or disengage when higher than normal resistance is encountered on a machine. An example of a safety clutch is the one mounted on the driving shaft of a large grass mower. If a stone or something else is encountered by the grass mower, it stops immediately and does not hamper the blades.

Centrifugal clutch Centrifugal and semi-centrifugal clutches are employed where they need to engage only at some specific speeds. There is a rotating member on the driving shaft, which rises up as the speed of the shaft increases and engages the clutch, which then drives the driven shaft.

Hydraulic Clutch

In a hydraulic clutch system, the coupling is hydrodynamic and the shafts are not actually in contact. They work as an alternative to mechanical clutches. They are known to have common problems associated with hydraulic couplings, and are a bit unsteady in transmitting torque.

Electromagnetic Clutch

These clutches engage the theory of magnetism on to the clutch mechanisms. The ends of the driven and driving pieces are kept separate and they act as the pole pieces of a magnet. When a DC current is passed through the clutch system, the electromagnet activates and the clutch is engaged.

2. **Plate friction material**

Different special friction materials are availablefor wet and dry running clutches and brakes. Thefriction material used represents the mostimportant part of each friction combination,which effectively consist of, in addition, thecounter frictional surface and, in the case ofwet-running, the oil. The friction combinationinfluences the behavior of the clutch or brakewhen being engaged and disengaged, thepermissible thermal loading, the behavior interms of wear and thereby the required size of theclutch or brake. Only when these importantproperties are known can the optimum frictioncombination for a given application be selectedin order to give the desired behavior and service life. In order to provide understanding of theapplication selection of friction combinations,the following sections will describe thecharacteristic properties and main areas of use ofour different standard friction combinations,namely steel/steel, steel/sintered lining and steelor cast iron/organic friction lining, all of which have proved themselves in use over manyyears.Should you have special requirements withregard to the dynamic torque, the static torque orthe lubricant to be used, please contact us. Forsuch cases, special friction materials such as platescoated with molybdenum are available.

Frictional behavior

The changes in the coefficient of friction duringthe course of an engagement (or disengagement)process together with the static coefficient offriction μ0, when torque is being transmitted,depend on a number of factors: . Combination of materials at the friction surfaces .Design of friction surfaces, e.g. with grooves orchannels .Surface structure, e.g. sliding finish .Friction surface pressure .Sliding speed .Temperature level and maximum temperature atfriction surface .Dry- or wet-running, e.g. lubrication behavior,direction of cooling oil.

3.LITERATURE REVIEW:

The Friction plate used in this Project is part of a Wet Multi-Plate clutch System which is normally used in commercial Motor vehicles. The clutch Friction plate is located between the Clutch Center and the Pressure plate. The clutch cushioning spring is a plate where is acts to absorb the vibration effect during clutch engagement as well as linking the clutch counter mate disc and the clutch disc base together.

Gorin and Shilyaev (1976)[1] studied the analytical solutions between two rotating annular disks having small gaps. Since the analytical solutions were derived from the Navier-Stokes equations using an integral approach, i.e. the Slezkin-Targ method, the inertial terms were not considered. The study was limited to laminar flow between a rotating and a stationary disk, and computed exactly the radial, axial and tangential velocity components.

Li and Tao[2] (1994) compared three types of outflow boundary conditions for recirculating flows with experiment data for convective heat transfer of a two-dimensional jet impinging on a rectangular cavity. They tried a local mass conservation method, a local one-way method and a fully-developed flow assumption. They concluded that, if possible, the area of the outflow boundary should be located far enough from the re circulating area in order to obtain a realistic numerical solution and avoid significant errors. Of the three methods that Li and Tao studied, the mass conservation method for the outflow boundary model having are circulating flow at the boundaries had the best agreement with the experimental data. Natsumeda and Miyoshi[3] (1994) developed a numerical solution for the clutch 15 engagement process including the permeability of the friction plate, the compressive strain and the asperity contact of the friction material. In addition, they solved the equations of heat conduction to model the heat generated by the asperity contact. Furthermore, the conducted experiments with multi-friction plates to measure the torque and temperature variation in the system. They found that during engagement the temperature at the centerline of the separator plates begins to rise from its initial state. Also, it was observed that during the engagement process the temperature at the end of clutch pack was much lower than that between the friction plates although the temperature at the both locations was almost identical prior to engagement. Since the friction material insulates the separator area surrounded by the friction plates, it achieves a higher temperature than that of the separator area, whose one side is in contact with the piston Berger et al.[4] (1996) developed a Finite-Element Model (FEM) model to simultate the engagement of rough, grooved, paper-based permeable wet clutches. A modified 16 Reynolds equation was adopted from the Patir and Cheng flow model using average flow factors to include surface roughness effects. The Reynolds equation and force balance equations were discretized using the Galerkin approach. The simulation results indicate that increasing the applied force increases the torque peak and decreases the engagement time. Furthermore, the permeability of the friction material affects the magnitude of the increase in torque peak and the corresponding decrease in engagement time. The FEM model radial grooves on the friction material and the computational results showed that an increase in groove width results in a decrease of the torque peak while groove depth only slightly affects the torque. Furthermore, the film thickness decay was shown to be related to increasing the torque peak. However, no comparison between the simulation and available experimental measurements were made. • In 1997, to obtain a more efficient solution to the problem, the modified Reynolds equation of Berger et al.[5] (1997) was simplified assuming axisymmetric flow, and neglecting the compressive strain of the friction material. The system of Reynolds and force balance equations was reduced to a single, first-order differential equation that resulted in a fast executing model. • Yuan et al. [6](2007) proposed an improved hydrodynamic model for open, wet-clutch behavior. This theoretical model includes not only the effects of trapped air bubbles, but also surface tension and wall adhesion. The surface tension between fluid and air at outer interface is assumed and the relation between the surface tension and the pressure jump is formulated. With the formulation, an equivalent radius assumption was made. The drag torque for the equivalent radius was validated with experiment results and the computed drag torque from this model was proven to be more accurate than previous models at high rpm. The analytical solution of Yan et al. agreed well with the experimental results, however the need for adjustment of the oil viscosity was rather problematic. Also, since the model corresponded to a non-grooved open wet clutch, there were limitations to any potential applications to a realistic wet clutch having a grooved friction plate and undergoing dynamic engagement.

CONCLUSION

In this project the clutch plate has been designed by using cad tool creo-2 and then importing into cae tool (Ansys Work Bench) and the clutch plate made up of steel and bronze materials and cork as a friction material in between For cork material we applied 0.25Mpa pressure on that and calculated results like deformation, stress and safety factor From the above results we identified one problem with existing material while increasing coefficient of friction the stress value also increased and to avoid this and we chosen copper powder metal and analyzed with same boundary conditions. The changing materials having less stress values compare to existing material and have good safety factor values. Finally the cu powder metal have less deformation and stress values and high safety factor and stiffness compare to cork results.

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