A Review Study of Thermal Analysis of 1618 Clutch Plate

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Abstract— An accurate estimation of temperature distribution is considered necessary to avoid the premature failure of friction clutches. In this work, different approaches were used to compute the surface temperatures of the friction clutch disc. The results presented the maximum surface temperature when the contact occurs between the rubbing surfaces during a single engagement and repeated engagements. Two approaches were used to simulate the thermal models of the automotive clutches to obtain the temperature field are heat partitioning approach and total heat generated approach. The analysis was conducted using developed axisymmetric finite element models to study the thermal behavior of the friction clutches during multi-engagements. The comparison was made between the temperature distributions based on the proposed approaches to show the accuracy of each approach. It was found that the heat partitioning approach was not accurate to investigate the thermal problem of the friction clutch during the multi-engagements.

Keywords: 1618 Clutch Plate

I. INTRODUCTION

Friction clutches are repeatedly subjected to a considerable amount of frictional heat generation on the contact surfaces. This kind of heat generation happened due to the existing slipping between contacting parts of the friction clutch (in a single-disc clutch e.g. pressure plate, clutch disc and flywheel). High surface temperatures appeared as a result of the frictional heat generated when the friction clutch started to work. In some case the maximum temperatures exceed the allowable working temperature; consequently, many drawbacks appear on the surfaces of contacting parts such as plastic deformations, fast wear and surface cracks. When the friction clutch works under these circumstances, the early failure may occur in the contacting area of friction clutch elements.

Friction clutches and brakes are considered to be the most common type used in automotive application. Two or more surfaces are pressed together by a normal force to create a friction torque. The friction surfaces could be flat and perpendicular to the axis of rotation. Figure 1 shows the main parts of typical single-disc clutch system during engagement and disengagement operations. The requirement for an accurate estimation of the surface temperature of the friction clutch increases for different applications in the mechanical engineering field to avoid the early failure or damage in the contact surfaces.

II. LITERATURE REVIEW

In this section research papers are discussed related to the present work. Published papers are highlight in this section.

A. Oday I. Abdullah

Presented work on the In order to evaluate the temperature distribution of the friction clutches during the heating period, it should be to minimize the existing error in the calculations process. The applied hypotheses to build the mathematical model have to be valid and realistic. The transient thermal problem of the friction clutch (single plate) during multi engagements has been solved using the heat partitioning and the total heat generated approaches. Axisymmetric finite element models were enhanced to find the numerical solution of the thermal problem of the friction clutches under operational conditions. The results show that the difference in the results of temperatures which obtained from both approaches was increased with a number of engagements due to the error exciting in the heat partitioning approach. The reason of this error is the heat partitioning approach didn't take the effect of the thermal capacity of the clutch parts in the calculation, and it's found the temperature field of each part of clutch separately, while the second approach (total heat generated approach) finds the temperature field for all systems in the same model. Therefore, it's recommended to use the total heat generated approach to evaluating the thermal behavior of the friction clutches during the sliding period (especially for multi engagements).

B. M.H. Faidh-Allah

In this research paper, a finite element model was developed to study and analyze the thermal problem of the friction clutch disc throughout six successive engagements assuming a uniform wear between the contact surfaces. The friction clutch disc was simulated numerically using a three-dimensional finite element model. The complete thermal behaviour during the six successive engagements were recorded and analyzed. The essential point was that the maximum surface temperature is function of the number of the successive engagements, where the surface temperature grown very fast during engagements. Therefore, in the design of friction clutch it should take into consideration the maximum number of successive engagements under the specific condition and what is the maximum surface temperatures expected during these engagements. Under the heavy duty conditions, the maximum surface temperature expected should be lower than the allowable working temperature of the selected friction material, and the difference between them will depend on the chosen safety factor of the design operation.

Also, it was found that the critical time for the friction clutch system occurred at the mid time of the sliding period for all successive engagements, where the maximum temperature appeared in the contact surface at this moment.

C. HU Dong-fang

According to analysis the pressure plate of tractor clutch, some results are obtained. The peak temperature is 65.19 and the temperature distribution is uneven. Temperature at outer diameter is higher than inner diameter. Stress peak lags behind the temperature peak and occurs near the mounting holes. The peak stress is up to 111.8 Mpa. The displacement deformation is 0.03022 mm.. Phenomena of stress concen tration and warping deformation are obviously. The structure

of the pressure plate has been changed. The original level on the surface is changed to a slope shape, and the original friction surface taper is increased by 1 degree. After the adjustment, the wear loss of side A and B of friction plate has decreased by 2.9% and 2.38%, and the wear loss of pressure plate has decreased by 14.29%. The overall performance of the pressure plate has been improved, which improve the service life of the clutch assembly.

D. Udit Singhal

After completion of stress and thermal analysis in ANSYS 16.0, it can be clearly seen that the values of equivalent stresses for material loading conditions are less than the allowable stresses for the designs under study. Under these loading conditions, none of the parts is going to yield and hence, the design is safe. While the factors of safety for the three design variants do not vary much, the highest factor of safety is of 3rd design variant. And as for maximum temperature reached, it is found to be minimum for 2nd design variant while the 1st design is having very high maximum temperature than the other two designs. The results occurred are quite favourable to what were expected. The stress, deformation and temperature clear the idea about what parameter should have been taken into account while defining the single plate friction clutch.

E. G. Shanthi

Structural analysis and Thermal analysis is done on the friction plates to verify the strength& temperature distribution of different Friction materials used are Cork , Copper,SF001 ,SFBU and CFRP Powder Metal. Material used for inner disc is steel and outer disc is bronze. By observing the analysis results, design is safe. Total Deformation and stress values are less using SFBU powder Metal than using cork, copper and SF001.Hence we conclude that for multi plate clutches using SFBU powder metal as friction material Strength is Improved, Deformation is reduced and temperature distribution and heat flux also improved and Material Life of the Clutch is improved.

III. Conclusion

The defect mode that occurs in most of the complained parts collected from the field under warranty is due to thermal effects. When the temperature of the friction surface increases to a critical value, it may make cracks on the pressure plates surfaces. Casting parts are more sensitive against to crack on surface or internal structure. Because crack on the casting can be enlarged by subsequent thermal effects, bringing the casting to a level where it could burst under the vehicle rpm

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