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#### “TRANSIENT ANALYSIS OF THERMAL SHUT-OFF VALVE CHAMBER FOR THERMAL POWER PLANT BY USING ANSYS”

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#### ABSTRACT

*Most flow applications require valve for flow of liquid, and usually the parameter of concern is the Most flow applications require regulating the flow of liquid, and usually the parameter of concern is the finite element analysis. There are many authors work on this pressure valve and thermal set up valve. This paper includes study of various papers related to self regulating pressure valve and other flow. In this project focus on flow of liquid between chamber. Electronic valves are available, however the intent of this design project is have a total mechanical system, which has an in built response mechanism. This project basically focused on the transient analysis of Thermal shutoff valve. This transient analysis is generally used to determine the Heat flow and heat flux of a structure under the action of any general time-dependent loads. Drawings, a major part of the project was undertaken on CATIA V5 R20. Thermal analysis was done on Ansys 17.0 workbench. Primary objective of reducing the cost of manufacturing and bringing down of the entire unit cost was kept in mind and was the primary driving motion.*

**Key Words:** Transient, Ansys, Flow, valves, Autodesk inventor, Thermal shutoff valve

#### I. INTRODUCTION

Many types of industrial systems involve processes and process liquids, specific characteristics of which need to be analyzed from time to time. An example is an electrical generating plant, the hot steam condensate of which is periodically checked for pH, contaminants and he like. Another example is a crude oil refining plant in which various “tapping” e.g. gasoline, kerosene, lubricating oil stock are heat extracted from the crude oil. The refiner periodically analyzes the chemical characteristics of the fractions. Analysis of the exemplary liquids mentioned above may be carried out in at least two ways, each of which involves “tapping” the pipe or other liquid carrier to draw off a liquid sample.

It is being used in SWAS panel for high temperature protection before high temperature samples can reach instrumentation. A thermal shut- off valve comprising a valve housing, means within said housing movable between a first position wherein said valve is open so as to permit flow there through and a second position wherein said valve is closed so as to block flow there through, means within said housing normally urging said movable means towards said second position, and thermally actuated means mounted outside of said housing normally maintaining said movable means in said first position, said thermally actuated means comprising a fusible link, first means holding one end of said link, and second means holding the other end of said link, said first and second means cooperating so as to hold

said link under tension, said second means comprising a rigid lever arm having a fulcrum position, one end of said arm engaging said other end of said link and means adjustably and releasably holding the other end of said arm in spaced relation to said housing with said fulcrum portion in blocking engagement with said movable means to prevent movement thereof to said second position, whereby when said link fuses due to the presence of the predetermined degree of heat the tension exerted on said link by said lever arm causes said link to separate, thus releasing said lever arm thereby said fulcrum portion automatically moves away from said blocking engagement, thus permitting said movable means to move second position pursuant to the impetus of said urging means.

## II. THERMAL SHUT OFF VALVE

TSV is a fully mechanical valve designed to protect instrumentation and personnel from the damaging effects of excessive sample temperatures. These temperature excursions could be the result of excessive sample flow rates.

The Thermal Setup Valve (TSV) includes an elongate, tube like housing which has an inlet port and an outlet port. An insert is threaded in to a stepped bore and such insert has a central passage that extends along the valve long axis. There is a cross-hole intersecting the passage and a valve seat is held in its fixed position by the insert. A stem extends through the central passage and has respective ends attached to the reset button and to the valve member of the valve body. A sealing ring prevents liquid leakage from the valve interior region as the stem moves with respect to the insert. The valve is configured to permit mounting through an instrument panel and is retained there by a lock nut which engages the thread. The valve member, part of a cap like device threaded to the body piece, has an annular valve surface which is angled with respect to the axis. When the device and its valve member are in the flow blocking second position, the surface is against the seat and flow through the opening in the seat is prevented. In a specific embodiment, the device has two opposed wrench flats, which are used during assembly to tighten the device with respect to the body piece.

## III. PARAFFIN WAX

One of the reasons for using paraffin wax as actuator material is its huge volume expansion when melted, 10-20%. Paraffin wax can also be loaded with hundreds of MPa and still shows a useful expansion. Scaling of a thermal actuator is also favourable looking at activation time and power consumption making it interesting for a micro actuator. By combining the paraffin with simple materials and processes, such as printed circuit boards and UV-curable adhesives (Epoxy), prototypes can be realized quickly. In this laboratory experiment a thermal paraffin membrane actuator is fabricated using UV-curable epoxy on a PCB with copper heaters. The actuator is characterized and tested with the aid of a contact probe. As per the requirement we have selected Astorstat HA18 paraffin wax.

## IV. TRANSIENT ANALYSIS

Transient thermal analyses determine temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as with cooling of electronic packages or a quenching analysis for heat treatment. Also of interest are the temperature distribution results in thermal stresses that can cause failure. In such cases the temperatures from a transient thermal analysis are used as inputs to a structural analysis for thermal stress evaluations. Transient thermal analyses can be performed using the ANSYS solver. Many heat transfer applications such as heat treatment problems, electronic package design, nozzles, engine blocks, pressure vessels, fluid-structure interaction problems, and so on involve transient thermal analyses. A transient thermal analysis can be either linear or nonlinear. Temperature dependent material properties (thermal conductivity, specific heat or density), or temperature dependent convection coefficients or radiation effects can result in nonlinear analyses that require an iterative procedure to achieve accurate solutions. The thermal properties of most materials do vary with temperature, so the analysis usually is nonlinear.

**Technical Data**

Inlet Pressure Rating . . . . . 5000 psi (344 bar)

Outlet Pressure Rating . . . . . 250 psi (17 bar)

Trip Point (Standard) . . . . . 120°F (49°C)

Optional Trip Points . . . . . 95°F (35°C)

Inlet Water Temp. = 170°C

Outlet Water Temp. = 100 °C

**Boundary conditions**

$$Q = h A (T_2 - T_1)$$

$$h = 350 \text{ to } 3000 \text{ w/m}^2\text{k}$$

$$A = \pi DL = \pi * 0.011 * .02395 = 0.00079 \text{ m}^2$$

$$\Delta T(\text{water}) = T_1 - T_2 = 170^\circ - 100^\circ = 70^\circ$$

$$Q = 350 * 0.00079 * 70^\circ = 19.3 \text{ Watt}$$

$$\text{Heat Flux } (q) = Q/A \text{ w/m}^2$$

$$q = 19.35 / 0.00079 = 24500 \text{ w/m}^2$$

Temperature Inside wax container = 49 °C

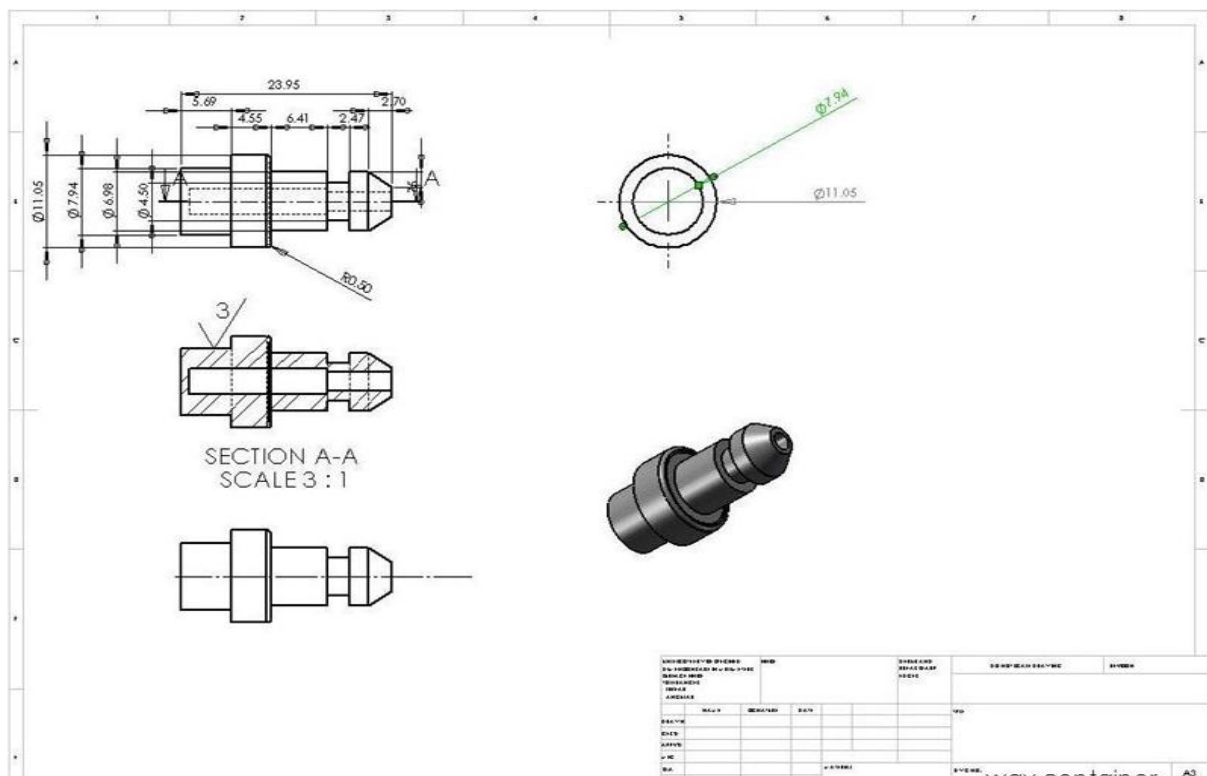


Fig.1 2D and 3D Modeling of valve

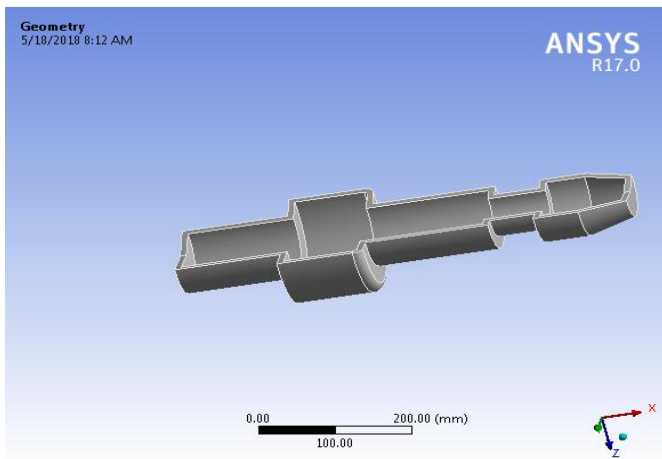


Fig.2 TSV Valve Geometry

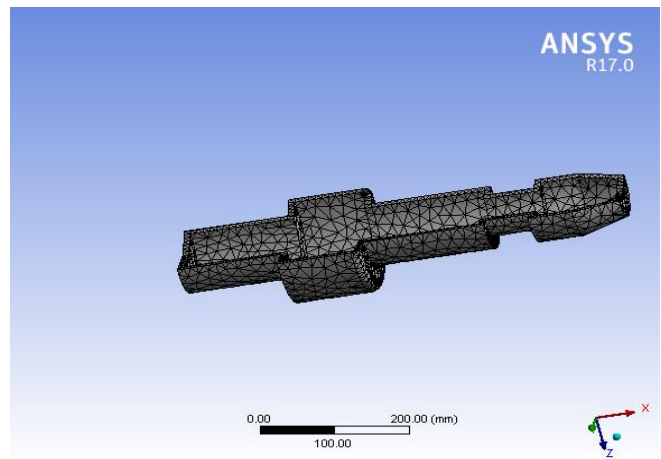


Fig.3 TSV Valve meshing

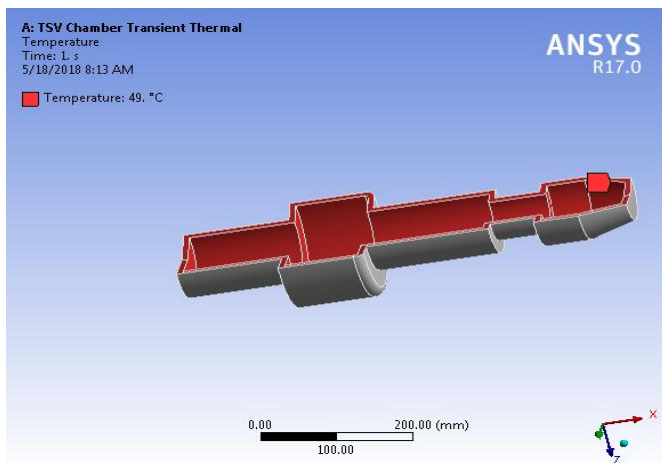


Fig.4 TSV Valve Temp. condition

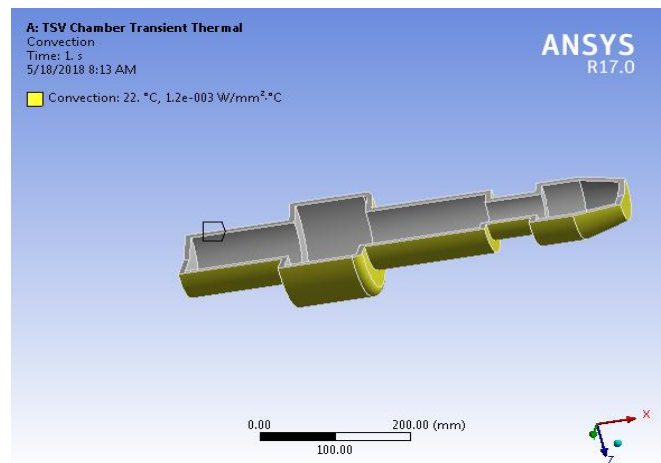


Fig.5 TSV Valve convection condition

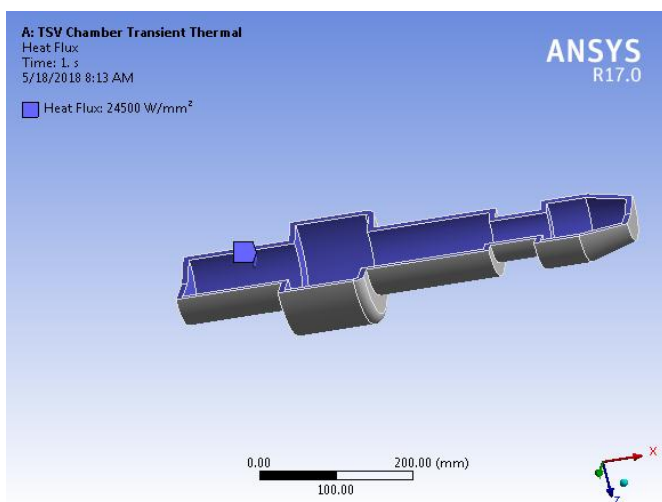


Fig.6 TSV Valve heat flow condition

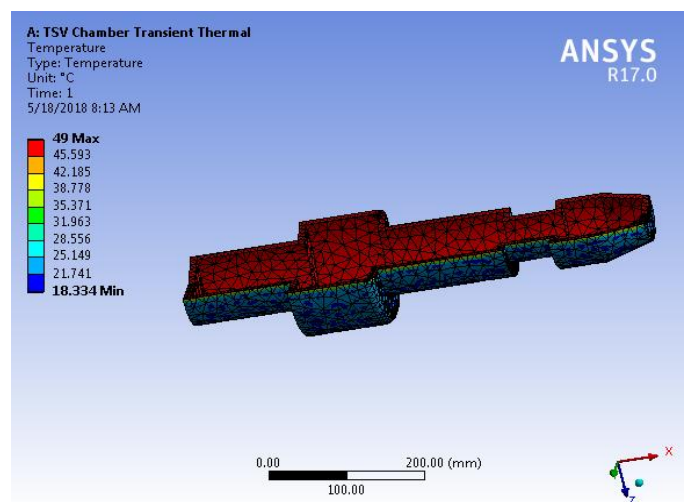


Fig.7 TSV Temp. Result

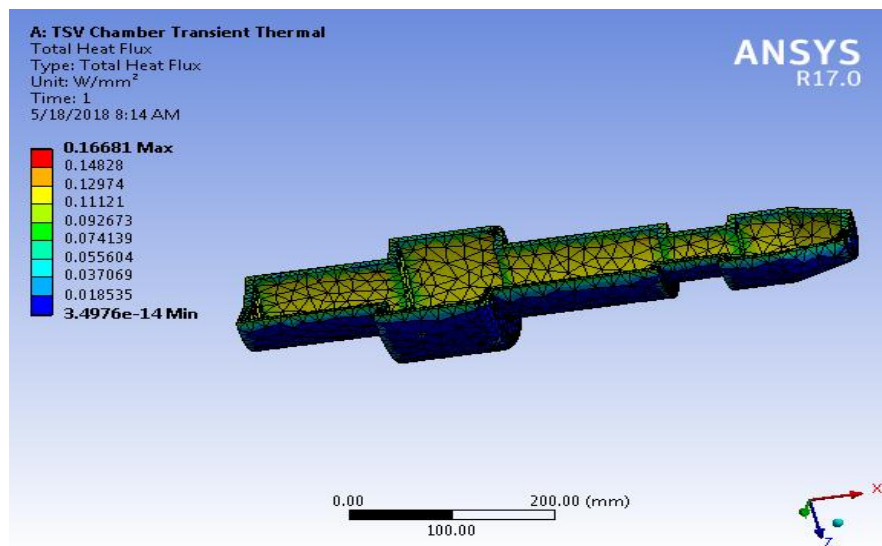


Fig.8 TSV heat flux Result

## V. RESULT COMPARISON

Tabke 1

Items	Exiting modal	Our modal
Weight(kg)	0.794	0.52
Pressure(Psi)	4400	5000
Trip Temp( <sup>0</sup> C)	49	49

## VI. CONCLUSION

Do not disassemble this valve there are no customer serviceable components, in this valve. Periodic exercising of the valve may be done by raising the sample temperature by increasing sample flow rate or decreasing cooling, water flow rate. This is necessary if sample water is very dirty. Verify that all analyzers are isolated before performing this operation.

- Thermal analysis (FEA & Transient Analysis) of temperature sensing chamber is done on ANSYS 17.0 software.
- Drawings of all components were made on CATIA V5 R20 in both 2D and 3D.
- Assembly was done on CATIA V5 R20.
- Operating temperature of the thermal shut off valve was reduced to 20<sup>0</sup>C by carefully selection of wax.
- Mass production can further reduce this cost.
- Forbes Marshall Pvt. Ltd. has been provided with all the detailed drawings of all the parts of Thermal shut-off valve.

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