RESEARCHERID
THOMSON REUTERS

[Soni* *et al.*, 6(5): May, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

# DESIGN & TRANSIENT ANALYSIS OF THERMAL SHUT-OFF VALVE FOR THERMAL POWER PLANT BY USING ANSYS SOFTWARE

**Rohit Soni*, Rajesh Kumar Singh**

* Assistant Professor, Department of Mechanical Engineering, Trinity Institute of Technology & Research, College, Bhopal, MP, India

M-Tech Scholar, Department of Mechanical Engineering, Trinity Institute of Technology & Research, College, Bhopal, MP, India

**DOI**: Will get Assigned by IJESRT Team

## 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 Autodesk Inventor Ver 2014. Thermal analysis was done on Ansys 18.0 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 notion.

**KEYWORDS**: Transient, Ansys, Flow, valves, Autodesk inventor, Thermal shutoff valve.

## 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 releasable 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.

**Thermal Shut off valve & its methodology**

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 floe blocking second position, the surface is against the seat and floe 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.

**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.

## 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 (T2 – T1)
h = 350 to 3000 w/m²k
A = πDL = π*0.011*.02395 = 0.00079 m²
Δ T**(water)** = T1 – T2 = $170^0$ - $100^0$ = $70^0$
Q = 350 * 0.00079 * $70^0$ = 19.3 Watt
<u>*Heat Flux*</u>
(q) = Q/A w/m²
q = 19.35 /0.00079 = 24500 w/m²
Temperature Inside wax container = 49 $^0$C

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

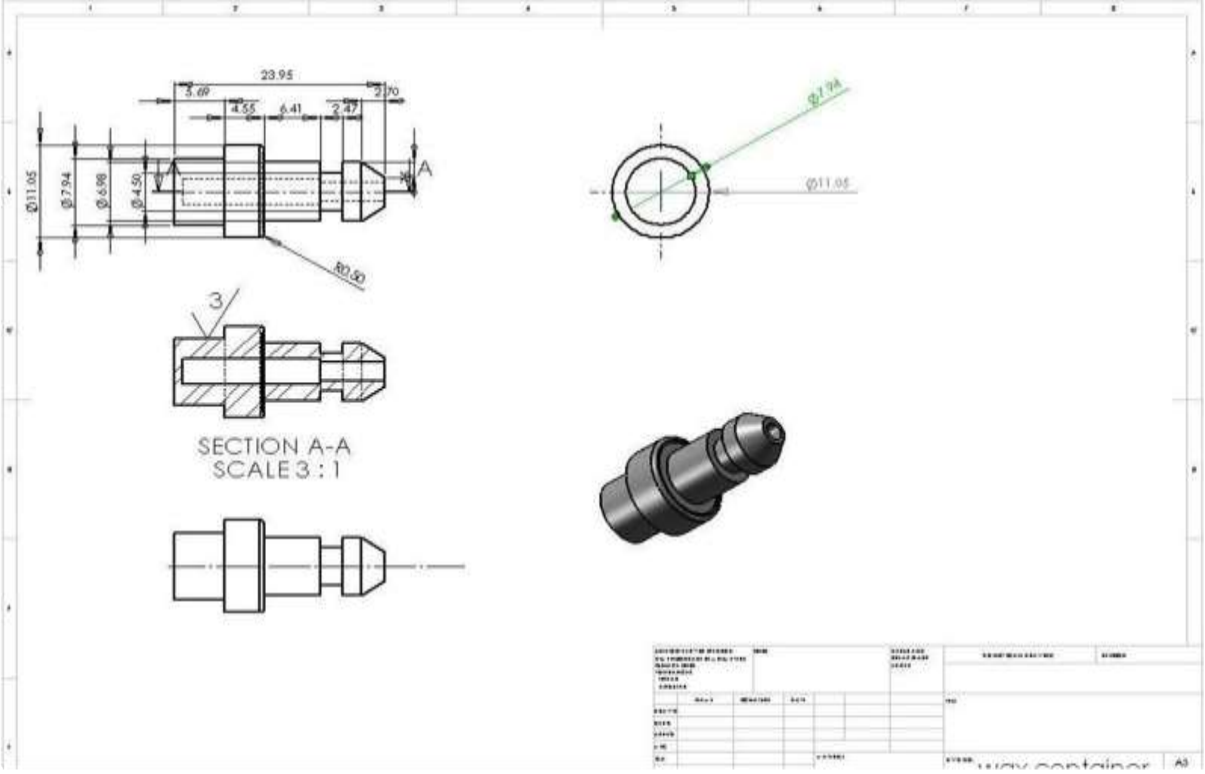


***Fig.1 2D and 3D Modeling of valve***

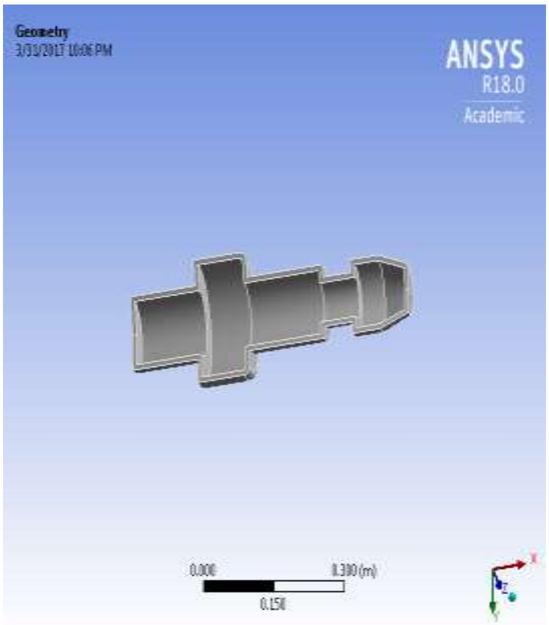


***Fig.2 TSV Valve Geometry***

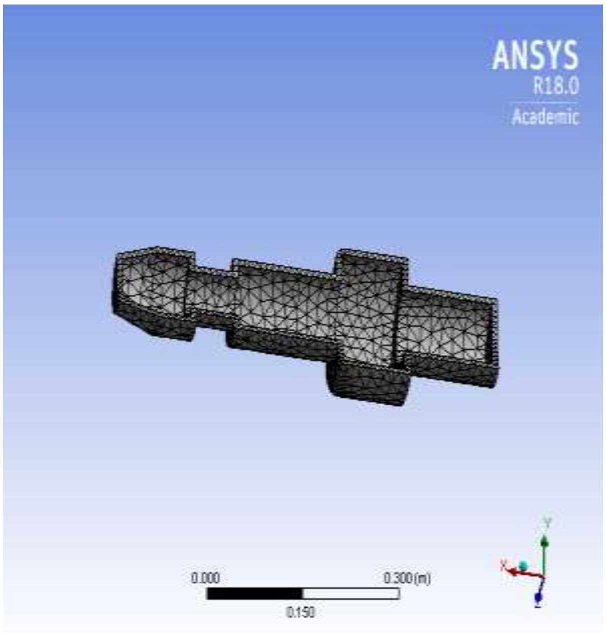


***Fig.3 TSV Valve meshing***

**ISSN: 2277-9655**
**Impact Factor: 4.116**
**CODEN: IJESS7**

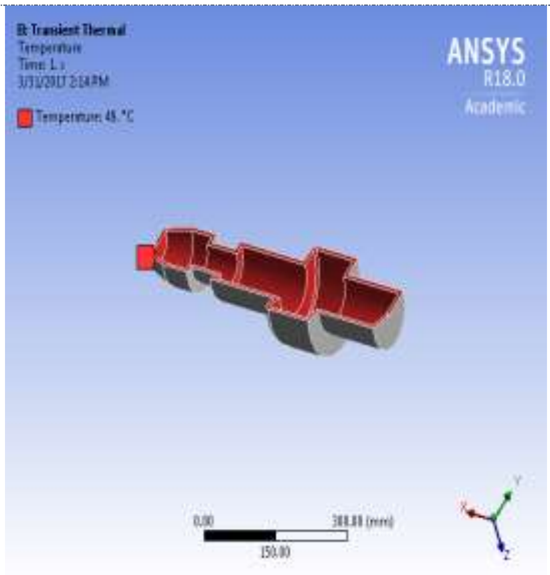


*Fig.4 TSV Valve Temp. condition*

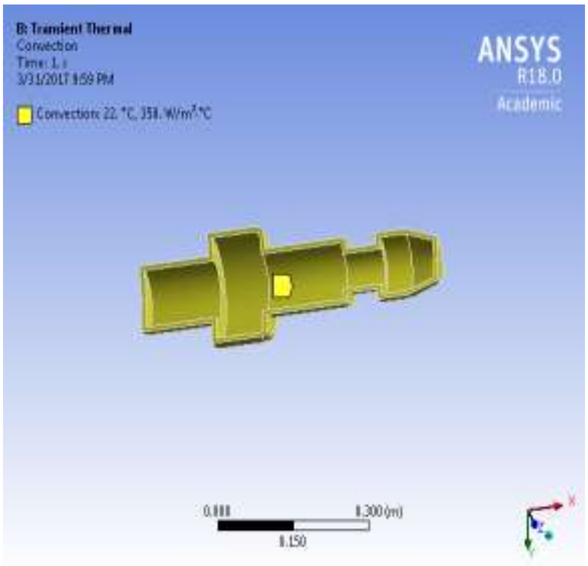


*Fig.5 TSV Valve convection condition*

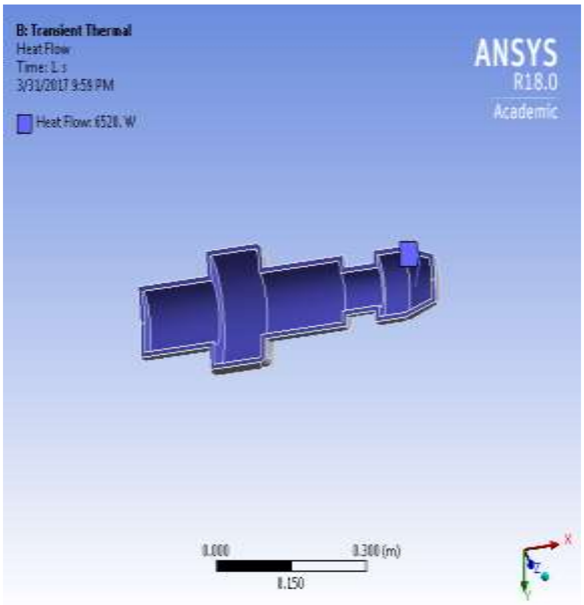


*Fig.6 TSV Valve heat flow condition*

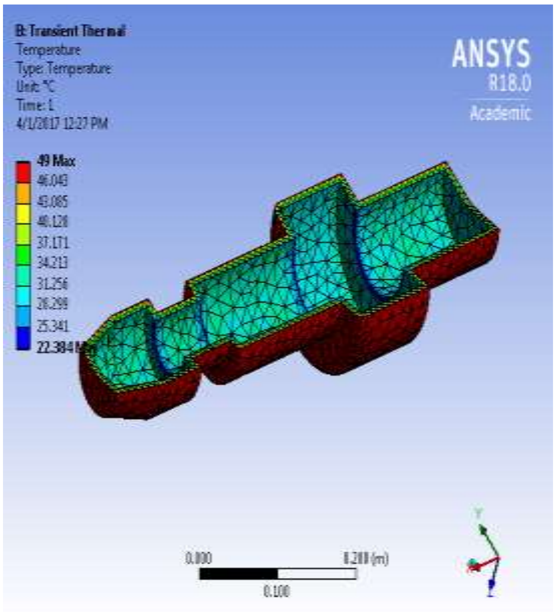


*Fig.7 TSV Temp. Result*

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

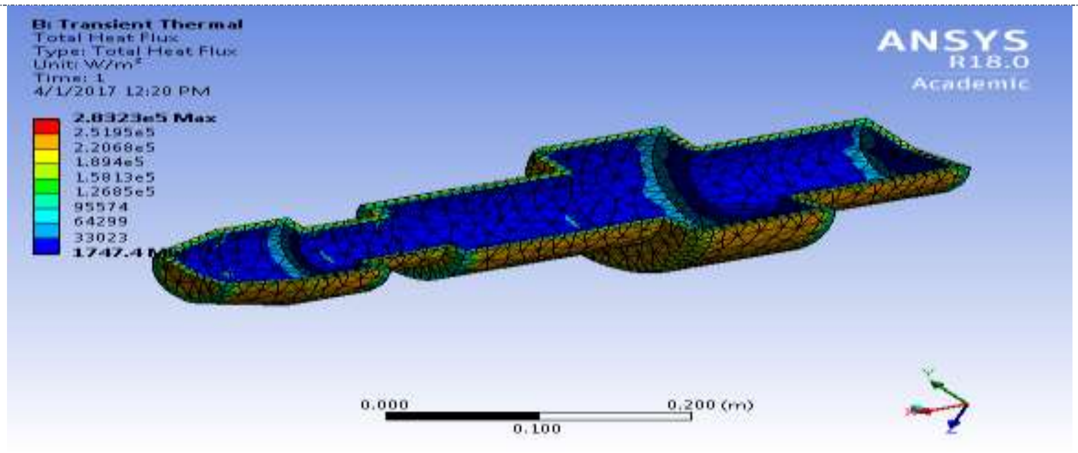


*Fig.8 TSV heat flux Result*

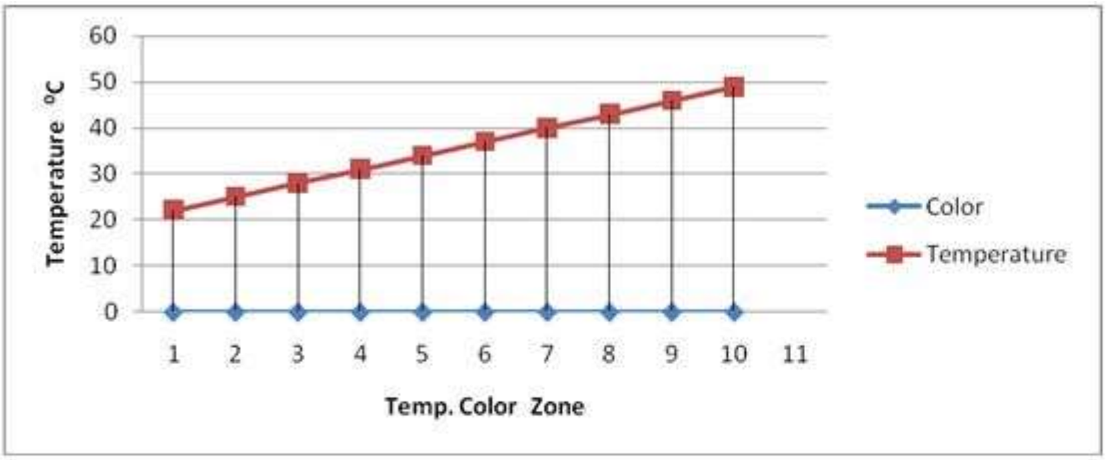


*Fig.9 TSV Temp. Graph Result*

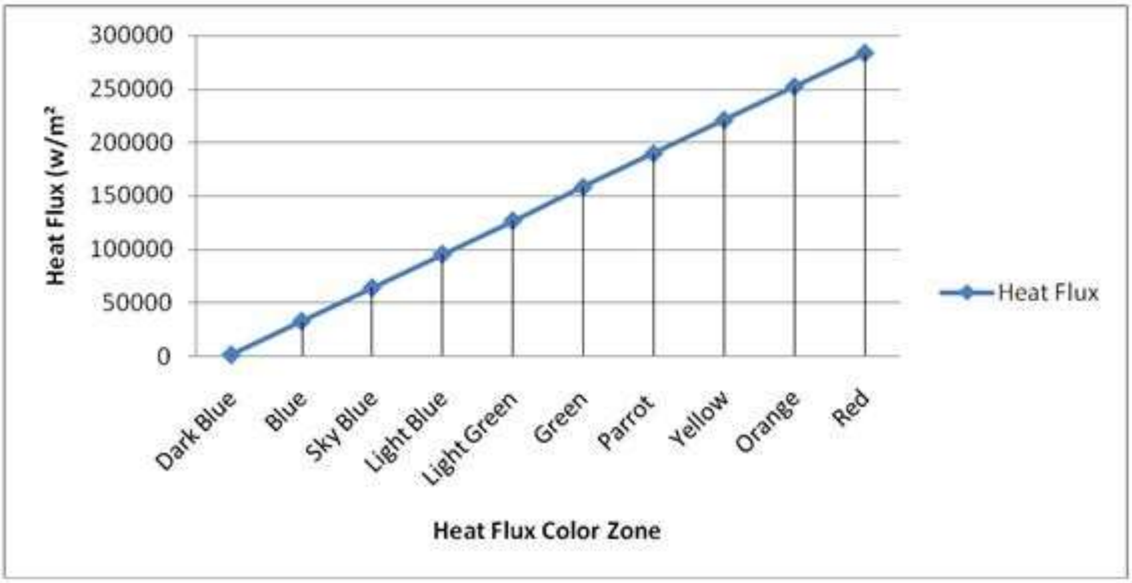


*Fig.10 TSV heat flux Graph Result*

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

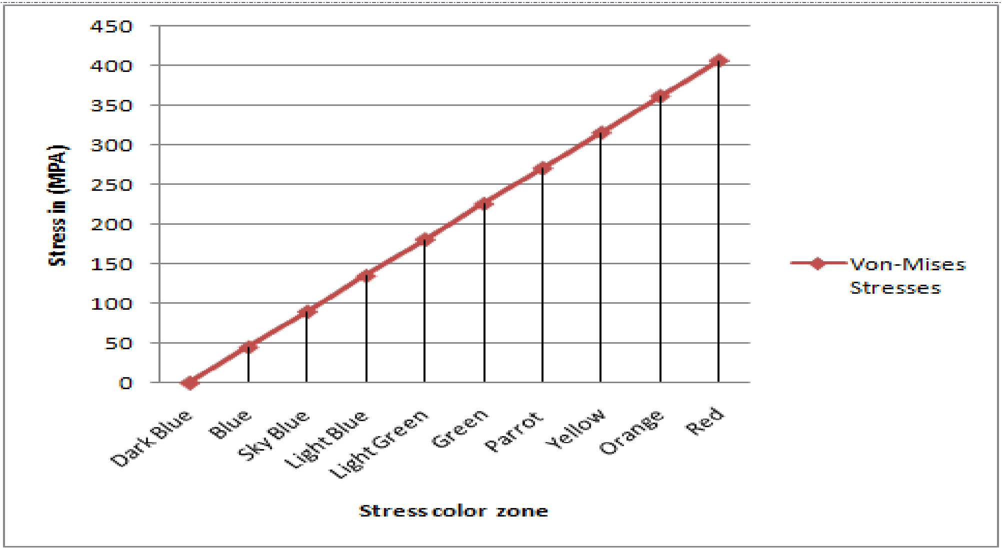


*Fig.11 TSV Stress Graph Result*

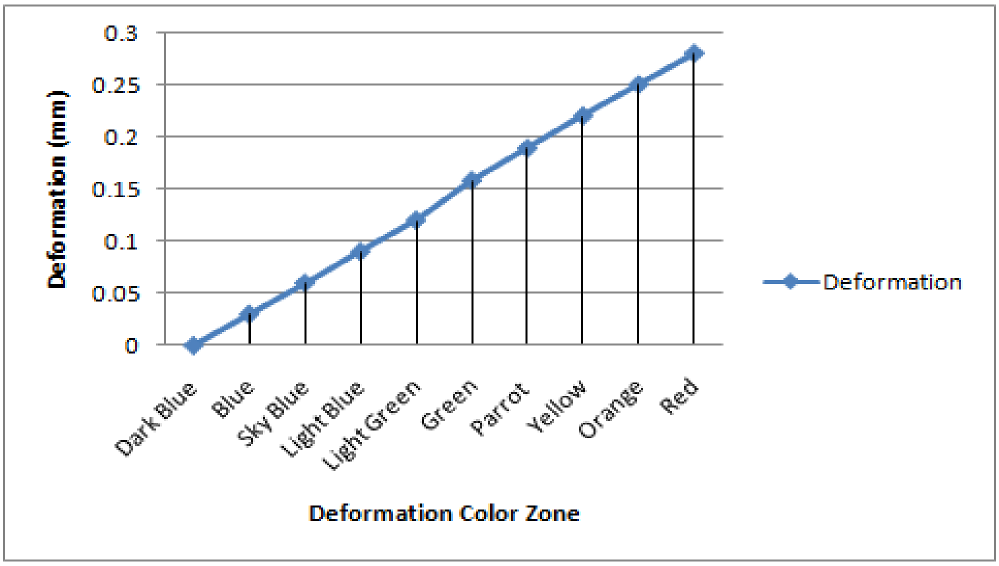


*Fig.12 TSV Deformation Graph Result*

## RESULT COMPARISON

*Table.1*

| Items | Exiting modal | Our modal |
|---|---|---|
| Weight(kg) | 0.794 | 0.52 |
| Pressure(Psi) | 4400 | 5000 |
| Trip Temp($^0$C) | 49 | 49 |

## CONCLUSION

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

- Thermal analysis (FEA & Transient Analysis) of temperature sensing chamber is done on ANSYS 18.0 software.
- Drawings of all components were made on AutoCAD Inventor in both 2D and 3D.
- Assembly was done on Autodesk Inventor ver 2014.
- Operating temperature of the thermal shut off valve was reduced to $20^0$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.

## REFERENCES

[1] Kukade Vaibhav, Jadhav S.G, Patil V.G, May 2015, "Literature Review on Weight Optimization of Pressure Relief Valve for Emergency Relief Operation", International Journal on Recent Technologies in Mechanical and Electrical Engineering (IJRMEE) Volume: 2, pp. 090 – 092.

[2] Aniket A. Kulkarni, Keshav H. Jatkar, Jun 2014, " A Review on Optimization of Finite Element Modelling for Structural Analysis of Pressure Vessel", International Journal of Engineering Trends and Technology (IJETT) – Volume 12 Number 1.

[3] C.J. Hos, A.R. Champneys, K. Paul, M. McNeely, (2014), " Dynamic behavior of direct spring loaded pressure relief valves in gas service: Model development, measurements and instability mechanisms", Journal of Loss Prevention in the Process Industries 31, pp. 70-81

[4] Prof. Vishal V. Saidpatil,Prof. Arun S. Thakare, June 2014, "Design & Weight Optimization of Pressure Vessel Due to Thickness Using Finite Element Analysis", International Journal of Emerging Engineering Research and Technology Volume 2, Issue 3, PP. 1-8.

[5] Mr. M. V. Awati, Prof. S. G. Jadhav,Vinay G. Patil, 2014, "Analysis of Pressure Safety Relief Valve using Finite Element Analysis", International Journal of Engineering Development and Research, Volume 2, pp. 2968-2973.

[6] Sushant M. Patil, Ramchandra G. Desavale, Imran M. Jamadar, 2013, "Conceptual Structure Design Through Thickness Optimization Of High Pressure And High Temperature Self Regulated Pressure Valve Using Non- Linear Transient Finite Element Method", International Journal of Engineering Research & Technology, Vol. 2, pp. 2043-2049.

[7] C. Bazsó, C.J.Hős, 2013, "An experimental study on the stability of a direct spring loaded poppet relief valve", Journal of Fluids and Structures 42, pp. 456–465.

[8] Himadri Chattopadhyay, Arindam Kundu, Binod K. Saha, Tapas Gangopadhyay, 2012, "Analysis of flow structure inside a spool type pressure regulating valve", Energy Conversion and Management 53 pp. 196–204.

[9] B.S.Thakkar, S.A.Thakkar, January-March 2012, "DESIGN OF PRESSURE VESSEL USING ASME CODE, SECTION VIII, DIVISION 1", International Journal of Advanced Engineering Research and Studies Vol. I/ Issue II, pp. 228-234.

[10] Qin Yang, Zhiguo Zhang, Mingyue Lie, Jing Hu, 2011, "Numerical Simulation of Fluid Flow inside the Valve", ELSEVIER Sciverse ScienceDirect, Procedia Engineering Vol.23, pp. 543-550.

[11] J. Ortega, B. N. Azevedo, L. F. G. Pires, A. O. Nieckele, L. F. A. Azevedo,2009. "Analysis of the discharge coefficient of a spring loaded pressure relief valve during its dynamic behavior". Journal of International Congress of Mechanical Engineering November 15-20, 2009.

[12] Xue-Guan Song, Young-Chul Park, Joon-Hong Park,2013, ―*Blowdown prediction of a conventional pressure relief valve with a simplified dynamic model*‖. *Mathematical and* Computer Modelling 57 (2013) 279–288

[13] A.Beune,J.G.M.Kuerten,M.P.C. van Heumen,2012 ―CFD analysis with fluid–structure interaction of opening high– pressure safety valves.‖Computers & Fluids 64 (2012) 108- 116.

[14] N.N. Manchekar, V. Murali Mohan,2013,―Design of gradual flow reducing valve by finite element analysis.International Journal of Engineering & Science Research June 2013 Volume 3, Issue-6,Pages 257-267.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

**CITE AN ARTICLE:**

**Soni, R., & Singh, R. K. (2017). DESIGN & TRANSIENT ANALYSIS OF THERMAL SHUT-OFF VALVE FOR THERMAL POWER PLANT BY USING ANSYS SOFTWARE. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *6*(5), 93-100. doi:10.5281/zenodo.571732**