MODELLING AND THERMAL ANALYSIS OF COMPRESSOR FINS

Ravi Kumar Panthangi[1], Pawar Sachin, A.Srinivas, V.Sai Prasad

[1]Professor, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India.

[2,3,4] Student, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India

Abstract

In this study, thermal analysis of Compressor fins is proposed and an effort is made to understand temperature distribution in compressor fins by employing cylindrical, square ,rectangular fins with different materials (Aluminium alloy 6082, Aluminium nitride, Siliconcarbide)whichaidinrapidheatremovaltothesurroundingsforensuringtheoptimalworkingof the compressor. Removal of heat generated in the compressor gets augmented by the application of fins to it. Modelling is done in CATIA V5 and Analysis is carried out using, ANSYS WORKBENCH. Heat flows out from the compressor to the surrounding through the casing and then to fins attached to it. Convective boundary condition is applied to one face ofafin.Theresultsreportthetemperaturedistributionandheattransferratecontourforvariationin fin length. Results show that ANSYS can be used effectively and efficiently to solve thechallengeofheattransferproblem.Heredifferentdesignsofheatfinsusingdifferentmaterialsareco nsideredand thermal analysis is carryout to find out the heat flux.

Keywords: Compressor fins, CATIAfile, ANSYS,Thermalanalysis,Heat flux.

1. INTRODUCTION

Manyengineeringdevicesgenerateheatduringtheiroperation.Ifthisgeneratedheatisnot dissipated rapidly to its surrounding atmosphere, this may cause rise in temperature of thesystem components. This cause overheating problems in device and may lead to the failure ofcomponent. Fins or extended surfaces are known for enhancing the heat transfer in a system.Liquid-cooling system enhances better heat transfer than air-cooling system, the constructionofair-coolingsystemisverysimpler,thereforeitisimperativeforanair-cooledenginetomakeuse of the fins effectively to obtain uniform temperature in the cylinder periphery. The majorheattransfertakesbytwomodesthatisbyconductionorbyconvection.Heattransferthroughfin to the surface of the fin takes place through conduction whereas from surface of the fin tothe surroundings, it takes place by convection. The amount of conduction, convection, orradiation of an object determines the amount of heat it transfers. Increasing the temperaturegradient between the object and the environment, increasing the convection heat transfercoefficient, or increasing the surface area of the object increases the heat transfer. Sometimesit is not feasible or economical to change the first two options. Thus, adding a fin to an objectincreases the surface area and can sometimes be an economical solution to heat transferproblem.

NecessityforCompressorcylinderCooling:

1. Enginevalves warp(twist) dueto overheating.
2. Damagetothematerialsofcylinder bodyandpiston.
3. Lubricatingoildecomposesto formgummyandcarbon
4. Reduces the strength of the materials used for piston and piston rings.
5. Overheating also reduces the efficiency.

2. PROBLEM FORMULATION

Analysingthetemperaturedistributionforfinwithdifferentcross-sections&materialsby thermal analysis and finding the optimum fin cross section with suitable material whichincrease the heat transfer rate. By this, the compressor efficiency will increase and the life ofthecompressoralso increases.To Analyse the temperature distribution for fins with different cross-sections andmaterials, you can use thermal analysis software such as ANSYS. These software packagesallow you to simulate heat transfer and temperature distribution in complex geometries, suchasfins.Tobegin,youwouldcreatea3D modelofthefininthesoftwareanddefinethe materialproperties of the fin and surrounding environment. You would also need to define the heatsources and boundary conditions for the simulation, such as the heat flux at the base of the finandthe temperatureof thesurrounding air.Next, you would run the simulation and analyse the temperature distribution along thelengthofthefinfordifferentcross-sectionalshapesandmaterials.Youcouldthencomparetheresults to determine which combination of cross-sectional shape and material provides thehighest heat transfer rate and the lowest temperature gradient along the fin. Once you haveidentified the optimum fin cross section with suitable material, you could use this informationtodesignandmanufacturefinsthatimprovetheheattransferrateofthecompressor.Thiscouldleadto increasedcompressor efficiencyandalongerlifespanforthe compressor.

3. OBJECTIVE

After studying the above research papers we concluded that, to perform the thermal analysisof different fins cross-sections by considering different fin materials and finding the optimumfinwhich has better heattransferrate.

4. METHODOLOGY

- By considering the fin dimensions, 3D fin is modelled in different cross sections usingCATIAV5 software.
- Aftermodellingisdone.Thefile isextractedintoANSYS15.0,subsequentmaterialisaddedto thecomponentandthermal analysis is performed.
- Thenthetemperaturedistributionisanalysedandfromwhichtheheatfluxisobtained.
- Aftercomputingheatfluxvalues,thefincrosssectionwithsuitablematerialwhichhashigherheatfluxvalueis consideredasoptimumfin(as ithasbetterheattransferrate)

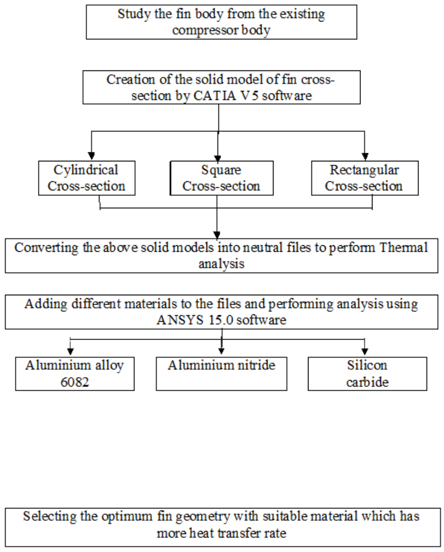

Fig. 4.1 Flow diagram

5. EXPERIMENTATION

ModellingofBaseplate:

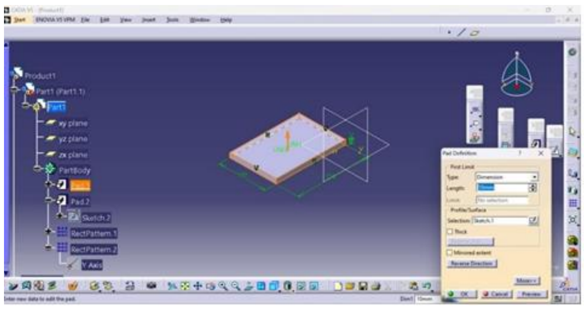

Fig.1 Thebaseplateis drafted with thedimensions

ModellingofRectangularfin:

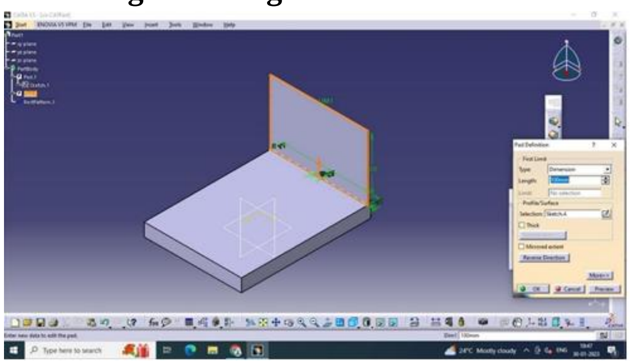

Fig.2 Thesingle rectangular

finisdraftedon thebasewithdimensions

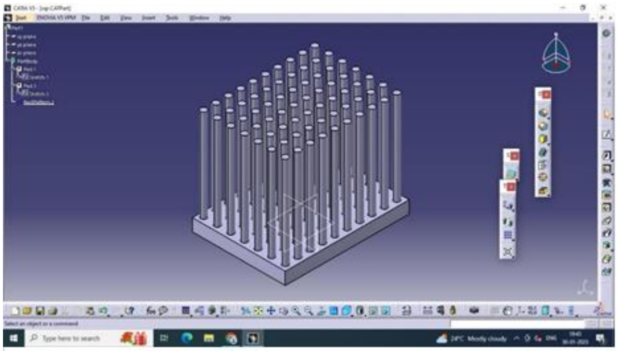

Fig.3 Using extrudecommandcylindrical pinfins aredraftedover thebase

TABULATIONOFRESULTS

Afterperformingthethermalanalysisthereults(Heatfluxvalues)obtainedarelistedbelowaccord ingto material wise forthreefin cross-sections.

Iteration1:Aluminiumalloy6082

Table1Heatflux valuesatgiven temp.fordifferent finprofilesfor Alalloy6082

Temperature	Rectangular fin	Cylindrical fin	Square fin
500 °C	6.1185e6	6.4758e6	4.3436e7
1000 °C	6.4124e6	1.325e7	8.887e7
1500 °C	1.8919e7	2.0024e7	1.3431e8

Iteration2:Aluminiumnitride

Table2Heat fluxvaluesat giventemp.for differentfinprofiles forAlnitride

Temperature	Rectangular fin	Cylindrical fin	Square fin
500 °C	5.4625e6	4.0239e7	4.0516e7
1000 °C	1.1176e7	8.233e7	8.2897e7
1500 °C	1.689e7	1.2442e8	1.8039e7

Iteration3:Siliconcarbide

Temperature	Rectangular fin	Cylindrical fin	Square fin
500 °C	4.8128e6	4.098e7	4.1285e7
1000 °C	9.8471e6	1.0811e7	8.4469e7
1500 °C	1.4881e7	1.2671e8	1.6522e7

6. COMPARISONOFRESULTS

Forrectangularfin

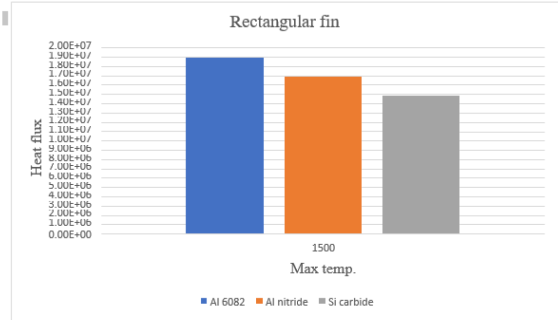

Fig.5 -Heatflux vsMax tempdistribution for3 materialsofrectangularfin

7. RESULTSANDDISCUSSION

Table3 Result table(heat fluxvaluesfrom resultsand discussion)

Temperature	Rectangular fin (Al 6082)	Cylindrical fin (Si-c)	Square fin (Al 6082)
500 °C	6.1185e6	4.098e7	4.3436e7
1000 °C	6.4124e6	1.0811e7	8.887e7
1500 °C	1.8919e7	1.2671e8	1.3431e8

8. CONCLUSION

In the present study, we have modelled different fin geometries (rectangular, cylindrical,square). We have replaced the fins with different materials such as Aluminium alloy 6082,Aluminium nitride, Silicon carbide. The fins are modelled using CATIA V5 and the thermalanalysis is performed using ANSYS. From the analysis, the observations were tabulated. Byobaserving the result table, we made a comparison to find the optimum fin material which hasgreater heat dissipation capacity for each fin cross-section separately. Then we have made afinalresultbycomparingtheabove3finprofileswiththeiroptimummaterialusingbargarph,itisconcludedthatSquarefinwithAluminiumaloy6082hasmoreheattransferratefol lowedbycylindrical and rectangularfins.

9. REFERENCE

1. J.AjayPaul,SagarChavanVijay,Magarajan&ThundilKaruppaRaj(2012),"ExperimentalandParametricStudyofExtendedFinsInTheOptimizationofInternalCombustionEngineCoolingUsingCFD",InternationalJournalofAppliedResearchinMechanicalEngineering
2. G. Babu and M. Lavakumar (2013). "Heat Transfer Analysis and Optimization of EngineCylinder Fins of Varying Geometry and Material." IOSR Journal of Mechanical and CivilEngineering(IOSR-JMCE)7(4): 24-29.
3. Md. Sikindar Baba, Nagakishore, Prof. M. Bhagvanth Rao (2014), "Thermal Analysis onFinnedTubeHeatexchangerofTwoStageAirCompressor,"IJRASET,vol.2issueV,May2014,ISSN; 2321-9653
4. R. Suresh, K. Lalith Narayan (Prof), Ch.Lakshmi Poornima (Asst. prof)Jan 2014, DesignandAnalysisofCylinderFins, Vol.3Issue1,January-2014ISSN:2278-0181IJERTV3IS10740
5. P. Sai Chaitanya, B. Suneela Rani, K. Vijaya Kumar, (2014). Thermal Analysis of EngineCylinderFinbyVaryingItsGeometryandMaterial,IOSRJournalofMechanicalandCivilEngineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 6Ver. I, PP 37-44
6. SantoshkansalPiyushlaad,[2015]ThermalAnalysisoffinsofusingdifferentconfigurationUsingCFDDOI:https://www.citefactor.org/journal OfCAD
7. MohsinAliandProf.(Dr.)S.MKherde Feb2015HeatTransferAnalysisbyCFDSimulationfordifferentshapesofFinshttps://www.ijraset.com/fileserve.php?FID=1665
8. Saurabh Pathak, Om Prakash, Ravikanth, [2016] Thermal analysis of fin with varyingGeometryofdifferentmaterialsDOI: https://www.ijsrd.com/articles/IJSRDV4I3ofFEA
9. Md.amit,(2016)Thermalanalysisof ModifiedpinfinheatsinkDOI:10.1109/ICIEV.2016.7759986
10. N.SrinivasaRao,G.V.Subhash,K.AshokKumar,[2016]"DesignandStudy TheEffectivenessOfEngineCylinder FinWithVariableGeometryAndMaterial",InternationalJournalof ResearchinEngineeringandTechnology,Volume:05,Issue:1
11. Dabbu, M., Karuppusamy, L., Pulugu, D., Vootla, S.R., Reddyvari, V.R., 2022, Water atom search algorithm-based deep recurrent neural network for the big data

classification based on spark architecture, International Journal of Machine Learning and Cybernetics, 10.1007/s13042-022-01524-8

12. Venkateshwarlu, M., Rajagopal, K., Reddy, C.O., Reddy, Y.S., 2022, Investigation of Groundwater Contamination due to Landfill Leachate, Indian Journal of Environmental Protection, Volume: 42
13. Suryanarayana, G., Prakash K, L., Mahesh, P.C.S., Bhaskar, T., 2022, Novel dynamic k-modes clustering of categorical and non categorical dataset with optimized genetic algorithm based feature selection, Multimedia Tools and Applications, 10.1007/s11042-022-12126-5
14. Balamurugan, D., Aravinth, S.S., Reddy, P.C.S., Rupani, A., Manikandan, A., 2022, Multiview Objects Recognition Using Deep Learning-Based Wrap-CNN with Voting Scheme, Neural Processing Letters, 10.1007/s11063-021-10679-4
15. Das, S., Nayak, S.C., Sahoo, B., 2022, Towards Crafting Optimal Functional Link Artificial Neural Networks with Rao Algorithms for Stock Closing Prices Prediction, Computational Economics, 10.1007/s10614-021-10130-9