IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 09-13

A review on various Factors affecting Temperature Variation in Dry Friction Clutch

Sushant S Jadhav, Suhas S Jadhav , A Karve, P Prem
(Department of Mechanical Engineering, Modern Education Society's College of Engineering, Pune, India)

Abstract: *It is necessary to consider the temperature distribution in friction clutches to avoid its premature failure. In this work, review of different research papers is conducted, and the results of these papers are shown in the form of graphs. In this work temperature variation w.r.t radius, that is from inner radius of friction lining to outer radius , temperature distribution along the axis of clutch system, i.e. at pressure plate, clutch disc, flywheel. The variation of temperature for successive engagements along the radius and along the axis of clutch system is calculated and plotted in the form of graph. Here, two methods are introduced to determine the temperature distribution at friction surfaces due to rubbing. For analysis, Finite Element Method is used and further graphs were plotted and conclusion was deduced.*
Keywords - *Clutch, Premature Failure, Successive engagement*

I. Introduction

The device used in transmission system to engage and disengage the vehicle from the engine is known as clutch. Therefore, the location of clutch is between the transmission system and clutch. The clutch is usually in engaged position for all vehicles. The clutch is disengaged when shifting gears, when starting the engine, when idling the engine and when stopping vehicle. The disengagement operation takes place by operating the pedal of clutch i.e. by pressing the vehicle's pedal towards the floor. The clutch is usually engaged when there is need to move the vehicle and remains in the engaged position when vehicle is moving. When properly operated clutch also takes the load which are applied gradually in order to prevent the jerky motion of the vehicle and avoid putting undue strain on the remaining parts of the power transmission.
It contains parts such as,

1. Clutch Disc
2. Flywheel
3. Pressure Plate
4. Diaphragm Springs

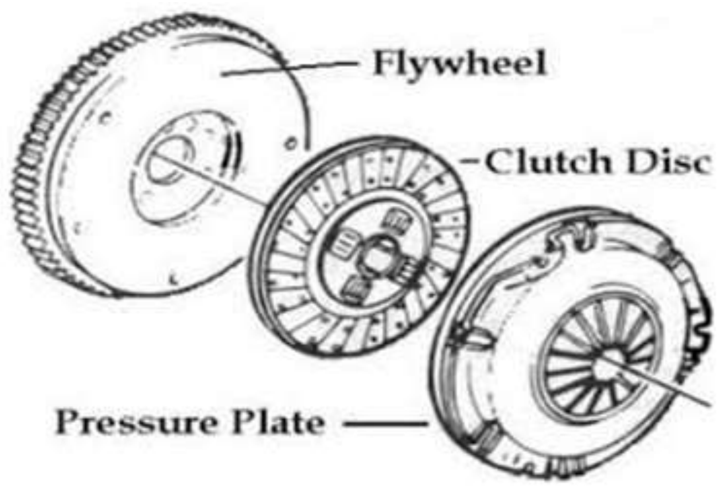


Fig-1: Clutch Components

During continuous engagement and disengagement of clutch disc from flywheel heat generation takes place at the contact of clutch plate and flywheel because of presence of friction between them. This generation of heat will lead to wear of friction lining of clutch plate. So it becomes important to understand how much heat generation takes place during successive engagement.

II. Literature Review

O.I. Abdullah a, J. Schlattmann's [1] studied use of finite element method to investigate the effect of thermal load on the temperature field of a clutch system. The software ANSYS 13 was used to carry out analysis. The analysis was carried out for two types of loads 'A' (uniform pressure) and 'B'(uniform wear). The process involves repeated engagements at regular intervals. The experiment was carried out for 10 engagements for a time period of 5 seconds. The results were obtained for maximum temperature distribution which are, for maximum temperatures at the inner and outer surfaces it was found that the difference between them does not exceed 1%. The study of temperature distribution of the clutch system for both the cases showed that the maximum temperature occurred in case A during all the engagements under the same conditions. The maximum temperatures were located near the outer radius in case of type load 'A' while it is uniformly distributing in case of type load 'B'. The temperature at pressure plate interface was to be greater than that of at the flywheel interface because of low thermal capacity of pressure plate. It was also observed that temperatures for type load A were greater than type load B for all intervals. The temperature distribution for both the cases was approximately equal at the mean radius even at different times. The value of temperature at the outer radius as well as the radius of disc at the contact region between flywheel and clutch plate for type load A was greater than type load B.

Fig -2. The contact model for clutch system (Uniform pressure)

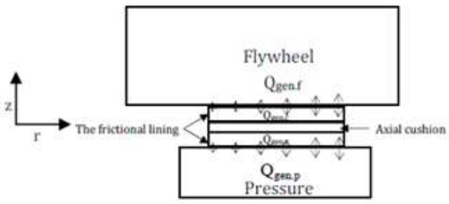
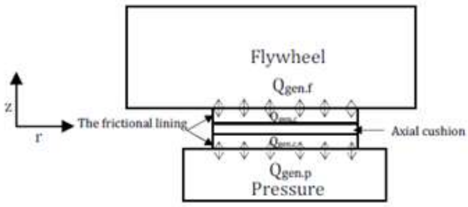
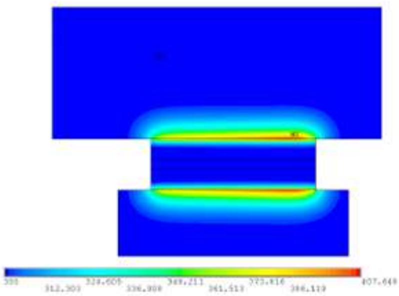
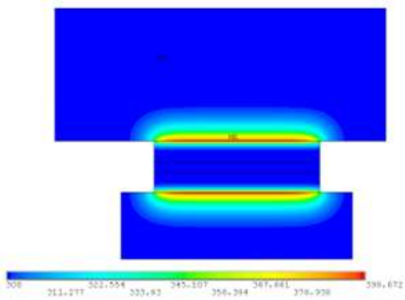


Fig-3. The contact model for clutch system (Uniform wear)

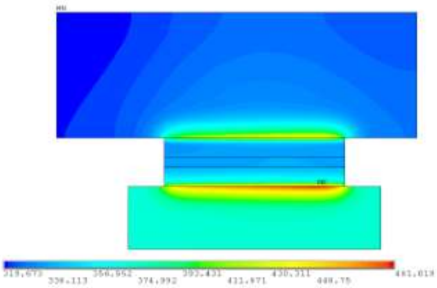




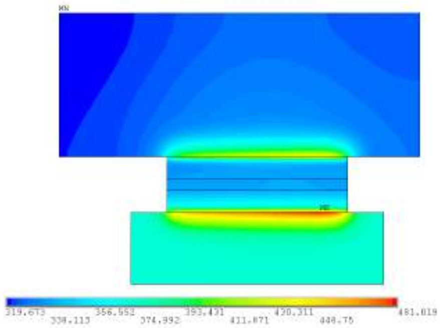
n=1 (t=0.2sec)/load type A



n=1(t=0.2sec)/load type B.



n=6 (t=27.2sec)/load type A



n=6 (t=27.2sec)/load type B

Fig 4:. Distribution of Temperature at the friction clutch elements for different number of engagements

O I. Abdullaha,, J Schlattmanna, M H. Majeedc, L A. Sabrid [2] studied two methods to determine the temperature distribution on friction surfaces due to rubbing .In the first method heat partition theory was used in which the heat generated due to slippage between the surfaces gets dissipated to the plate depending upon the material properties of the plate that are in contact. This method does not consider the material of pressure plate and flywheel for heat dissipation. A finite element model was created using heat partition theory with two asymmetrical plates that were engaged and disengaged multiple times for a certain interval of time and the heat generated during contact for successive engagement. Graphs were plotted to determine the maximum temperature for particular engagement. The graphs were plotted for ten successive engagements. In second method total heat generation approach was used in which heat generated due to contact between plates gets dissipated via plates and through pressure plate and flywheel. This method considers the material of clutch plate and pressure plate. Similar to first method a finite element model of clutch was created and was simulated for ten successive engagements and accordingly graphs were plotted for each engagement indicating the maximum temperature during engagement. Both the FEA models were created assuming uniform wear theory.

The temperature obtained during first engagement by both methods were approximately same but as the no. of engagement increased the maximum temperature obtained by both methods during engagement started to vary with a certain value. The results from the successive engagement shows that the variation in results of temperatures obtained from both partitioning approach and total heat generated approach continuously increased i.e error increased with increase in number of engagement. The cause of the error is that in heat partitioning approach, thermal capacity of clutch parts are not taken in consideration and finds temperature of each part separately. So the accurate results are given by total heat generated approach and it is more reliable.

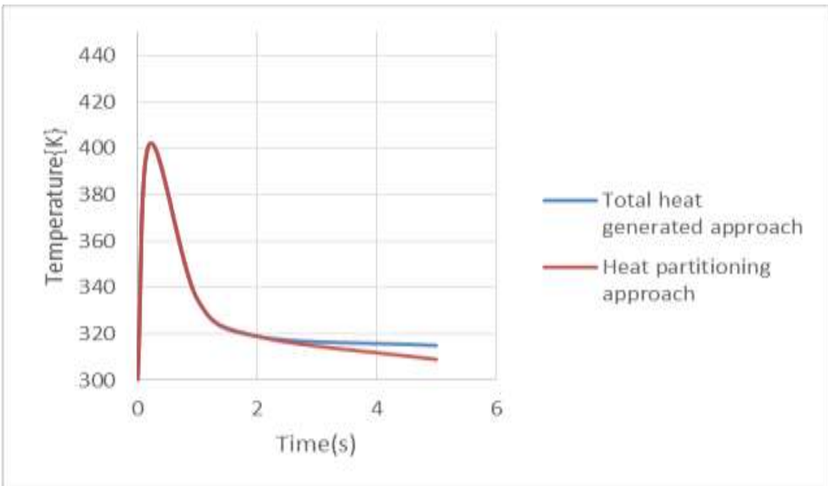


Fig 5: Temperature variation for 1st engagement

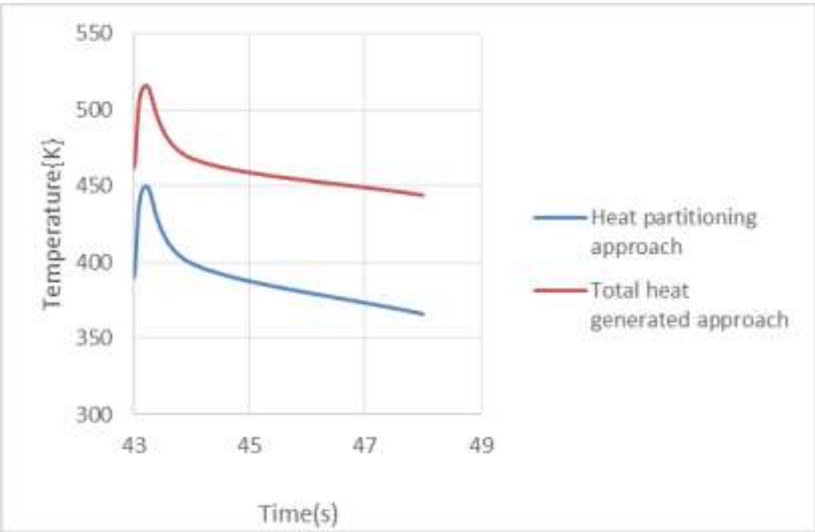


Fig 6: Temperature variation for 10th engagement

O.I. Abdullah, J. Schlattmann , A.M. Al- Shabibi developed numerical model which was simulated using a finite element method to investigate the effect of various boundary conditions on the thermo-elastic behavior of clutch system [3]. The simulations consist of two models; the first one is the elastic contact model which was used to calculate the pressure variation between contact surfaces. The 2nd model is the heat conduction model used to calculate the temperature field or temperature variation during the slipping period. Four different cases of boundary conditions were taken into consideration in this work; The contact pressure distribution on the surfaces in contact of both sides of clutch disc i.e flywheel and pressure plate sides at selected time intervals was calculated through graphs through graphs. From the results it can be seen that the maximum value of the contact pressure increases with time but on the other side the contact area decreases with time. The pressure distribution on friction surfaces goes through changes due to thermal deformations which is known as thermoelastic transition. In the similar way as that of pressure, temperature varies on clutch disc surface along the radius. The temperature is maximum when the radial distance is approximately at the midway of radius and the graph of same is shown in following figure 7.

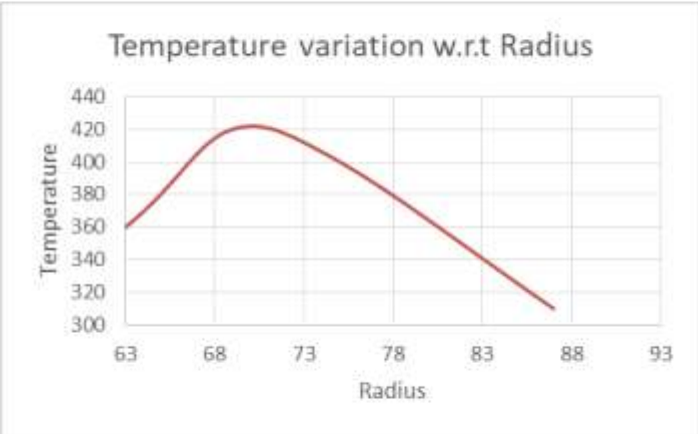


Fig 7: Temperature variation wrt radius

M.H. Faidh-Allah [4] studied a number of computerized runs to check the effect of the successive engagements on dry friction clutches regarding thermal behavior. A 3D model of friction surface was built based on FEM technique to analyze the temperature effect. During the analysis the pressure was considered uniform over the area of plate at any instant for successive engagements. Results obtained were plotted in the form of graph accordingly. From number of graphs it was observed that the variation of temperature was uniform over the surface at any time during engagement, the maximum surface temperature occurred at the middle thickness of sliding time. Also the temperature at inner and outer radius are approximately same and there is no effect of thermal properties on the mid thickness of clutch disc until 4th engagement.

The maximum temperature's variation on a friction clutch disc through the six engagement cycles at different levels in engagements also showed that for all the engagements the values of temperature decreased rapidly when moved away from the surface in the direction of the depth of the friction material and the maximum temperature reached for each engagement continuously increased.

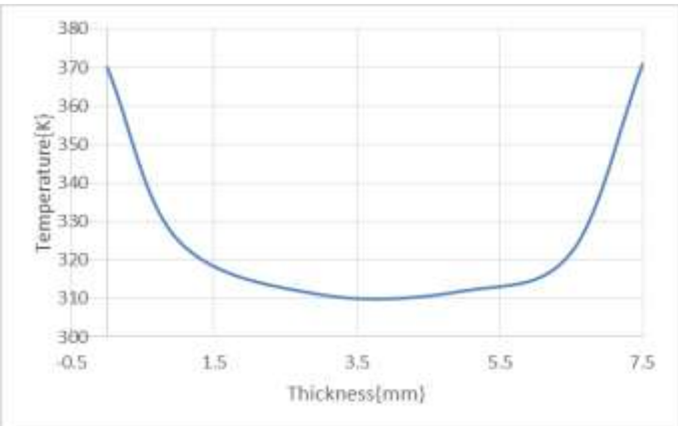


Fig 8: Temperature variation wrt radius

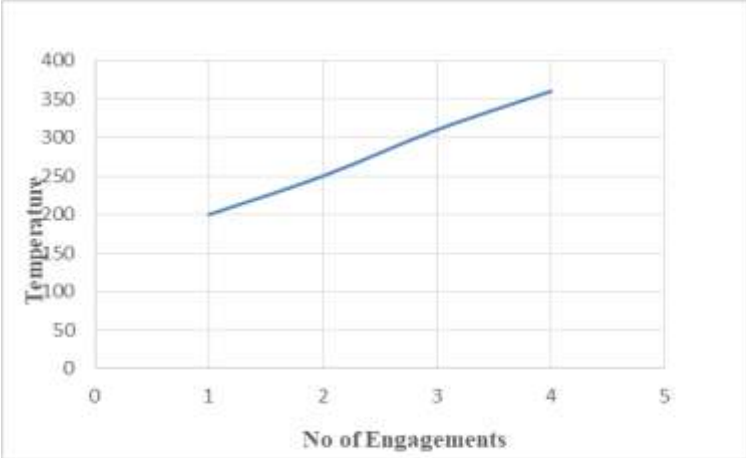


Fig 9: Temperature variation w.r.t Thickness of Clutch Disc

III. Conclusions

As the clutch is continuously engaged and disengaged the slippage between flywheel and clutch plate goes on increasing which results in heat generation and wear of material. So the clutch should be designed by determining the heat generated using finite element method and simulate it for number of engagements cycles. For all successive engagements, as we moved away from the surface towards the depth of the material, temperature values reduced swiftly hence causing dramatic rise in temperatures. It was observed that the distribution of temperature was uniform over the contact surfaces of the clutch at any instant during all engagements

Conflict of interest The authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1]. O.I. Abdullah a, J. Schlattmann "Finite Element Analysis of Temperature Field in Automotive Dry Friction Clutch", Tribology in Industry Vol. 34, No. 4 (2012) 206-216.
[2]. Oday I. Abdullaha,b, Josef Schlattmanna, Mahir H. Majeedc, Laith A. Sabrid "The temperatures distributions of a single-disc clutches using heat partitioning and total heat generated approaches", Case Studies in Thermal Engineering 11 (2018) 43–54.
[3]. O.I. Abdullah, J. Schlattmann , A.M. Al- Shabibi "Thermo- mechanical Analysis of the Dry Clutches under Different Boundary Conditions", Tribology in Industry Vol. 36, No. 2 (2014) 172-180.
[4]. M.H. Faidh-Allah "The Temperature Distribution in Friction Clutch Disc under Successive Engagements", Tribology in Industry Vol. 40, No. 1 (2018) 92-99.