International Journal of Engineering Science and Advanced Technology (IJESAT)
Vol 24 Issue 11, NOV, 2024

THERMAL ANALYSIS OF CUTTING FLUIDS ON HSS AND CARBIDE TOOLS BY USING FEA

SHAIK MANSOOR ALI[1], G.KRISHNA KISHORE[2]
[1]PG Student, Dept of Mechanical Engineering, GCET, Kadapa.
[2]Associate Professor, Dept of Mechanical Engineering, GCET, Kadapa.

Abstract –
Any liquid or gas applied directly to machining operation to improve cutting performance two main problems addressed by cutting fluids: Heat generation at shear zone and friction zone, Friction at the tool-chip and tool-work interfaces. Other functions and benefits: Wash away chips (e.g., grinding and milling), Reduce temperature of work part for easier handling, Improve dimensional stability of work part. Cutting fluids are used in machining for a variety of reasons such as improving tool life, reducing work piece thermal deformation, improving surface finish. Mota and Machado (1995) concluded that reducing cutting tool cost and increased production can be achieved through the use of appropriate cutting fluids. In this thesis Air, water and palm kernel oil were used as coolants in machining operations. Tungsten carbide and HSS cutting tools are employed as cutter with different temperatures. Thermal analysis is done on the parametric model to determine the effect of different cutting fluids on the cutters. Parametric Modelling is done in Pro/Engineer and analysis is done in Ansys.

I. INTRODUCTION

Milling is the approach of decreasing away fabric by using feeding a work piece past a rotating more than one tooth cutter. The decreasing motion of the much enamel round the milling cutter offers a rapid method of machining. The machined surface would possibly additionally be flat, angular, or curved. The flooring may moreover also be milled to any combination of shapes. The laptop computer for maintaining the work piece, rotating the cutter, and feeding it is acknowledged as the Milling machine. Milling cutters are reducing equipment oftentimes used in milling machines or machining facilities (and as soon as in whilst in one-of-a-kind computing machine tools). By the movement of milling cutter these cast off material within the desktop such as ball nostril mill or without delay from the cutter's shape such as a structure tool eg., a hobbling cutter. There are greater varieties of cutters for putting off large quantity cloth leaving with terrible floor end such as roughing and there are some cutters for removing smaller amounts of material however leaves a suitable surface end such as finishing. The cutter which used for roughing has notched enamel for flouting up the chips to smaller pieces. This variety of tooth leaves tough floor but the cutter used for ending system has 4 teeth or extra to put off material with care. However, the large wide variety of flutes leaves little room for environment friendly swarf removal, so they are less excellent for doing away with large quantities of material.

II. GENERIC STEPS TO SOLVING ANY PROBLEM IN ANSYS

Build Geometry

Construct at woo three dimensional representation of the object to be modelled and tested using the work plane coordinates system within ANSYS.

Define Material Properties

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modelled. This includes thermal and mechanical properties.

Generate Mesh

At this point ANSYS understands the makeup of the part. Now define how the modelled system should be broken down into finite pieces.

Apply Loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

Obtain Solution

This is actually a step, because ANSYS needs to understand within what state (steady state, t ransient…etc.) the problem must be solved.

Specific capabilities of ANSYS:

Static Analysis–Need to define displacements and stresses in static loading circumstances. ANSYS can compute both linear static analyses and also nonlinear static analyses. Nonlinear static analysis includes homes such as creep, fantastic stress plasticity, stress stiffening, large deflection, hyper elasticity and contact surfaces.

Structural analysis is likely the most frequents of aware of the finite aspect technique as it implies bridges and buildings, naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and computing device housings, as nicely as mechanical components such as pistons, machine parts, and tools. Transient Dynamic Analysis–Need to define the response of a structure to arbitrarily time variable loads. Totally nonlinear evaluation cited under Static Analysis beyond is permitted. Buckling Analysis - Need to estimate the buckling masses and outline the buckling type shape. Both linear buckling and nonlinear buckling research are potential. Besides of above analysis types, several optimal motive aspects are provided such as Fracture mechanics, Composite material analysis, Fatigue each p-Method and Beam analyses. ANSYS is proficient of both regular nation thermal evaluation and transient analysis of any solid by way of ability of thermal boundary conditions.

Such loads incorporate the following:

- Convection
- Radiation
- Heatwaft rates
- Heat fluxes(heat drift per unit area)
- Heater a rates such as warmness waft per unit extent and
- Perpetual temperature boundaries.

A steady-state thermal analysis might also be both linear, with regular fabric properties; and nonlinear, with fabric residences that rely on temperature. The thermal homes of first-rate material vary with temperature. This temperature dependency being substantial, the evaluation turns into nonlinear. Radiation boundary occasions also create the analysis nonlinear. Transient calculations are time based and ANSYS will collectively remedy distributions in addition to make video for time incremental shows of models.

III. FLUID FLOW

The ANSYS/FLOTRAN CFD (Computational Fluid Dynamics) gives complete tools for inspecting two-dimensional and three-d fluid float fields. ANSYS is successful of modelling a huge vary of evaluation kinds such as: airfoils for pressure evaluation of plane wings (lift and drag), glide in supersonic nozzles, and complex, third-dimensional waft patterns in a pipe bend. In addition, ANSYS/FLOTRAN ought to be used to perform duties including:

- Calculating the gas pressure and temperature distribution in an engine exhaust manifold
- Studying the thermal stratification and break up in piping systems.
- Using waft mixing research to evaluate plausible for thermal shock.
- Doing natural convection analyses to calculate the thermal overall performance of chips in digital fields.
- Conducting warmness exchanger survey comprising specific fluids parted via stable regions.

IV. 3D MODELING AND ASSEMBLY OF CUTTING TOOL AND WORKPIECE

MODEL OF CUTTING TOOL SKETCH:

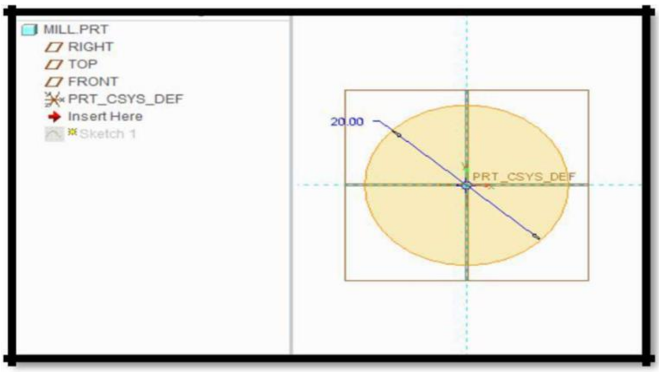


FIG: Model of cutting tool (topview)

EXTRUDE:

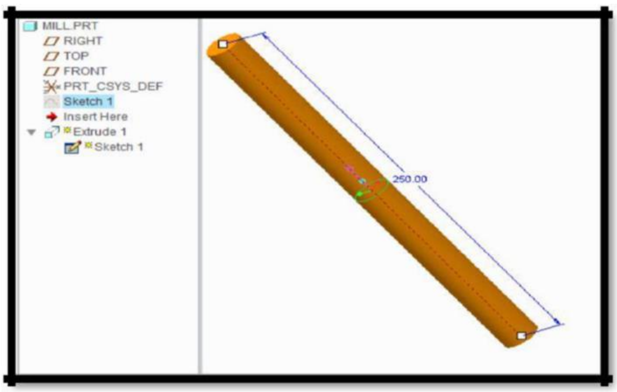


FIG: Cutting tool extrude

HELICAL SWEEP PROFILE:

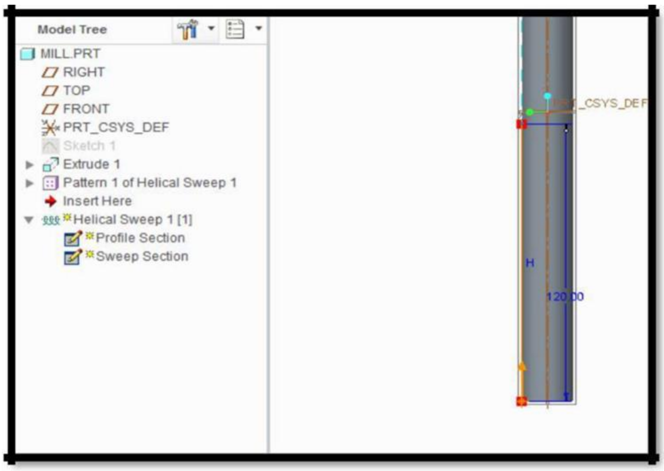


FIG: Helical sweep profile

HELICAL SWEEP SECTIONS:

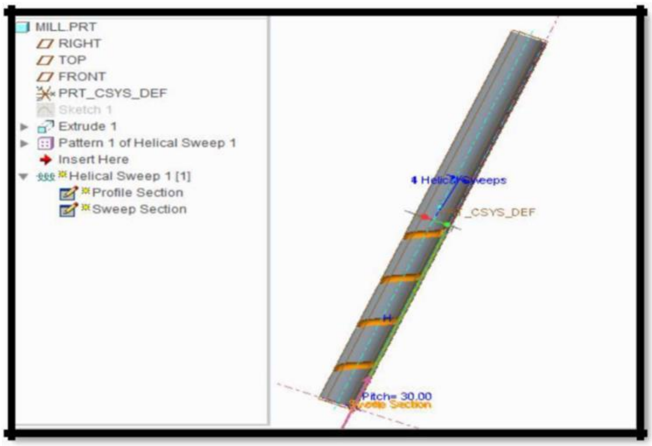


FIG: Helical sweep section

PATTERN:

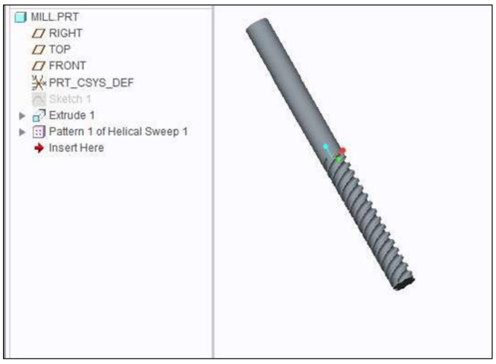


FIG: Cutting tool pattern

WORKPIECE: SKETCH:

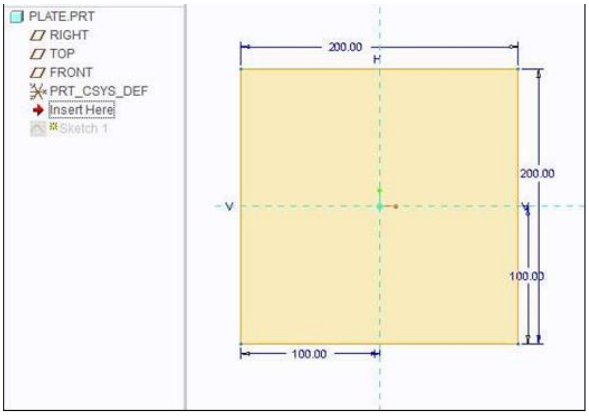


FIG: Work piece

EXTRUDE:

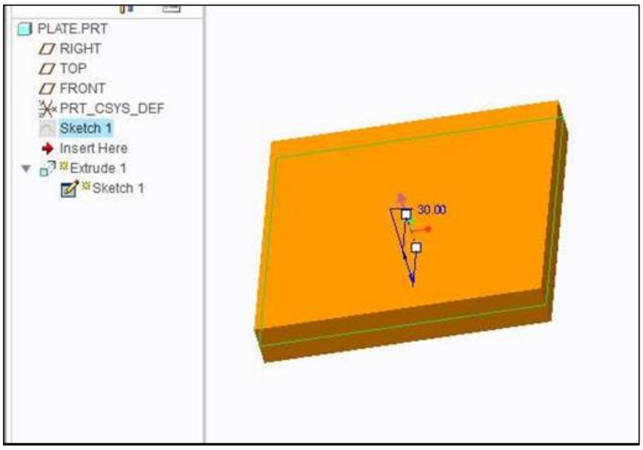


FIG: Work piece extrude

SOLIDPART:

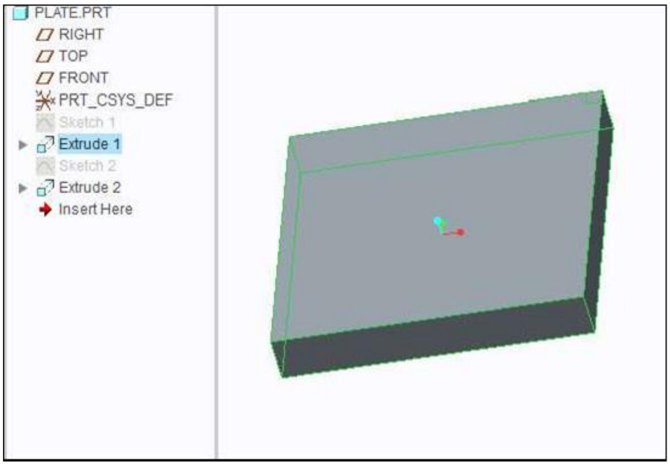


FIG: Work piece solid part

V. THERMAL ANALYSIS

MATERIAL PROPERTIES CuttingTool–HSS

Thermal conductivity=0.019W/mmK

Specific Heat –460J/Kg K

Density=0.0000081 Kg/mm^3

Work Piece–Alluminum alloy 6063 Thermal conductivity=0.2 W/mmK Specific Heat – 900J/Kg K

Density=0.0000027 Kg/mm^3

CUTTING TOOL MATERIAL-HSS

COOLANT-AIR TEMPARATURE-410K

Imported model

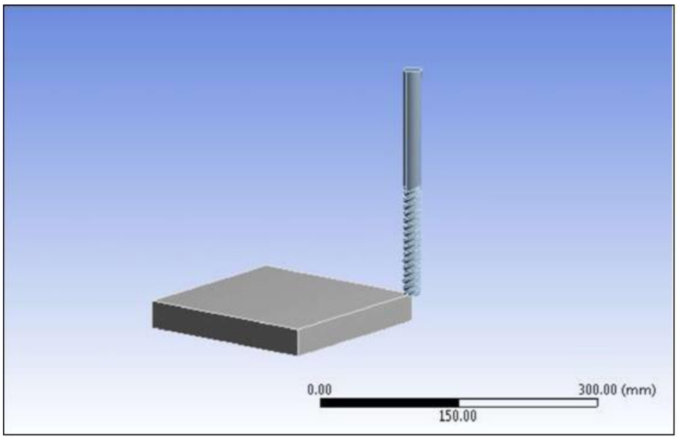


FIG: Imported model

MESHEDMODEL:

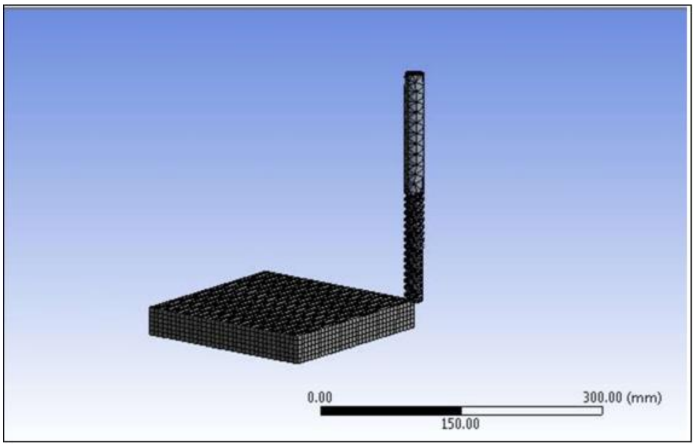


FIG: Meshed model

TEMPERATURE:

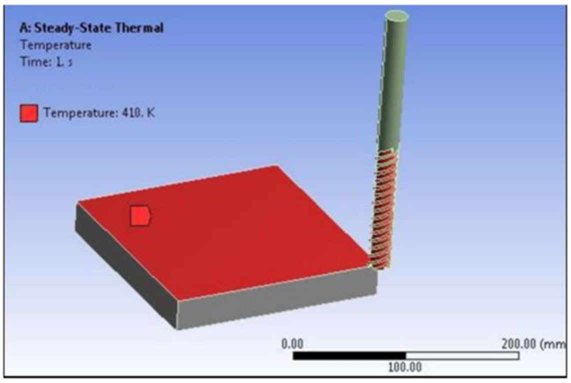


FIG: Temperature 410k

CONVECTION:

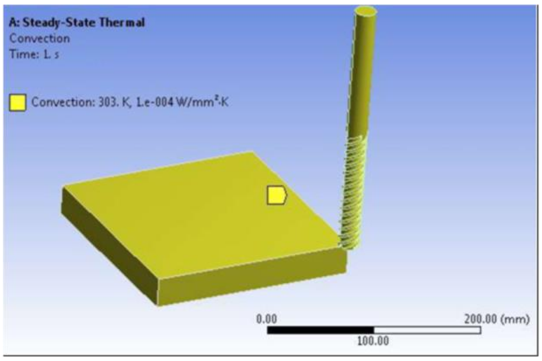


FIG: by applying convection

HEATFLUX:

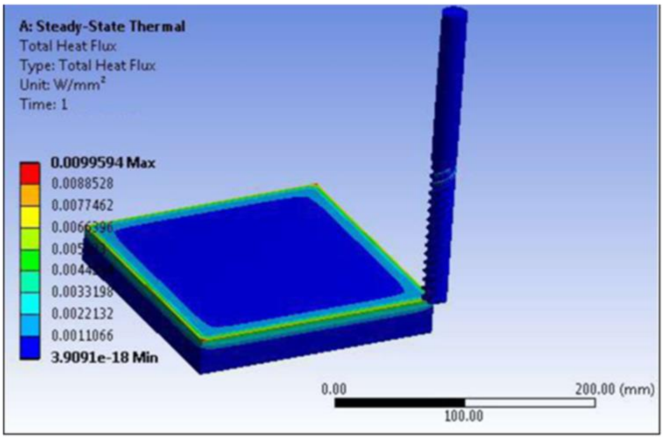


FIG: Heat flux

TEMPERATURE:
TEMPERATURE–460K

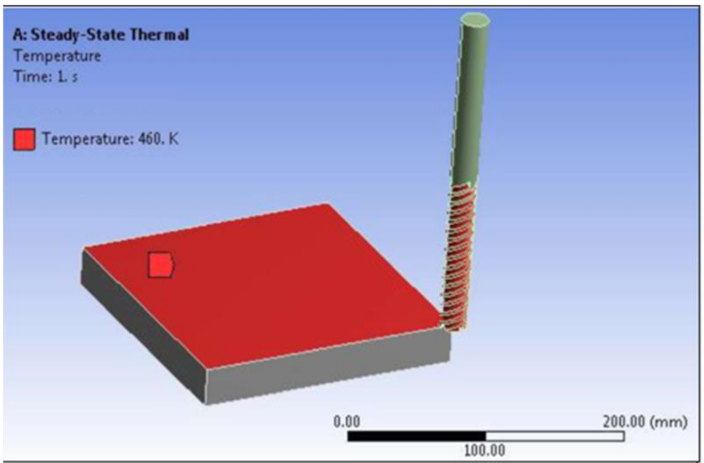


FIG: Temperature 460k

CONVECTION:

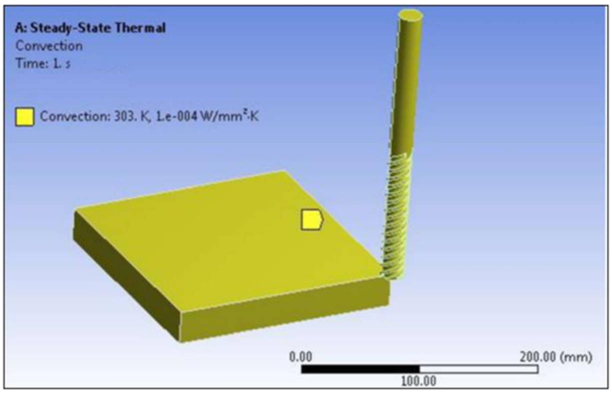


FIG: Convection at 460k

HEATFLUX:

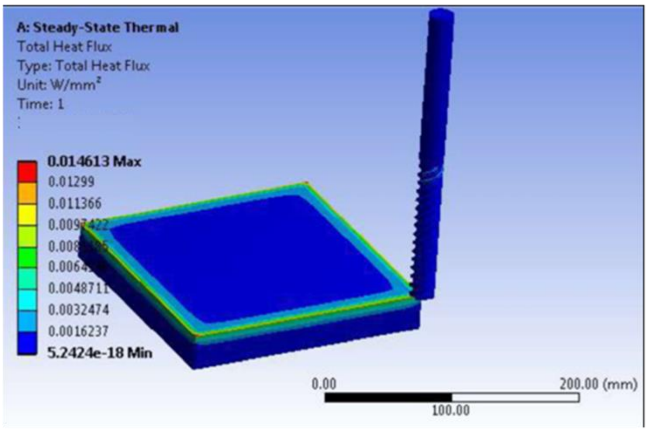


FIG: Heat flux at 460k

TEMPERATURE-510K

TEMPERATURE:

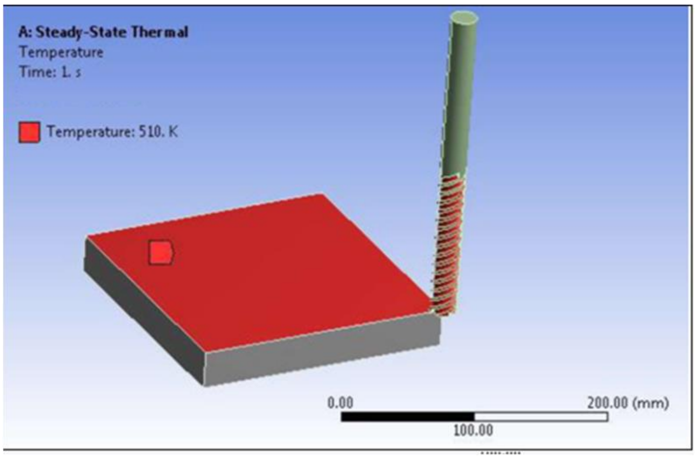
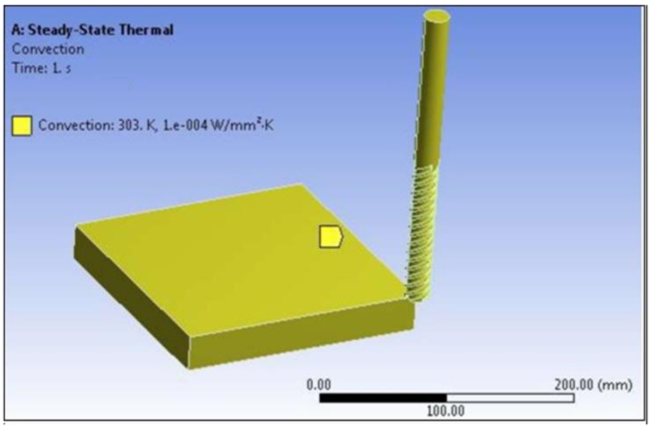


FIG: Temperature 510k

CONVECTION:



s

FIG: Convection at temperature 510k

HEATFLUX:

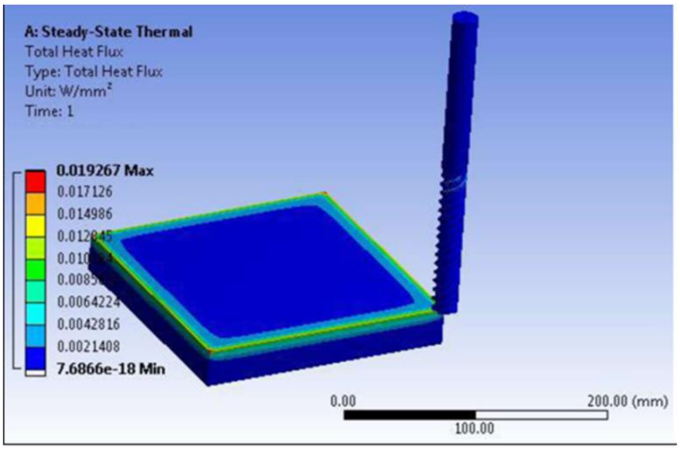


FIG: Heat flux at 510k

MATERIAL PROPERTIES CuttingTool–CARBIDE

Thermal conductivity=0.028W/mmK

Specific Heat –292J/Kg K

Density=0.000001582Kg/mm^3

Work Piece–Alluminum alloy 6063

Thermal conductivity=0.2 W/mmK Specific Heat –460J/Kg K

Density=0.0000027 Kg/mm^3

CUTTING TOOL MATERIAL-HSS

COOLANT-AIR TEMPARATURE-410K

Imported model

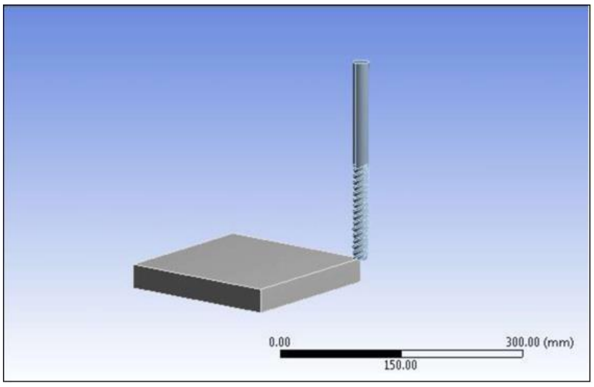


FIG: Imported model

MESHED MODEL:

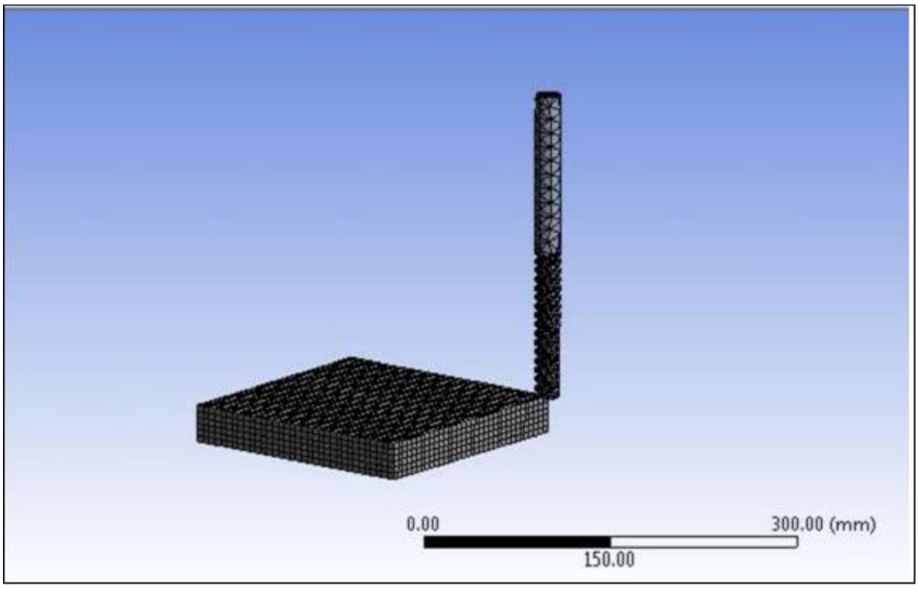


FIG: Meshed model

TEMPERATURE:

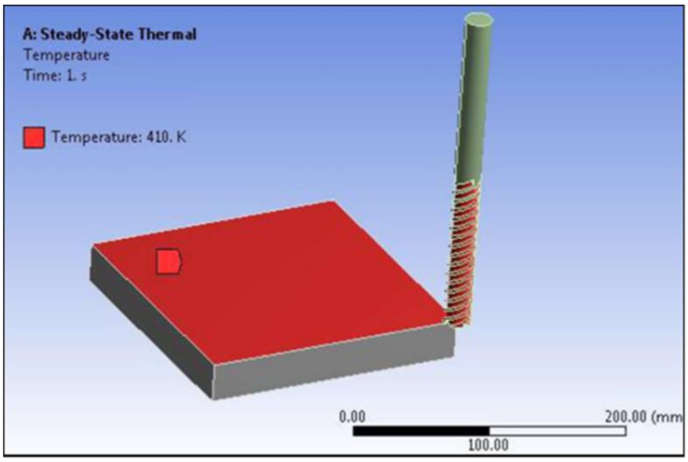
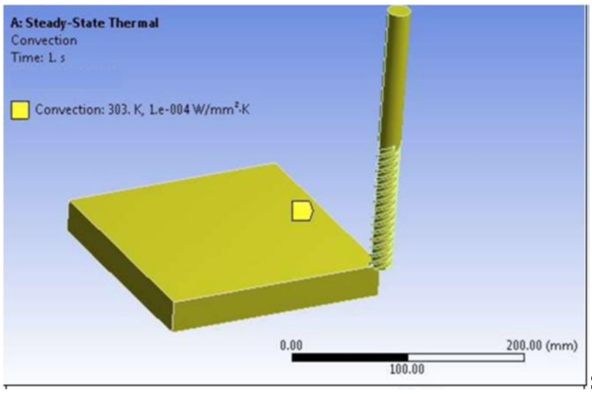


FIG: Temperature 410k

CONVECTION:



s

FIG: by applying convection

HEATFLUX:

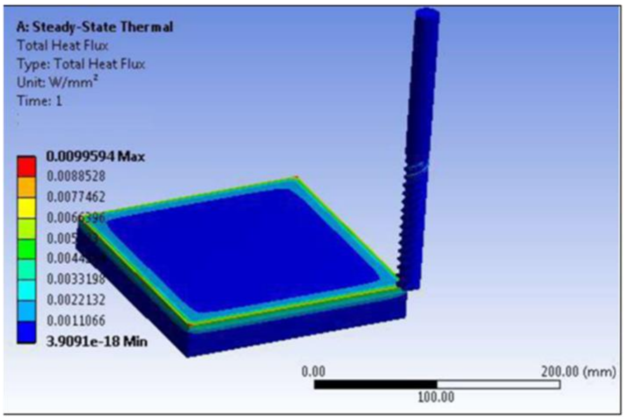


FIG: Heat flux

RESULTS TABLE:

HSS:

	Temperature (K)	Temperature(K)	Heat flux (W/mm^2)
KERNEL	410	414.08	0.016068
	460	465.98	0.023576
	510	517.88	0.031084
AIR	410	412.93	0.009594
	460	464.3	0.014613
	510	515.86	0.019267
WATER	410	414.06	0.015971
	460	465.96	0.023434
	510	517.86	0.030898

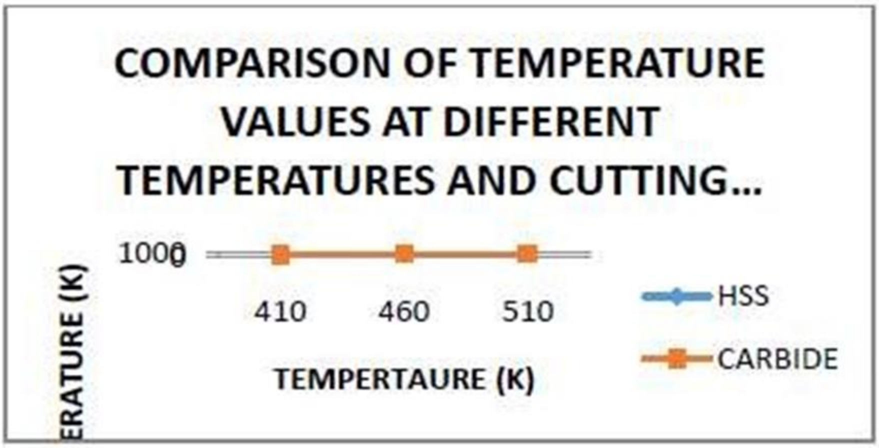
TABLE: RESULTS TABLE FOR HSS TOOL

CARBIDE:

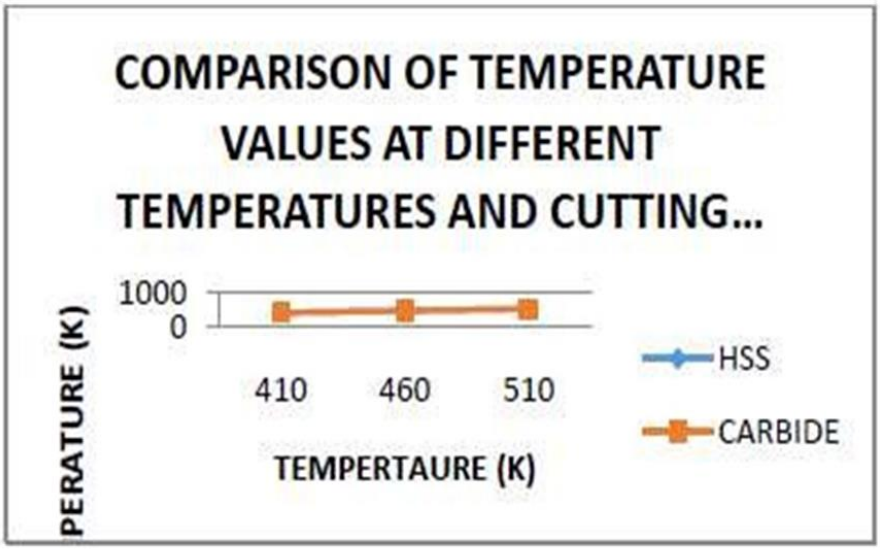
	Temperature (K)	Temperature(K)	Heat flux (W/mm^2)
KERNEL	410	412.3	2.3389
	460	463.38	3.4318
	510	514.46	4.5248
AIR	410	410	0.14218
	460	460	0.20862
	510	510	0.27505
WATER	410	410.55	0.86954
	460	460.81	1.2759
	510	511.07	1.6822

TABLE: RESULTS TABLE FOR CARBIDE TOOL

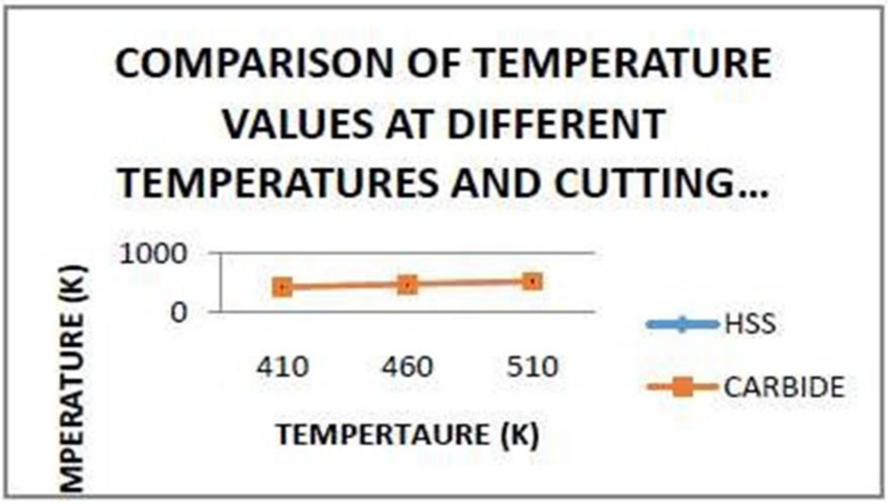
GRAPHS:



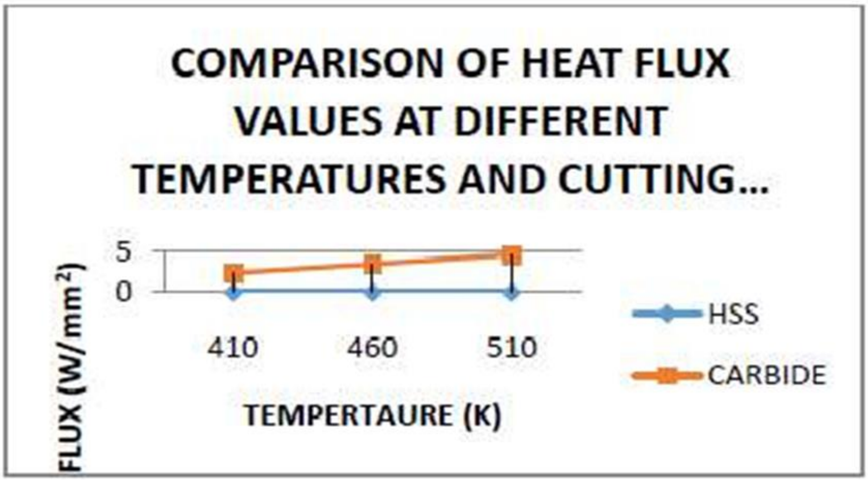
Graph: Comparison of Temperature Values at 410K Temperatures and Cutting fluids



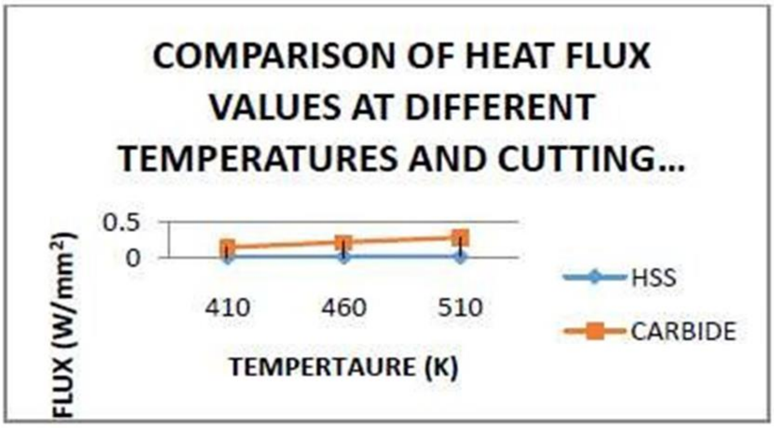
Graph: Comparison of Temperature Values at 460K Temperatures and Cutting fluids



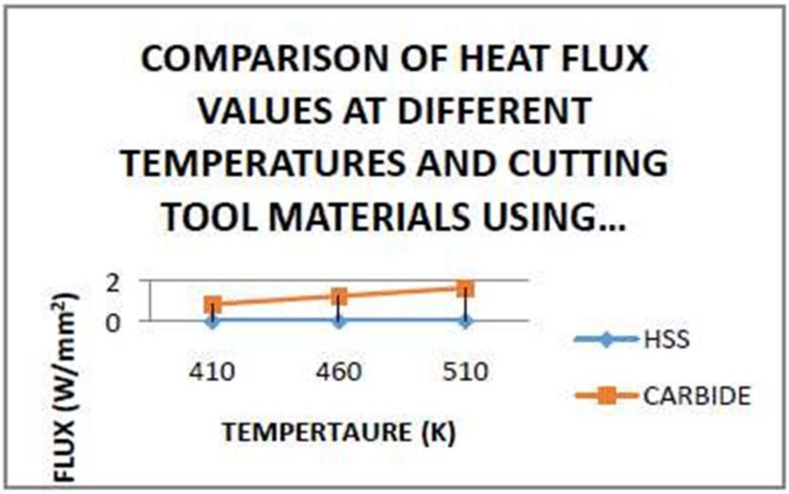
Graph: Comparison of Temperature Values at 510K Temperatures and Cutting fluids



Graph: Comparison of Heat flux Values at 410K Temperatures and Cutting fluids



Graph: Comparison of Heat flux Values at 460K Temperatures and Cutting fluids



Graph: Comparison of Heat flux Values at 510K Temperatures and Cutting fluids

CONCLUSION

In this thesis air, water and palm kernel oil are used as coolants in machining operations. Tungsten carbide and HSS slicing equipment are employed as cutter with three different temperatures of 410 k, 460 k and 510 k. Thermal analysis is carried out on the parametric mannequin to decide the effect of one-of-a-kind reducing fluids on the cutters. Parametric Modelling is completed in pro-E and evaluation is done in Ansys. By observing the evaluation results, the heat flux is more when the fluid Palm Kernel is used considering that thermal flux is greater than Air and water. When compared the values for device materials, the warmness transfer prices are more for carbide device than HSS tool.

REFERENCES

1) The Measurement of chip-tool interface Temperature in the Turning of steel by L. B. Abhang, M. Hameedullah, International Journal of Computer Communication and Information System (IJCCIS),–Vol2.No1. ISSN: 0976–1349 July –Dec 2010.
2) Effect of tool geometry variation on finish turning –A Review by M. Dogra,V. S. Sharma, J. Dureja, Journal of Engineering Science and Technology Review 4 (1) (2011) 1-13.
3) Using the Response Surface Method to Optimize the Turning Process of AISI 12L14 Steel.
4) Optimization of Process Parameters of Turning Parts: A Taguchi Approach by Neeraj Sharma, Renu Sharma.
5) The Effect of Tool Construction and Cutting Parameters on Surface Roughness and Vibration in Turning of AISI 1045 Steel Using Taguchi Method by Rogov Vladimir Aleksandrovich, GhorbaniSiamak
6) Parametric investigation of turning process on mild steel aisi 1018 material by J. M. Gadhiya, P. J. Patel
7) Evaluation and Optimization of Machining Parameter for turning of EN 8 steel by Vikas B. Magdum, Vinayak R. Naik
8) Analyses of surface roughness by turning process using Taguchi method by S.

Thamizhmanii, S.Saparudin, S. Hasan

9) Application of Taguchi Method for Optimizing Turning Process by the effects of Machining Parameters by Krishankant, JatinTaneja, MohitBector, Rajesh Kumar
10) Multi-Objective Optimization of the Cutting Forces in Turning Operations Using the Grey-Based Taguchi Method by Yigit
11) Experimental investigation of Material removal rate in CNC turning using Taguchi method by Kamal, Anish and M.P.Garg.