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Thermal Analysis of Coolant Plumbing Pipe

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Abstract: A heat pipe is a heat-transfer device that combines the principles of both thermal conductivity and phase transition to efficiently manage the transfer of heat between two solid interfaces. At the hot interface of a heat pipe a liquid in contact with a thermally conductive solid surface turns into a vapor by absorbing heat from that surface. The vapor then travels along the heat pipe to the cold interface and condenses back into a liquid – releasing the latent heat. The liquid then returns to the hot interface through capillary action, centrifugal force, or gravity, and the cycle repeats. Due to the very high heat transfer coefficients for boiling and condensation, heat pipes are highly effective thermal conductors. The effective thermal conductivity varies with heat pipe length, and its thermal properties of materials. The objective of this project is to study the heat transfer in the sq and select the best material on basis of thermal analysis results. Cad model is generated in Uni graphics premium. And thermal analysis has done in Ansys thermal simulation.

Keywords: Coolant Plumbing Pipe, Solar Collector Arrays, Unigraphics.

I. INTRODUCTION

A typical heat pipe consists of a sealed pipe or tube made of a material that is compatible with the working fluid such as copper for water heat pipes, or aluminum for ammonia heat pipes. Typically, a vacuum pump is used to remove the air from the empty heat pipe. The heat pipe is partially filled with a working fluid and then sealed. The working fluid mass is chosen so that the heat pipe contains both vapor and liquid over the operating temperature range. Below the operating temperature, the liquid is too cold and cannot vaporize into a gas. Above the operating temperature, all the liquid has turned to gas, and the environmental temperature is too high for any of the gas to condense. Whether too high or too low, conductions still possible through the walls of the heat pipe, but at a greatly reduced rate of thermal transfer. Working fluids are chosen according to the temperatures at which the heat pipe must operate, with examples ranging from liquid helium for extremely low temperature applications (2–4 K) to mercury (523–923 K), sodium (873–1473 K) and even indium (2000–3000 K) for extremely high temperatures. The vast majority of heat pipes for room temperature applications use ammonia (213–373 K), alcohol (methanol (283–403 K) or ethanol (273–403K)) or water (298–573K) as the working fluid. Copper/ water heat pipes have a copper envelope, use water as the working fluid and typically operate in the temperature range of 20 to 150 °C.[1][2] Water heat pipes are sometimes filled by partially filling with water, heating until the water boils and displaces the air, and then sealed while hot. For the heat pipe to transfer heat, it must contain saturated liquid and its vapor (gas phase). The saturated liquid vaporizes and travels to the condenser, where it is cooled and turned back to a saturated liquid. In a standard heat pipe, the condensed liquid is returned to the evaporator using a wick structure exerting a capillary action on the liquid phase of the working fluid. Wick structures used in heat pipes include sintered metal powder, screen, and grooved wicks, which have a series of grooves parallel to the pipe axis. When the condenser is located above the evaporator in a gravitational field, gravity can return the liquid. In this case, the heat pipe is a thermo syphon. Finally, rotating heat pipes use centrifugal forces to return liquid from the condenser to the evaporator.

A. Solar Thermal

Heat pipes are also widely used in solar thermal water heating applications in combination with evacuated tube solar collector arrays. In these applications, distilled water is commonly used as the heat transfer fluid inside a sealed length of copper tubing that is located within an evacuated glass tube and oriented towards the sun. In connecting pipes, the heat transport occurs in the liquid steam phase because the thermal transfer medium is converted into steam in a large section of the collecting pipeline. In solar thermal water heating applications, an individual absorber tube of an evacuated tube collector is up to 40% more efficient compared to more traditional "flat plate" solar water collectors. This is largely due to the vacuum that exists within the tube, which slows down convective and conductive heat loss. Relative efficiencies of the evacuated tube system are reduced however, when compared to flat plate collectors because the latter have a larger aperture size and can absorb more solar energy per unit area. This means that while an individual evacuated tube has better insulation (lower conductive and convective losses) due to the vacuum created inside the tube, an array of tubes found in a completed solar assembly absorbs less energy per unit area due to there being less absorber surface area pointed toward the sun because of the rounded design of an evacuated tube collector. Therefore, real world efficiencies of both designs are about the same.

II. INTRODUCTION TO CAD

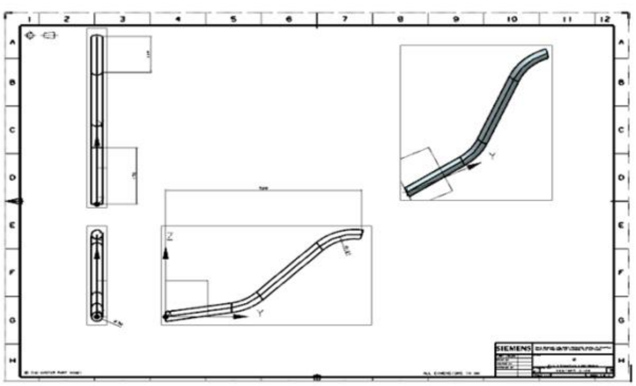
A. Introduction To Uni-Graphics

The UNIGRAPHICS NX Modeling application provides a solid modeling system to enable rapid conceptual design. Engineers can incorporate their requirements and design restrictions by defining mathematical relationships between different parts of the design. Design engineers can quickly perform conceptual and detailed designs using the Modeling feature and constraint based solid modeler. They can create and edit complex, realistic, solid models interactively, and with far less effort than more traditional wire frame and solid based systems. Feature Based solid modeling and editing capabilities allow designers to change and update solid bodies by directly editing the dimensions of a solid feature and/or by using other geometric editing and construction techniques.

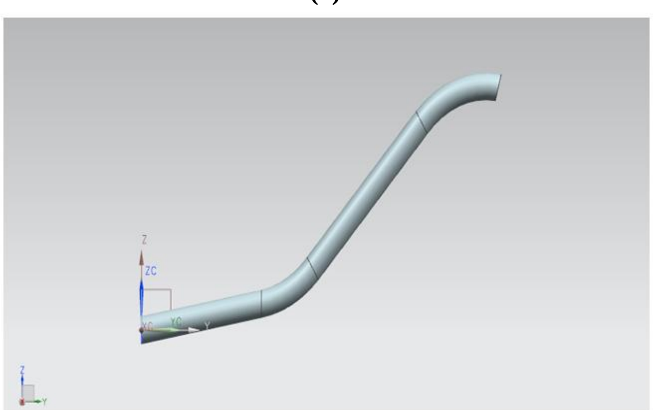
B. Boolean Operations

Modeling provides the following Boolean Operations: Unite, Subtract, and Intersect. Unite combines bodies, for example, uniting two rectangular blocks to form a T-shaped solid body. Subtract removes one body from another, for example, removing a cylinder from a block to form a hole. Intersect creates a solid body from material shared by two solid bodies. These operations can also be used with free form features called sheets.

III. 3D MODELING OF COOLANT PLUMBING PIPE



(a)



(b)

(c)

Fig.1. 3D model in isometric view.

Schuller W., Eckstein U.,[1] had invented a piston made of plastic, which is manufactured by means of injection molding as shown in Fig.1. The advantages of the plastic piston are positive sliding properties of the piston in the pump housing. In order to improve the sliding properties and to reduce wear, the plastic of the piston can have TEFLON components added to it. The piston pump, in which the piston is polytetrafluor ethylene. Hauser M., Alaze N., et al. [2] to make a piston of the piston pump easy and inexpensive to manufacture, the invention proposes that the piston be comprised of a sleeve like shaped part and a valve seat part that is made of plastic and is press fitted into the shaped part. The invention permits a small and compact design of the piston pump. Other advantages are the fact that it is manufactured from simple and inexpensively producible components and is comprised of a small number of components. The piston is optimized with regard to its manufacture while simultaneously retaining its full functionality. Nakamura K., [3] invented the piston and the body are made of resinous material and are molded as a single body thereby reduce the resultant weight and the cost. It is an object of the invention to provide a new and improved piston for a cylinder device. Schardt M. M. [4] says each of the pistons has a metallic, ceramic or high glass nylon plastic core insert with glass filled nylon plastic molded around it to form the finished piston. The invention relates to master cylinder pistons which are constructed in composite form and more particularly to such pistons having a metallic, ceramic or high glass-filled nylon plastic core covered with an envelope of a suitable material such as glass filled nylon plastic molded around it to form the finished piston. Genz O. F., Park E., et al [6] the main objective of the invention to provide a piston for a cylinder whereby a condition incident to the operation of the cylinder is turned to advantage causing the bearing and wear absorbing functions to be performed and coaxiality of the piston and cylinder is maintained.

IV. INTRODUCTION ANSYS &FEM

The Basic concept in FEA is that the body or structure may be divided into smaller elements of finite dimensions called

"Finite Elements". The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called "Nodes" or "Nodal Points". Simple functions are chosen to approximate the displacements over each finite element. Such assumed functions are called "shape functions". This will represent the displacement within the element in terms of the displacement at the nodes of the element. The Finite Element Method is a mathematical tool for solving ordinary and partial differential equations. Because it is a numerical tool, it has the ability to solve the complex problems that can be represented in differential equations form. The applications of FEM are limitless as regards the solution of practical design problems. Due to high cost of computing power of years gone by, FEA has a history of being used to solve complex and cost critical problems. Classical methods alone usually cannot provide adequate information to determine the safe working limits of a major civil engineering construction or an automobile or an aircraft. In the recent years, FEA has been universally used to solve structural engineering problems. The departments, which are heavily relied on this technology, are the automotive and aerospace industry. Due to the need to meet the extreme demands for faster, stronger, efficient and lightweight automobiles and aircraft, manufacturers have to rely on this technique to stay competitive.

V. THERMAL ANALYSIS OF PLUMBER PIPE

Material properties of Aluminum A360:

Density -2.65 g/cm3

Ultimate Tensile strength -300MPa

Yield tensile strength -180MPa

Modulus of elasticity -71GPa

Poisson ratio - 0.33

Specific heat -963J/kg-K

Thermal conductivity -113W/m-K

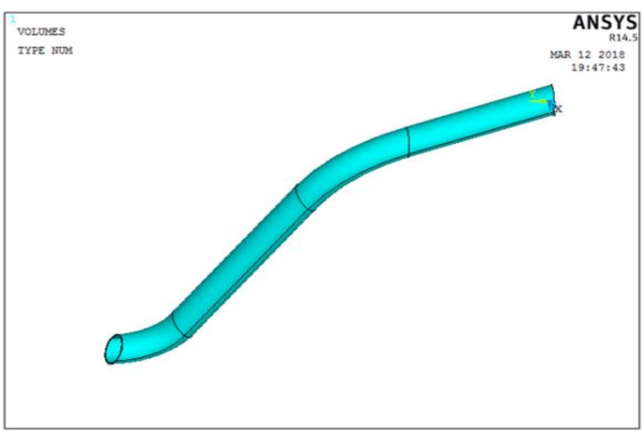


Fig.2.

A. Creating A Finite Element Mesh

According to given specifications the element type chosen is solid 227. Solid 227 is higher order version of the 3-D eight node thermal element (Solid 70). The element has 20 nodes with single degree of freedom, temperature, at each node. The 20-node elements have compatible temperature shape and are well suited to model curved boundaries. The 20-node thermal element is applicable to a 3-D, steady state or transient thermal analysis. The parasolid file is imported into ansys and is meshed with 20 node thermal solid 227 element type. The structure, number of nodes and input summary of the element is given below Fig.2.

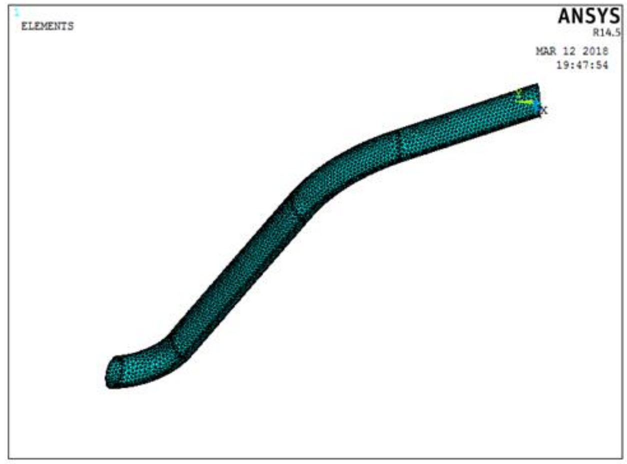


Fig.3.

B. Thermal Boundary Conditions

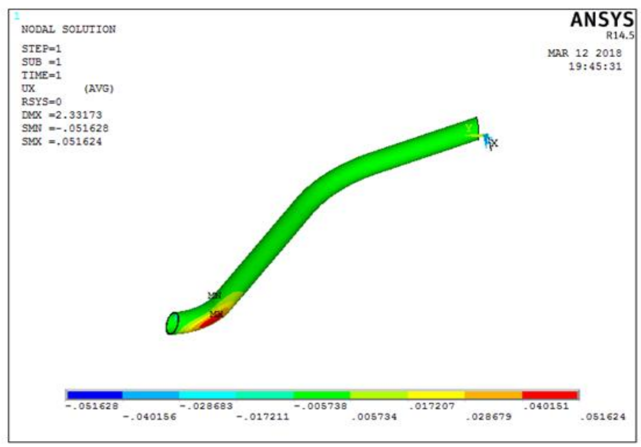


Fig.4.

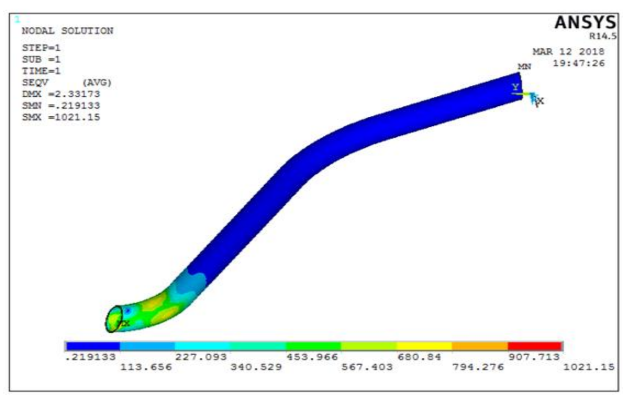


Fig.5.

C. Thermal Analysis Of Plumber Pipe Using Copper

Material properties of Copper C18200:

Density -8.89 g/cm3

Ultimate Tensile strength -379MPa

Yield tensile strength -379MPa

Modulus of elasticity -117GPa

Poisson ratio - 0.181

Specific heat -380J/kg-K

Thermal conductivity -323W/m-K

D. Creating A Finite Element Mesh

According to given specifications the element type chosen is solid 227. Solid 227 is higher order version of the 3-D eight node thermal element (Solid 70). The element has 20 nodes with single degree of freedom, temperature, at each node. The 20-node elements have compatible temperature shape and are well suited to model curved boundaries. The 20-node thermal element is applicable to a 3-D, steady state or transient thermal analysis. The parasolid file is imported into ansys and is meshed with 20 node thermal solid 227 element type. The structure, number of nodes and input summary of the element is given below.

Fig.6.

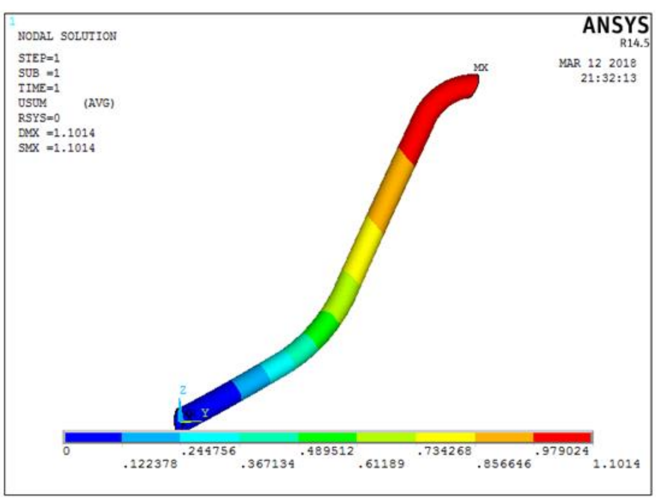


Fig.7.

VI. RESULTS AND CONCLUSION

From Thermal analysis of coolant plumbing pipe by using Aluminum, Maximum Temperature distribution (Reduced temperature) formed on pipe is 300 K and maximum thermal flux 5.63 (W/m2) is found. Also maximum deformation on pipe found is 2.33 mm and Von misses stress (Thermal stress) is 1021.15 MPa. But yield strength of Aluminum material is 180 MPa. So pipe is subjected fail using Aluminum because of thermal stress formed greater than yield strength of Aluminum. From Thermal analysis of coolant plumbing pipe by using Copper C18200, Maximum Temperature distribution (Reduced temperature) formed on pipe is 300K and maximum thermal flux 9.12 (W/m2) is found. Also maximum deformation on pipe found is 1.10 mm and Von misses stress (Thermal stress) is 195.75 MPa. But yield strength of Aluminum material is 379 MPa. So pipe is safe under loading conditions using Copper because of thermal stress formed greater than yield strength of Copper.

TABLE I:

Results type	By using Aluminum	By using Copper
Temperature distribution (K)	300	300
Deformation (mm)	2.333	1.10
Thermal stress(MPa)	1021.15	195.75
Thermal flux (W/m^2)	5.63	9.12

VII. REFERENCES

[1] T. Panczak et al, Thermal Desktop® User's Manual, www.crtech.com.

[2] D. Johnson et al, “Novel Simulation Techniques for Design of Air-cooled Electronics,” IPACK2001-15523, July 2001.

[3]S. Ring, SinapsPlus® User’s Manual, www.crtech.com

[4] J. Baumann et al, “Nonlinear Programming Applied to Calibrating Thermal and Fluid Models to Test Data,” SEMI-THERM, March 2002.

[5] B. Cullimore, “Dealing with Uncertainty and Variations in Thermal Design,” IPACK2001-15516, July 2001.

[6] B. Cullimore, “Nonlinear Programming Applied to Thermal and Fluid Design Optimization,” ITHERM, May 2002.

[7] SINDA/FLUINT User’s Manual, HEATPIPE and HEATPIPE2 utilities, www.crtech.com

[8] J. Ku, “Operating Characteristics of Loop Heat Pipes,” SAE 1999-01-2007, July 1999.

[9] Baumann et al, “Steady State and Transient Loop Heat Pipe Modeling,” SAE 2000-ICES-105, July 2000.

[10] J. Baumann et al: “Noncondensible Gas, Mass, and Adverse Tilt Effects on the Start-up of Loop Heat Pipes,” SAE 1999-01-2048.

[11] J. Baumann et al, “An Analytical Methodology for Evaluating Start-up of Loop Heat Pipes,” AIAA 2000-2285.

[12] Thermacore's Xeon™ Processor Cooler, www. thermacore.com/therma_sink.htm.