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Effect of Nano Fluids as Cutting Fluids in CNC Milling of Aluminum Alloys

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ABSTRACT:

Machining is one of the largest and most widely used methods of producing segments in industries. In this way, cutting fluids play an important role in minimizing production time, cost and energy in different machining operations. Determination of the maximum temperature and temperature distribution along the rake face of the cutting tool is of particular importance because of its controlling influence on tool life, as well as, the quality of the machined part.

In this thesis, the effect of nano-fluids as cutting fluids in milling of aluminium alloy is analytically investigated when machined using different cutting tools HSS and Tungsten Carbide. The nano-fluids made from base fluid Castor Oil adding to aluminium nano-fluid and silicon nano-fluid. The properties of nano-fluids are calculated from the theoretical calculations. CFD and Thermal analysis are done by applying the temperatures to determine heat transfer rates and the comparisons are for better fluids. 3D modelling is done in Pro/Engineer and analysis is done in Ansys.

INTRODUCTION:

INTRODUCTION TO MILLING:

Milling is the process of cutting away material by feeding a work piece past a rotating multiple tooth cutter. The cutting action of the many teeth around the milling cutter provides a fast method of machining. The machined surface may be flat, angular, or curved. The surface may also be milled to any combination of shapes. The machine for holding the work piece, rotating the cutter, and feeding it is known as the Milling machine.

GENERAL METHOD FOR CHOOSING SUITABLE PARAMETERS:

The choice of cutting parameters is dependent on numerous criteria:

- Productivity
- Surface condition
- Cost of the part
- Machine characteristics
- Part/machine/tool rigidity

The selection method takes these criteria into account, together with the adjustment of the following parameters:

- Forces / power
- Cutting speed
- Feed
- Engagements
- Machining direction
- Lubrication
- Range / strategies
- Vibrations
- Balancing

LIMITATION OF POWER:

The notion of power required at the spindle is an essential parameter of rough machining, as it allows the machining method to be selected or the operating conditions to be altered depending on the power available on a given machine. It must be noted that the required cutting power that has been calculated added to the no-load power at the same rotational speed must be less than the machine's available power.

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ADVANTAGES AND LIMITATIONS:

The benefits of CNC are

1. High accuracy in manufacturing
2. Short production time
3. Greater manufacturing flexibility
4. Simpler fixturing
5. Contour machining
6. Reduced human error

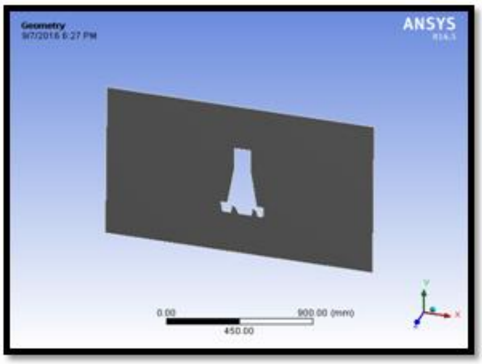
The drawbacks of CNC are

1. High cost
2. Maintenance
3. Requirement of skilled part programmer

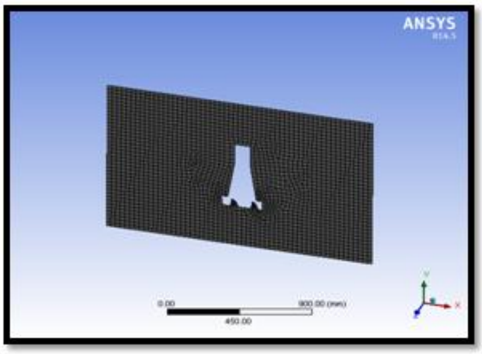
CFD ANALYSIS OF CUTTING FLUIDS IN CNC MILLING

FLUID- AL_2O_3

IMPORT MODEL

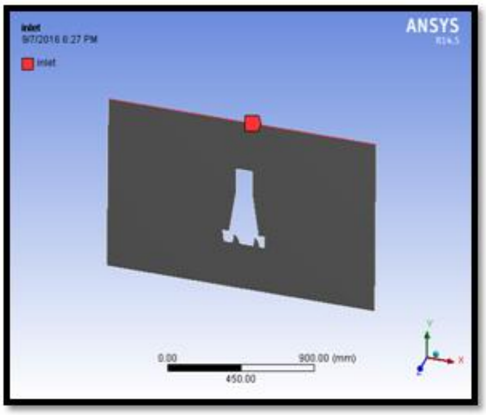


MESHED MODEL

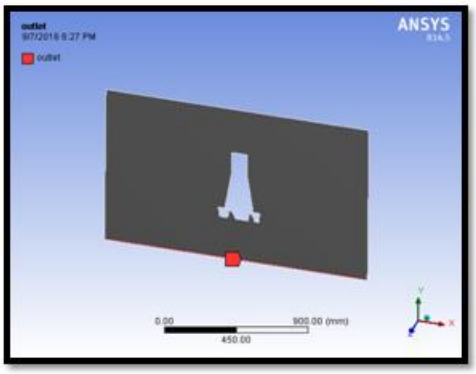


SPECIFYING BOUNDARIES FOR INLET AND OUTLET

INLET

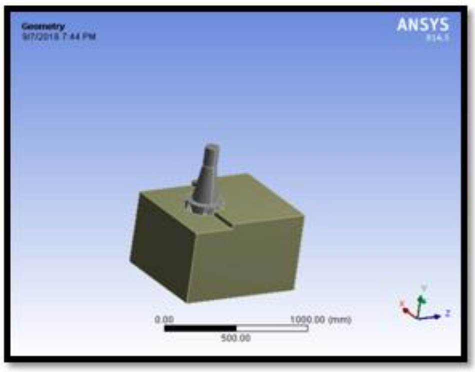


OUTLET



THERMAL ANALYSIS OF CUTTING FLUIDS IN CNC MILLINGCUTTING TOOL MATERIAL – HSSFLUID – ALUMINUM OXIDE

IMPORTED MODEL



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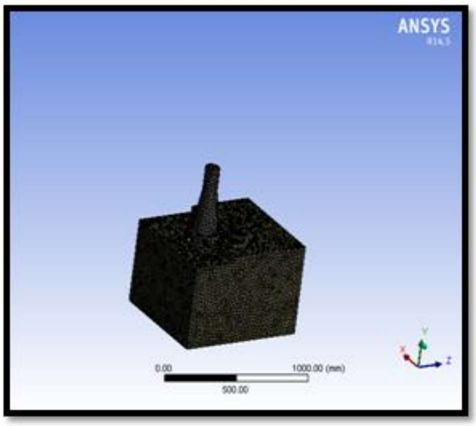

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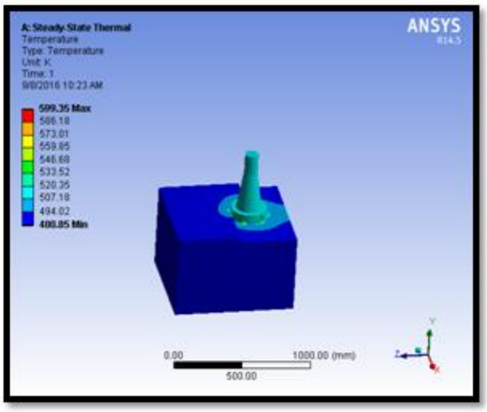

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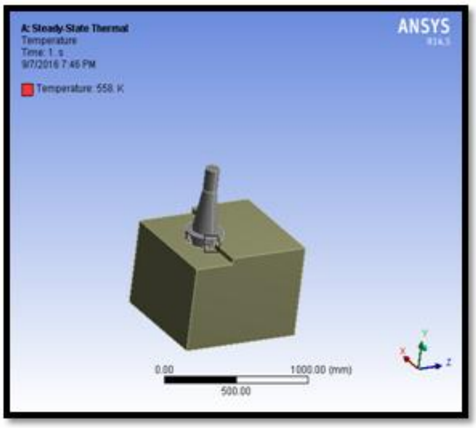
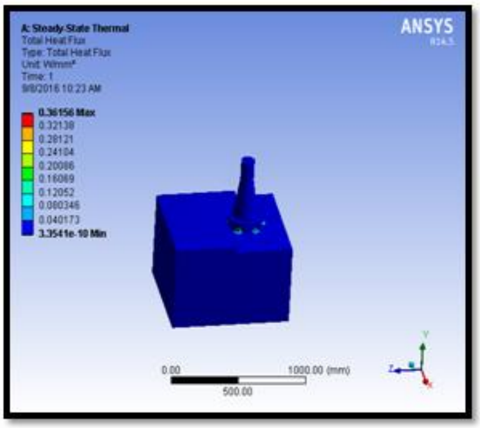
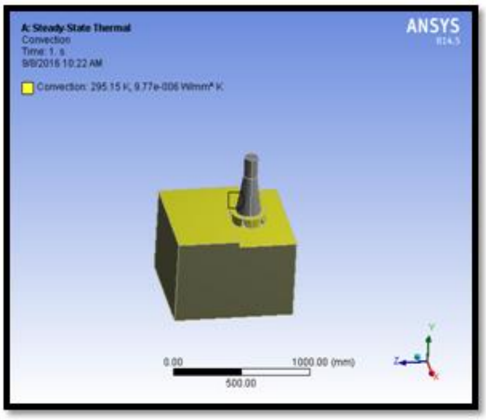


HEAT FLUX



CONVECTION



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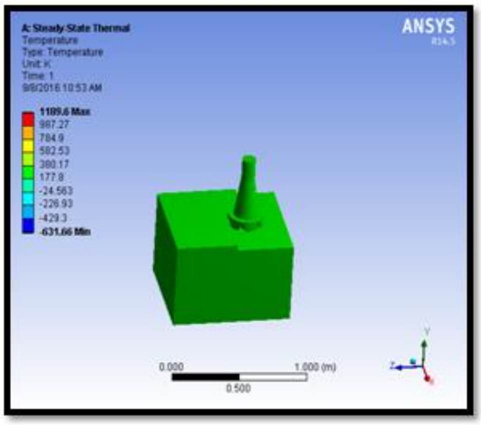

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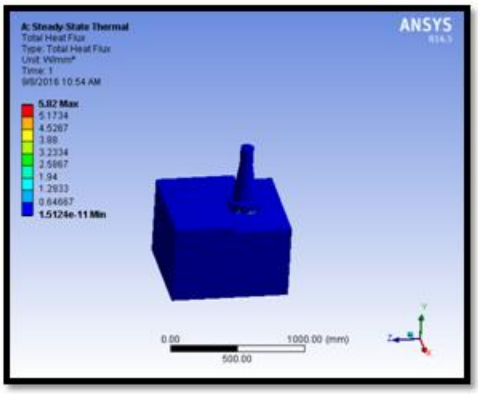

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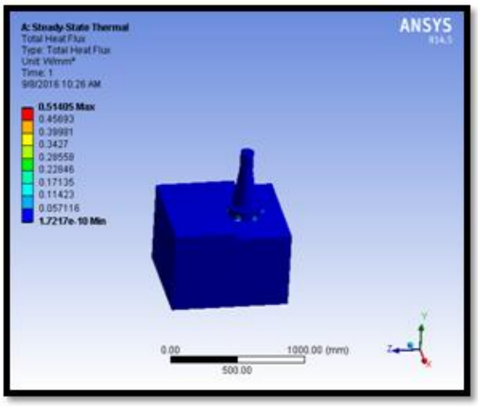
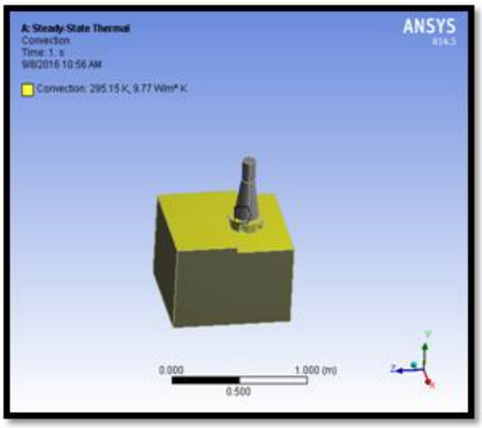


MATERIAL – TUNGSTEN CARBIDE
FLUID – ALUMINUM OXIDE
CONVECTION



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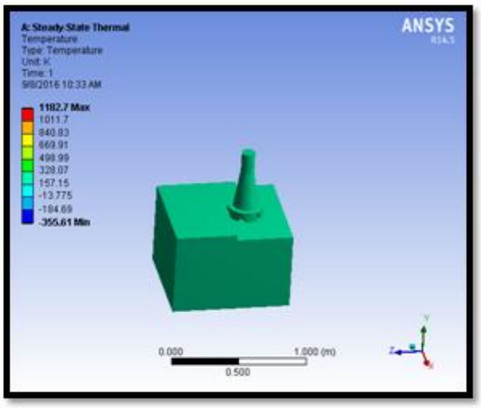

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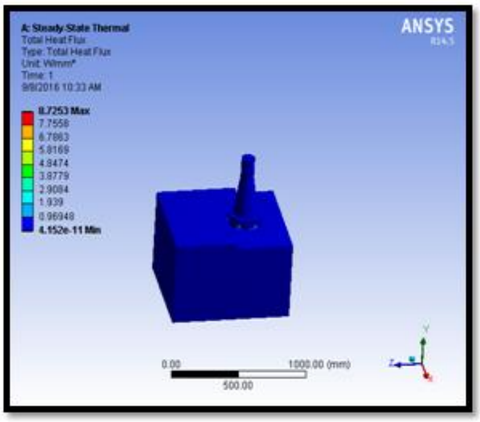

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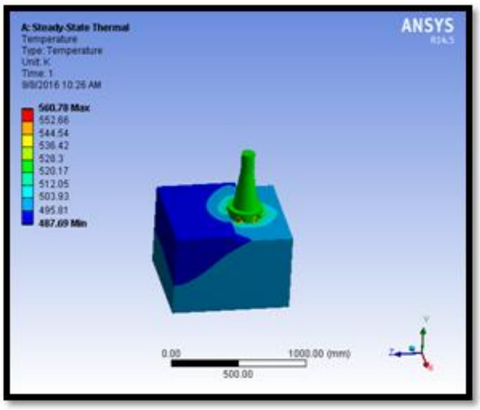

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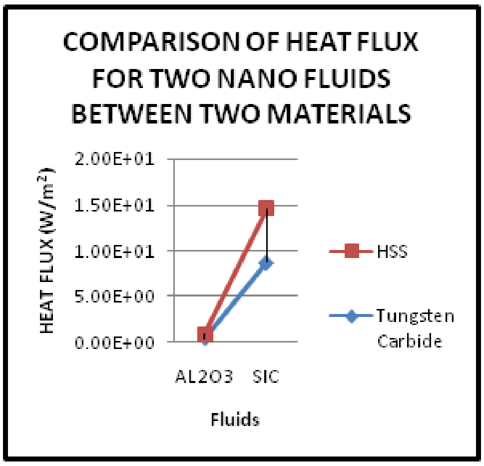
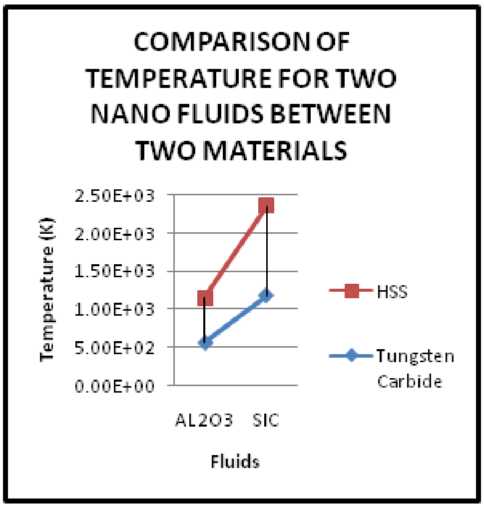
GRAPHS





TABLES

THERMAL ANALYSIS

Tool Materials	Nano-Fluids	Convection (W/m^2-k)	Temperature (K)	Heat flux (W/m^2)
Tungsten Carbide	Al_2O_3	9.77e-006	560.78	0.51405
	SiC	9.8e+006	1182.7	8.7253
HSS	Al_2O_3	9.77e-006	599.35	0.36156
	SiC	9.8e+006	1189.6	5.82

CONCLUSION:

In this thesis, the effect of nano-fluids as cutting fluids in milling of aluminium alloy is analytically investigated when machined using different cutting tools HSS and Tungsten Carbide. The nano-fluids made from base fluid Castor Oil adding to aluminium nano-fluid and silicon nano-fluid. The properties of nano-fluids are calculated from the theoretical calculations.CFD and Thermal analysis are done by applying the temperatures to determine heat transfer rates and the comparisons are for better fluids.3D modeling is done in Pro/Engineer and analysis is done in Ansys. By observing CFD analysis results, the heat transfer coefficient is more when Aluminum nano fluid is used than Silicon Carbide. That is the temperature difference between the cutting tools and cutting fluid is more when Aluminum nano fluid is used. The heat transfer rate is more when Silicon carbide is used.

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