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THERMAL ANALYSIS OF TWO WHEEL DISC BRAKE MADE BY CAST IRON, ALUMINIUM, VANADIUM STEEL, STAINLESS STEEL

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ABSTRACT Slowing down is a cycle which changes over the motor energy of the vehicle into mechanical energy which should be scattered as warmth. The circle brake is a gadget for de-speeding up or halting the turn of a wheel. A brake circle (or rotor) typically made of cast iron or fired composites, is associated with the haggle/the pivot. Grating material as brake cushions (mounted on a gadget called a brake caliper) is constrained precisely, powerfully, pneumatically or electromagnetically against the two sides of the plate to stop the wheel. The current exploration is fundamentally manages the displaying and examination of strong and ventilated circle brake utilizing Pro-E and ANSYS. Limited component (FE) models of the brake-circle are made utilizing Pro-E and mimicked utilizing ANSYS which depends on the limited component technique (FEM). In this examination Analysis Thermal investigation) is acted to discover the strength of the circle brake. Warm examination warm slopes, heat stream rates, and warmth motions to be computes by changing the diverse cross segments, materials of the circle. Correlation should be possible for temperatures, and so forth for the 5 materials to recommend the best material for FSAE vehicle.

The plate brake is a gadget utilized for easing back or halting the pivot of the vehicle. Number of times utilizing the brake for vehicle prompts heat age during slowing down occasion, to such an extent that plate brake goes through breakage because of high Temperature. Circle brake model is finished by CATIA and examination is finished by utilizing ANSYS workbench. The principle motivation behind this undertaking is to examine the Thermal investigation of the Materials for examination between the 5 materials for the Thermal qualities and material properties acquired from the Thermal investigation low warm slope material is liked. Thus best appropriate plan, low warm angle material Vanadium steel is liked for the Disk Brakes for better execution.

INTRODUCTION

I n the present developing car market the opposition for better execution vehicle is developing massively. The circle brake is a gadget utilized for easing back or halting the pivot of the wheel. A brake is typically made of solid metal or fired composites incorporate carbon, aluminum, Kevlar and silica which is associated with the haggle, to

stop the vehicle. A rubbing material delivered as brake cushions is constrained precisely, using pressurized water, pneumatically and electromagnetically against the both side of the plate. This grating makes the plate and appended wheel slow or to stop the vehicle. The strategies utilized in the vehicle are regenerative stopping mechanism and rubbing slowing mechanism. A rubbing brake produces the frictional power in at least two surfaces rub against to one another, to decrease the development. In light of the plan setups vehicle rubbing brakes are gathered into circle brakes and drum brakes. Our task is about circle brakes demonstrating and examination.

Monotonous slowing down of a vehicle produces huge measure of warmth. This warmth must be disseminated for better execution of brake. Slowing down execution to a great extent influenced by the temperature ascend in the brake parts. High temperature might cause warm breaks, brake blur, wear and decrease in coefficient of contact.

During slowing down, the motor and expected energies of a moving vehicle get changed over into nuclear power through grating in the brakes. The warmth created between the brake cushion and plate must be dispersed by ignoring air them. This warmth move happens by conduction, convection and to some degree by radiation. To accomplish appropriate cooling of the plate and the cushion by convection, investigation of the warmth transport marvel between circle, cushion and the air medium is essential. Then, at that point examine the warm presentation of the plate stopping mechanism to foresee the expansion in temperature during slowing down. Convective warmth move model has been created to examine the cooling execution. Brake circles are furnished with slices to expand the region interacting with air and further develop heat move from plate.

LITERATURE REVIEW

Gao and Lin (2012) introduced Transient temperature field investigation of a brake in a non-axisymmetric three-dimensional model [1]. The circle cushion brake utilized in a car is isolated into two sections: the plate, mathematically axisymmetric; and the cushion, of which the calculation is three-dimensional. Utilizing a two-dimensional model for warm investigation infers that the contact conditions and frictional warmth motion move are free of y. This might prompt bogus warm flexible contortions and ridiculous contact conditions. A logical model is introduced in this paper for the assurance of the contact temperature circulation on the functioning surface of a brake. To consider the impacts of the moving warmth source (the cushion) with relative sliding pace variety, a transient limited component method is utilized to describe the temperature fields of the strong rotor with suitable warm limit conditions. Mathematical outcomes shows that the working attributes of the brake apply a basically effect on a superficial level temperature conveyance and the maximal contact temperature.

Voller, et al.(2013) play out an Analysis of auto plate brake cooling qualities The point of this examination was to consider auto circle brake cooling attributes tentatively utilizing an uncommonly evolved turn apparatus and Singh and Shergill 85 mathematically utilizing limited component (FE) and computational liquid elements (CFD) strategies. Every one of the three methods of warmth move (conduction, convection and radiation) have been dissected alongside the plan components of the brake gathering and their interfaces. The impact of brake cooling boundaries on the plate temperature has been examined by FE demonstrating of a long drag brake application. The nuclear energy scattered during the drag brake application has been broke down to uncover the commitment of every method of warmth move.

Choi and Lee, (2014) introduced a paper on Finite component investigation of transient thermoelastic practices in plate brakes [3]. A transient examination for thermoelastic contact issue of circle brakes with frictional warmth age is performed utilizing the limited component strategy. To examine the thermoelastic marvel happening in plate slows down, the coupled warmth conduction and flexible conditions are tackled with contact issues. The mathematical reproduction for the thermoelastic conduct of circle brake is gotten in the rehashed brake condition. The computational outcomes are introduced for the dispersions of pressing factor and temperature on every grinding surface between the reaching bodies.

Qi and Day (2017) examined that utilizing a planned trial approach, the elements influencing the interface temperature, including the quantity of slowing down applications, sliding pace, slowing down burden and kind of grating material were contemplated [4]. It was tracked down that the quantity of slowing down applications had the most grounded impact on the contact interface temperature. The genuine contact region between the plate and cushion, for example cushion districts where the greater part of the active energy is disseminated through contact, significantly affected the slowing down interface temperature. For understanding the impact of genuine contact region on neighborhood interface temperatures and grinding coefficient, limited component investigation (FEA) was led, and it was tracked down that the greatest temperature at the erosion interface doesn't increment directly with diminishing contact region proportion. This finding is possibly huge in enhancing the plan and definition of contact materials for stable rubbing and wear execution.

CATIA molding

We at CADCAMGURU have perceived the significance of CATIA accreditation in any event, when the idea of CATIA was new on the lookout. We have a multi week accreditation course for CATIA confirmation. We offer numerous exceptional elements during the preparation which incorporates preparing of 3D CAD demonstrating of projecting, forgings, plastice segments, sheet metals, and so forth This preparation is planned considering the current day mechanical prerequisites, for example, remastering, Class A to B change, figuring out, wire outline displaying, and so forth Understudies get on project insight during the preparation program. Preparing program likewise incorporates making the understudies acquainted with different variant of CATIA like CATIA V5. Subsequently making CADCAMGURU a favored instructional hub for CATIA confirmation. Every one of the mentors at CADCAMGURU are Certified by Dassault Systemes for CATIA, who gives quality preparing to CADCAMGURU understudies

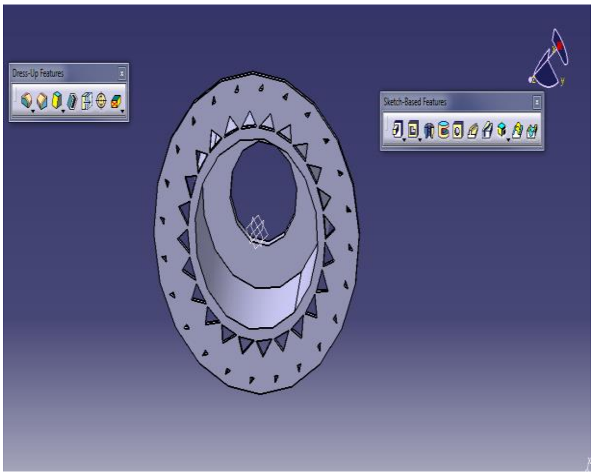


Fig: 5.1 design disk break

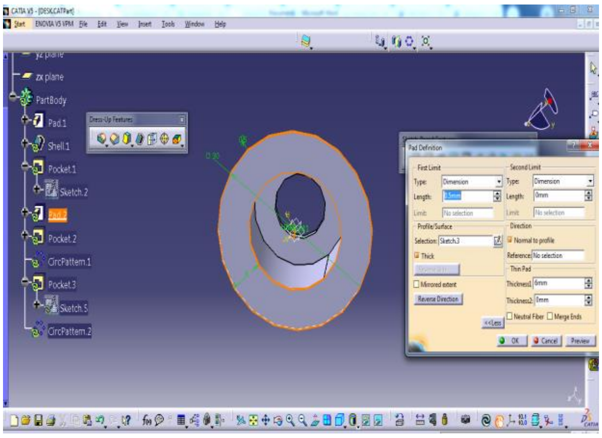
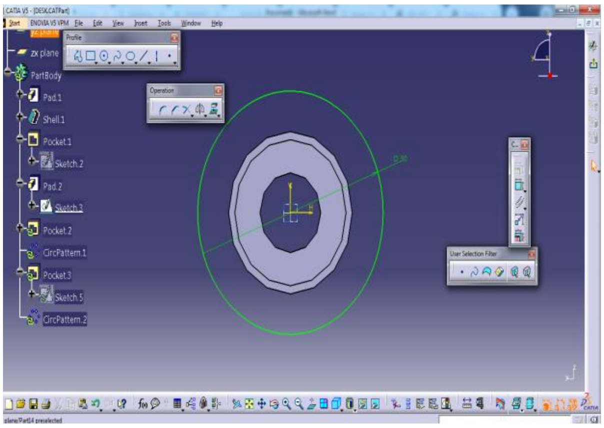


Fig: 5.4 plane disk break



: Fig: 5.5 plane disk break

DISC BRAKE CALCULATIONS

CALCULATION FOR INPUT PARAMETERS:

In the aspect of the car accident prevention, the braking performance of vehicles has been a critical issue. The rotor model heat flux is calculated for the car moving with a velocity 27.77 m/s (100kmph) and the following is the calculation

Procedure: Data:

1) Mass of the vehicle = 300 kg
2) Initial velocity (u) = 22.22 m/s (80 kmph)
3) Vehicle speed at the end of the braking application (v) = 0 m/s
4) ~~Brake rotor diameter~~ = 0.262 m
5) Static front axle load = (γ)=0.3

Total motor cycle load

6) Percentage of kinetic energy that disc absorbs (90%) k=0.9
7) Acceleration due to gravity g =9.81m/s2

Coefficient of friction for

ANALYTICAL TEMPERATURE RISE

Material Properties		
Thermal conductivity(w/m k)	36	50
Density , ρ (kg/m3)	7100	6600
Specific heat , c (J/Kg c)	320	380
Thermal expansion , α (10-6 / k)	0.12	0.16
Elastic modulus, E (GPa)	210	110
Coefficient of friction, μ	0.5	0.5
Film co-efficient h(w/km2)	240	280
Operation conditions		
Angular velocity,(rad /s)	50	50
Braking Time Sec	5	6
Hydraulic pressure, P (M pa)	1	1

CALCULATIONS:

The contact region between the cushions and circle of brake parts, heat is created because of grating. For estimation of warmth age at the interface of these two sliding bodies, two strategies are recommended based on "law of protection of energy which expresses that the motor energy of the vehicle during movement is equivalent to the scattered warmth after vehicle stop".

The material properties and boundaries took on in the computations are as displayed in table.

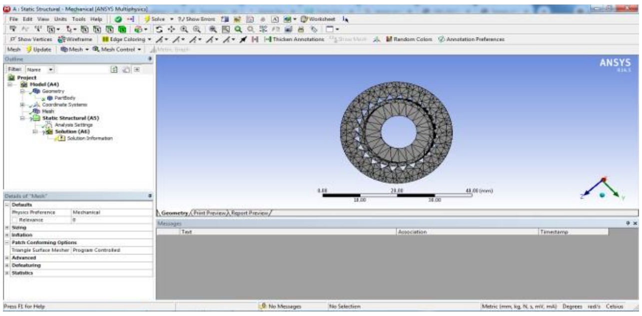


Fig: 7.2 designed disk brake

7.4Vanadium steel

TABLE 12
Steel > Constants

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

TABLE 13
Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 14
Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

TABLE 15
Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

TABLE 16
Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

TABLE 17
Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 18
Steel > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

TABLE 19
Steel > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

TABLE 20
Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.e+005	0.3	1.6667e+005	76923

TABLE 21
Steel > Isotropic Relative Permeability

Relative Permeability
10000

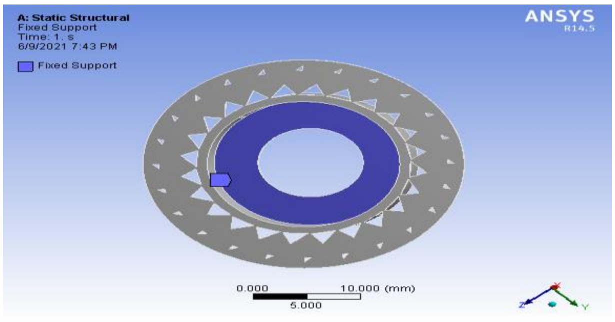


Fig: 7.3 flex support

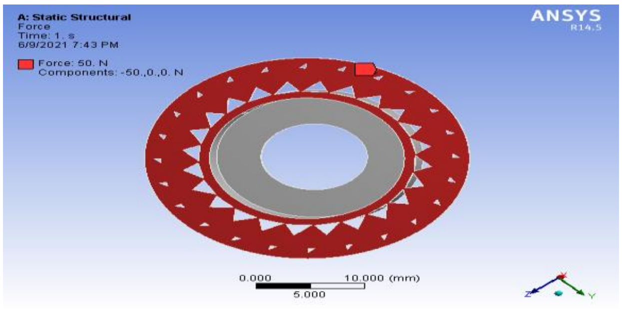


Fig:7.4 thermal force

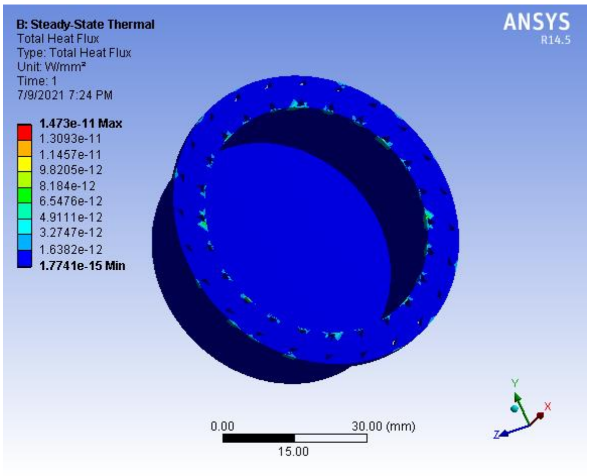


Fig:7.6 total heat flux

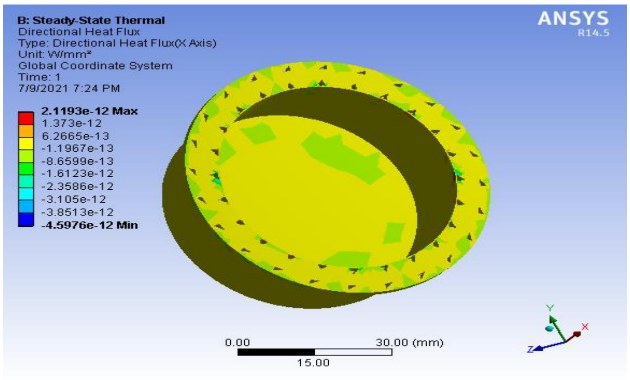


Fig: 7.7 directional heat flux

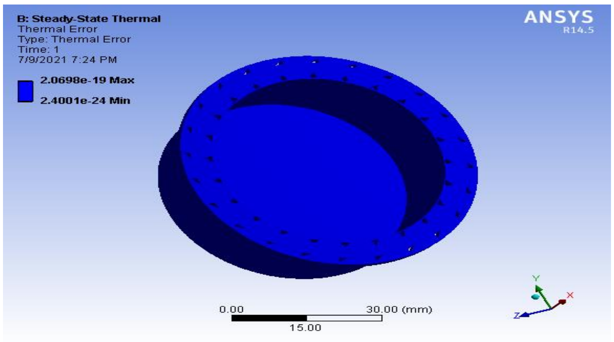


Fig:7.8 Thermal error distribution

7.5 Aluminum Alloy

TABLE 12
Aluminum Alloy > Constants

Density	2.77e-006 kg mm^-3
Coefficient of Thermal Expansion	2.3e-005 C^-1

Specific Heat	8.75e+005 mJ kg^-1 C^-1

TABLE 13
Aluminum Alloy > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 14
Aluminum Alloy > Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 15
Aluminum Alloy > Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 16
Aluminum Alloy > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
310

TABLE 17
Aluminum Alloy > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 18
Aluminum Alloy > Isotropic Thermal Conductivity

Thermal Conductivity W mm^-1 C^-1	Temperature C
0.114	-100
0.144	0
0.165	100
0.175	200

TABLE 19
Aluminum Alloy > Alternating Stress R-Ratio

TABLE 20
Aluminum Alloy > Isotropic Resistivity

Resistivity ohm mm	Temperature C
2.43e-005	0
2.67e-005	20
3.63e-005	100

TABLE 21
Aluminum Alloy > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

TABLE 22
Aluminum Alloy > Isotropic Relative Permeability

Relative Permeability
1

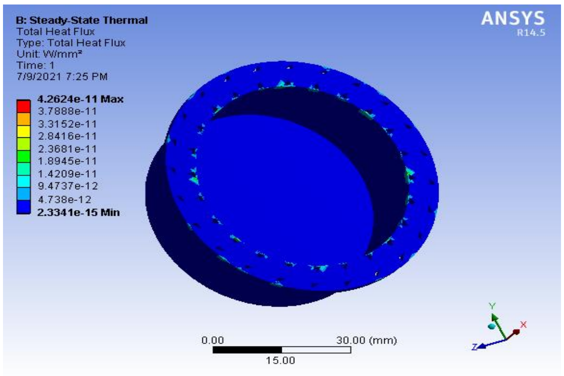


Fig:7.9 total heat flux

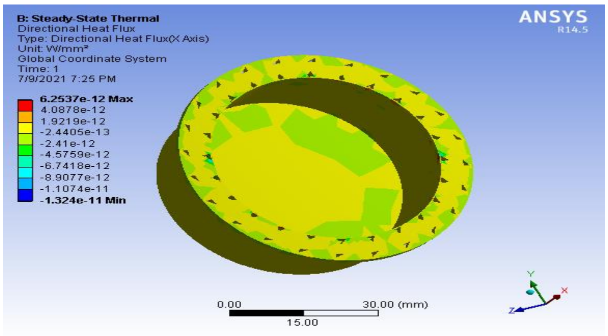


Fig: 7.10 directional heat flux

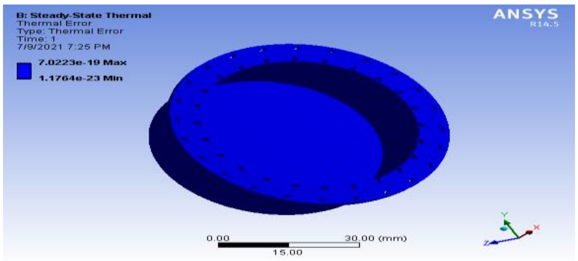


Fig:7.11 Thermal error distribution

7.6 Stainless Steel

TABLE 12
Stainless Steel > Constants

Density	7.75e-006 kg mm^-3
Coefficient of Thermal Expansion	1.7e-005 C^-1
Specific Heat	4.8e+005 mJ kg^-1 C^-1
Thermal Conductivity	1.51e-002 W mm^-1 C^-1
Resistivity	7.7e-004 ohm mm

TABLE 13
Stainless Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 14
Stainless Steel > Compressive Yield Strength

Compressive Yield Strength MPa
207

TABLE 15
Stainless Steel > Tensile Yield Strength

Tensile Yield Strength MPa
207

TABLE 16
Stainless Steel > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
586

TABLE 17
Stainless Steel > Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 18
Stainless Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	1.93e+005	0.31	1.693e+005	73664

TABLE 19
Stainless Steel > Isotropic Relative Permeability

Relative Permeability
1

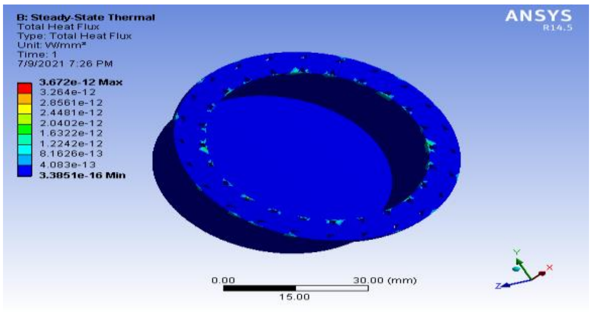


Fig:7.12 total heat flux

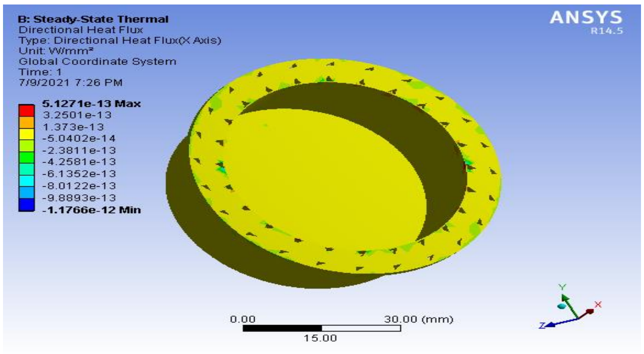


Fig: 7:13 directional heat flux

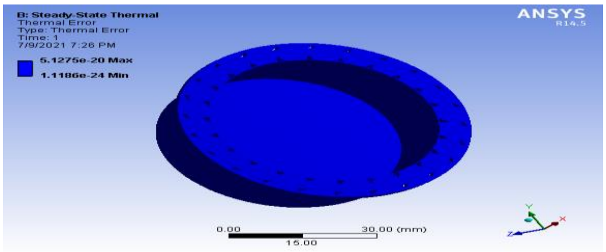


Fig:3.14 Thermal error distribution

7.7 CAST IRON Alloy

TABLE 12
CAST IRON> Constants

Density	8.3e-006 kg mm^-3
Coefficient of Thermal Expansion	1.8e-005 C^-1
Specific Heat	3.85e+005 mJ kg^-1 C^-1
Thermal Conductivity	0.401 W mm^-1 C^-1

TABLE 13
CAST IRON> Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 14
CAST IRON> Compressive Yield Strength

Compressive Yield Strength MPa
280

TABLE 15
CAST IRON> Tensile Yield Strength

Tensile Yield Strength MPa
280

TABLE 16
CAST IRON> Tensile Ultimate Strength

Tensile Ultimate Strength MPa
430

TABLE 17
CAST IRON> Isotropic Secant Coefficient of Thermal Expansion

Reference Temperature C
22

TABLE 18
CAST IRON> Isotropic Resistivity

Resistivity ohm mm	Temperature C
1.548e-005	0
1.694e-005	20
2.277e-005	100

TABLE 19
CAST IRON> Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	1.1e+005	0.34	1.1458e+005	41045

TABLE 20
CAST IRON> Isotropic Relative Permeability

Relative Permeability
1

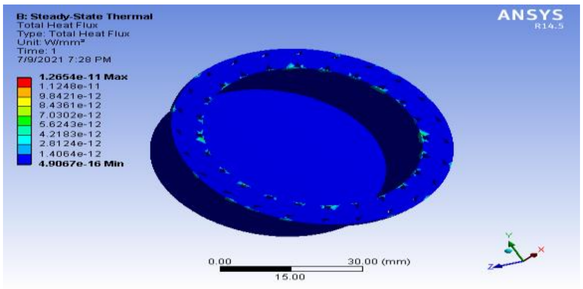
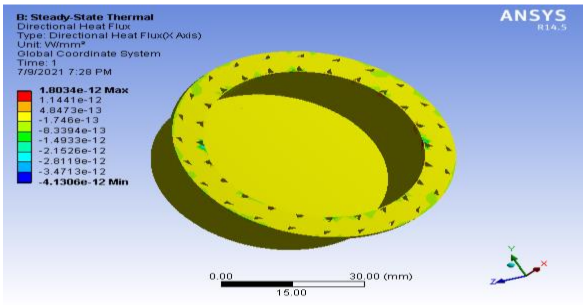


Fig:7.15 total heat flux



ig: 7.16 directional heat flux

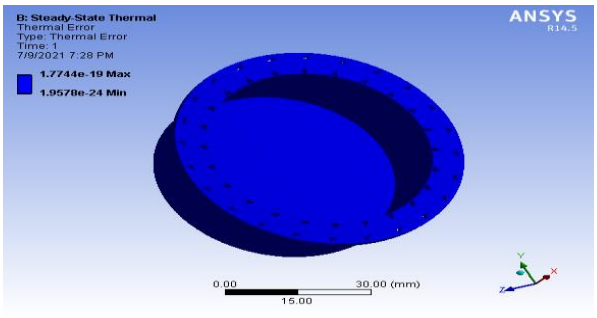


Fig:7.17 Thermal error distribution

7.8 VANADIUM STEEL

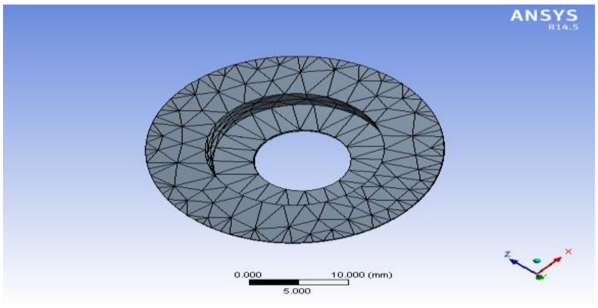


Fig: 7.17 meshing

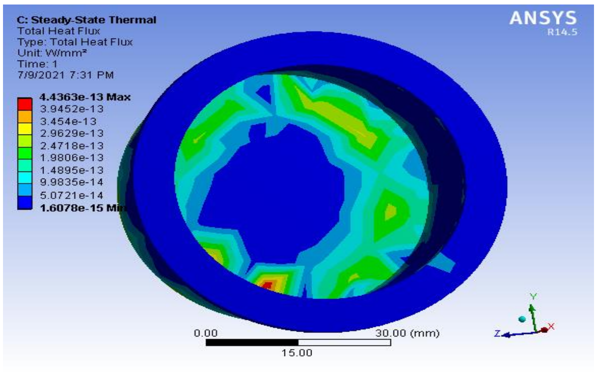


Fig:7.18 total heat flux

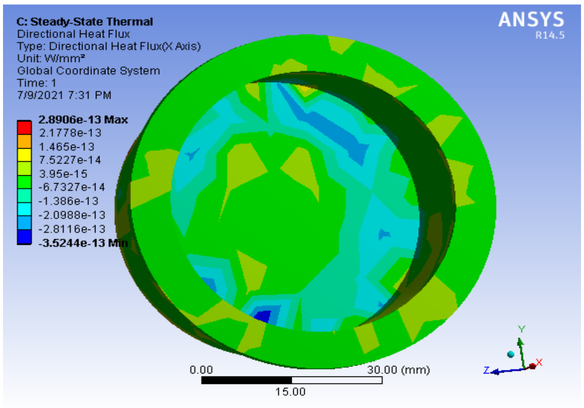


Fig: 7.19 directional heat flux

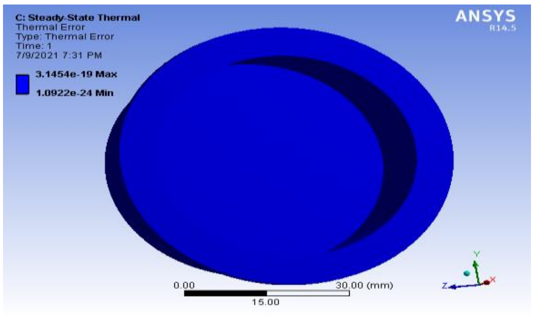


Fig:7.20 Thermal error distribution

7.9 STAINLESS STEEL

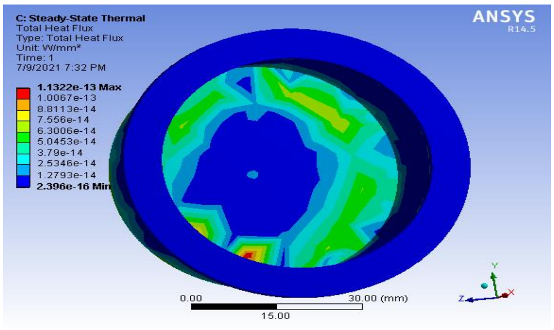


Fig:7.21 total heat flux

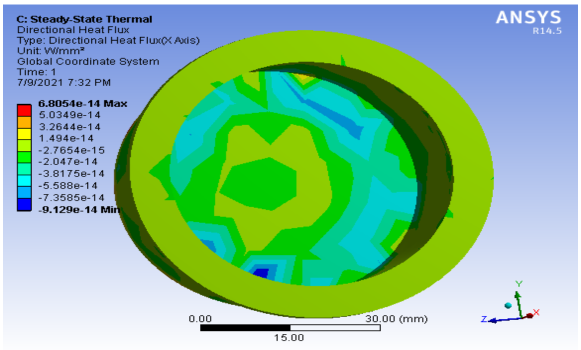


Fig:7.22 directional heat flux

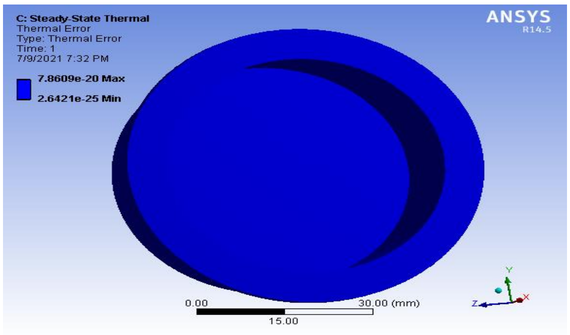


Fig:7.23 Thermal error distribution

7.10 ALUMINIUM

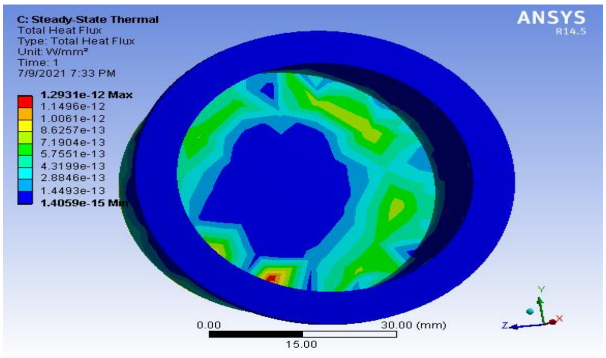


Fig:7.24 total heat flux

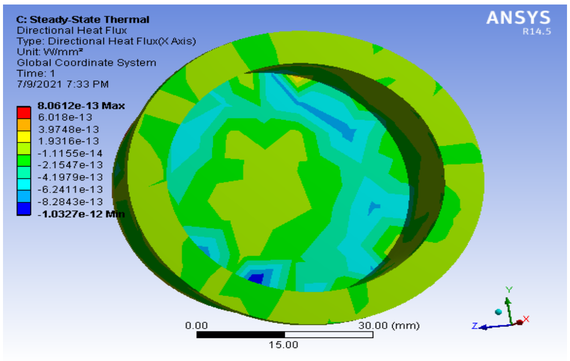


Fig: 7.25 directional heat flux

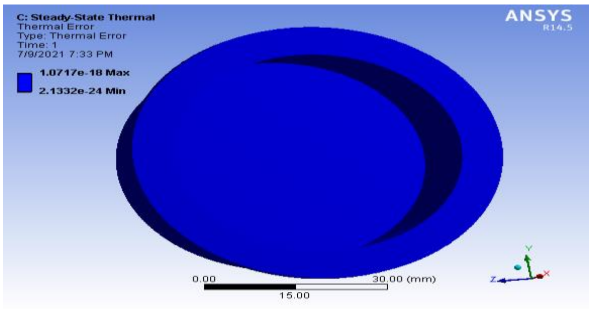


Fig:7.26 Thermal error distribution

7.11 CAST IRON

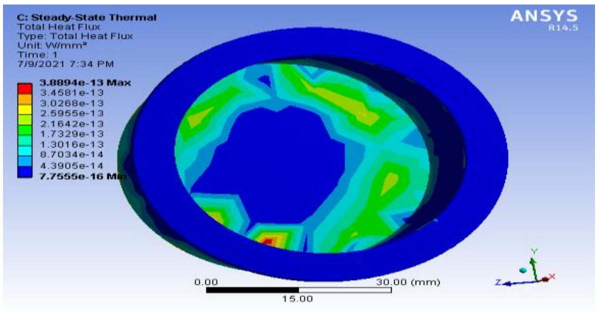


Fig:7.27 total heat flux

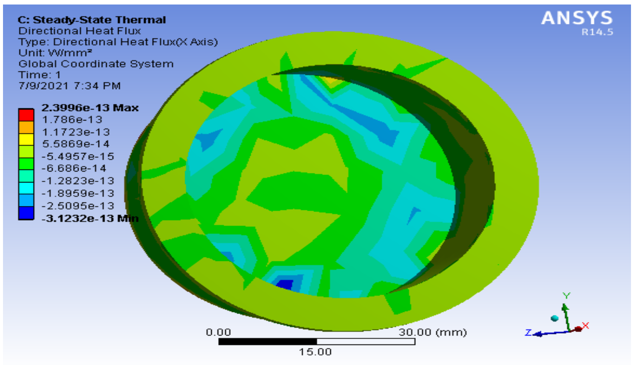


Fig: 7.28 directional heat flux

RESULTS & DISCUSSIONS

The 3D model of poppet circle break were planned by utilizing CATIA programming. The model is fit by utilizing ANSYS. The FEA was finished by ansys. The warm investigation was effectively completed to decide the all out heat transition, directional warmth motion and temperature appropriation on the circle break. Both the dis were investigated with various materials

8.1 MODEL 1 PLANE DISC BREAK

MODEL 1 PLANE DISC						
	Temperature		Total Heat Flux in (W/m^2)		Directional heat flux (W/m^2)	
Material	Min.	Max.	Min.	Max.	Min.	Max.
VANADIUM STEEL	320	320	1.473	1.7741	2.1193	4.5976
STAINLESS STEEL	7.0223	1.1764	4.2624	2.3342	6.2537	1.324
ALUMINIUM alloy	5.1275	1.1186	3.672	3.3851	5.1271	1.1766
CAST IRON	1.7744	1.9578	1.2654	4.9067	1.8034	4.1306

8.2 MODEL 2 DESIGN DISC BREAK

MODEL 2 DESIGN DISC BREAK						
	Temperature		Total Heat Flux in (W/m^2)		Directional heat flux (W/m^2)	
Material	Min.	Max.	Min.	Max.	Min.	Max.
VANADIUM STEEL	3.1454	1.0922	4.4363	1.6078	2.8906	3.5244
STAINLESS STEEL	7.8609	2.6421	1.1322	2.396	6.8054	9.129
ALUMINIUM alloy	1.0717	2.1332	1.2931	1.4059	8.0612	1.0327
CAST IRO	2.6933	1.4514	3.8894	7.555	2.3996	3.1232

By observing above table the max. Heat flux was observed low in Vanadium Steel disk break. So Vanadium steel is best suitable material for disk break among three materials.

CONCLUSIONS

In this undertaking the 3D model of poppet plate break were planned by utilizing CATIA programming. The model is coincided by utilizing ANSYS. The FEA was finished by ANSYS.

The warm examination was effectively completed to decide the absolute warmth transition, directional warmth motion and temperature dispersion on the plate break.

The plate break has been changed

Both the plate break s were dissected with various materials.

Analyzed and recommended best material for both the plate break s.

In this investigation discovered, in warm examination the maximum. Warmth motion was noticed low in chrome Vanadium steel plate break.

So chrome Vanadium steel is best appropriate material for exhaust plate break among three materials.

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