Design and Analysis of Full Lift Relief Valve

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Abstract: **Full-lift relief valve is designed to overcome with a continuous problem was facing in the imported valve failure frequently, that is material & workmanship of supplier. We have faced one critical problem damage on the body of brass material. To avoid the damage of brass body, Spraying systems India PVT Ltd, was taken up for this assignment for the develop of Full-lift relief valve complete stainless steel & manufactured aesthetic & ergonomically designed and this valve we can use our own system to avoid depend on the imported valves from Germen & other abroad countries. The advantages of Full-lift relief valve are**

- **high efficiency**
- **good lifetime of wear parts**
- **low maintenance costs**
- **maintenance friendly design**

I.INTRODUCTION

Full lift relief valves are highly quality instruments, to ensure the correct performance of full lift relief valve all parts are made with exact precision as per our drawing. Only this precision ensures the correct functioning of the pressure relief valve.The relief valve is designed or set to open at a predetermined set pressure to protect pressure vessels and other equipment from being subjected to pressures that exceed their design limits. When the set pressure is exceeded, the relief valve becomes the "path of least resistance" as the valve is forced open and a portion of the fluid is diverted through the auxiliary route.In some cases, a so-called bypass valve.

The sealing surfaces have metal to metal contact made it with ground & lapped with high precision to ensure the required tightness. Even though the surfaces are extremely hard. One must take care to prevent impurities from entering the valves during transportation, installation & operation. One of the most critical automatic safety devices in a steam system is the safety valve. The safety valve provides a protective measure for lives, equipment, and property from potentially dangerous levels of temperature and forces caused by excessive steam pressure in a system. Safety valves are required by code and insurers. Therefore, it is important to have good, up-to-date records of all safety valves in the steam system. With today's readily available technology, a database should be developed containing all the relative information of all safety devices in a facility. The safety valve database should be reviewed on a periodic basis depending on plant standards, insurance company recommendations, and the local, state, or federal government requirements.

II.LITERETURE REVIEW

The Full-lift relief valve is meant for removing the excess pressure at the time of descaling. This is a direct pumping system which takes excess pressure for prefiltered water from JSPL water system & feeds to descale header mounted on descale box in the exit side of furnace.

Pressure relief valve selection and applications for hydraulic systems assoc. Prof. Dr. M. Sc. Ergur h. Sevil: In the design of pressure relief systems regulations, codes and standards must be taken into account seriously. Otherwise, design assignment might be complex and time consuming. In order to execute the design efficiently, decision trees are used. Figure 1 is for the selection of the location of pressure relief valves. After the identification of the valves, Figure 2 is used for the selection of the type of pressure relief valves. For the selection of the special features of safety valves and bursting discs, Figure 3 is used. Besides all these studies, evaluations are also advisable to reverse the decision trees into practical design tools.

Dynamic behavior of hydraulic pressure relief valve, b. J. Patil, dr. V. B. Sondur: The effect of the poppet clearance geometry on the system dynamic characteristics has been examined by means of the shown mathematical model. Under the same operating conditions, the behaviour of the pressure relief valve is varied, by chasing the poppet clearance. The simulation results are presented through system Pressure, Fig. 5-9. An optimum value of the radial clearance is estimated from the graph as shown in Fig. 9. This figure shows that the settling time is within 0.02 seconds and the maximum percentage of overshoot is considerably reduced. By using the simulation model, it is possible to predict the pressure relief valve behavior during its working. In addition, by using the mathematical model it is possible to select the optimal setting points of the

pressure relief valve (poppet radial clearance with respect to the system requirements.

Design and Analysis of Pressure Safety Release Valve by using Finite Element Analysis,Mr.V.D.Rathod, Prof.G.A.Kadam, Mr.V. G. Patil: Analysis results are reliable as seen in Mesh Sensitivity convergence and actual testing. Concerned with FEA analysis more accurate results are achieved using HEX element compared to TET element with fine meshing but increased time.FEA Validation shows we can increase efficiency of pressure safety release valve by providing rib at both side of nozzle.

Structural And Thermal Analysis Of Spring Loaded Safety Valve Using Fem,AjitabhPateriya, Mudassir Khan: From Study it is conclude that for spring loaded safety valve and marine feed check valve Aluminum alloy is best material than existing material as per the Ansys result obtained. In order to examine the performancecharacteristics of the safety valve of highpressure, Structural and thermal analysis wereconducted. The following conclusion was obtained. For spring loaded safety valve the maximum shear stress that produce for existing material is 0.20395 Mpa which is greater than the for Aluminum alloy, i.e., 0.20268 Mpa. Also as per the weight and cost comparison the Aluminum alloy material is preferred.

CFD Analysis of A Pressure Relief Valve KishanPatel,A. D. Patel Institute of Technology: As discussed in this paper, CFX analysis is found to be an excellent tool for designing a weir type diaphragm for improved flow characteristics. ANSYS Fluent can be used for CFX analysis to find out values of various flow parameters at different locations of valve. Conditionof flow in the valve can be understood easily with the help of graphical results generated in the software.

Review on Weight Optimization of Pressure Relief Valve for Emergency Relief Operation, KukadeVaibhav, Jadhav S.G, Patil V.G: All the above paper were related to design and FEA of pressure valve and optimization concept. Understanding the transient behavior of relief valve is crucial because critical conditions may be attained, damaging the pipeline. In this paper transient structural analysis has been introduced in order to finalize the geometrical parameter of pressure relief valve. Above all paper helps in finalization of material, plate thickness and spring stiffness.

A review on weight optimization of pressure relief valve for emergency relief operation, mr. Kumbhars.v, dr. R.g.Todkar: Understanding the transient behavior of relief valve is crucial because critical conditions may be attained, damaging thepipeline. In this paper transient structural analysis has been introduced in order to finalize the geometricalparameter of pressure relief valve. Above all paper helps in finalization of material, plate thickness and springstiffness. Pressure vessel has several functions apart from holding the gas pressure. Also from literatures itappears that pressure vessel can be designed using experimental, analytical and numerical techniques.

Optimal Orifice Geometry for a Hydraulic Pressure-Reducing Valve, N. D. Manring, R. E. Johnson: This paper has attempted to show that the geometry of the inlet flow passage of the valve significantly influences the flow gain characteristics and that a preferred choice for this geometry exists. In particular, flow passages of circular shape, rectangular shape, diamond shape, and triangular shape have been examined. In conclusion, it has been shown that a non-perturbed steady-state flow gain satisfying the criteria exhibits steady-state stability in the nonlinear simulation as well. Furthermore, it is shown that the non-perturbed steady-state flow gain must be determined numerically and that different orifice shapes of similar size create different results for this parameter that a rectangular shaped flow passage tends to exhibit the worst control characteristics while triangular shaped flow passages are highly preferred.

Review on Design of Self Regulating Pressure Valve by using Transient Finite Element Analysis,Gouri A. Bodhe, Sayli M. Jadhav,RohitSinha, VinaayPatil; It conclude that all above review of papers used for the design of self-regulating pressure valve by using finite element analysis which is very useful for designing .For geometrical modeling of self-regulating pressure valve ANSYS software can be used. In this paper transient structural analysis has been introduced in order to finalize the geometrical parameter of gradual flow reducing valve.

The Transient solution was extremely useful in order to know the effects of friction and bending pressure parameters, and enabled us to finalize the spring stiffness, saving on crucial prototype and testing costs.

III.DESIGN OF FULL LIFT RELIEF VALVE WITH SOLIDWORKS AS TOOL

The part modeling and detailed drafting of full-lift relief valve is done by using the CAD tool SOLIDWORKS.

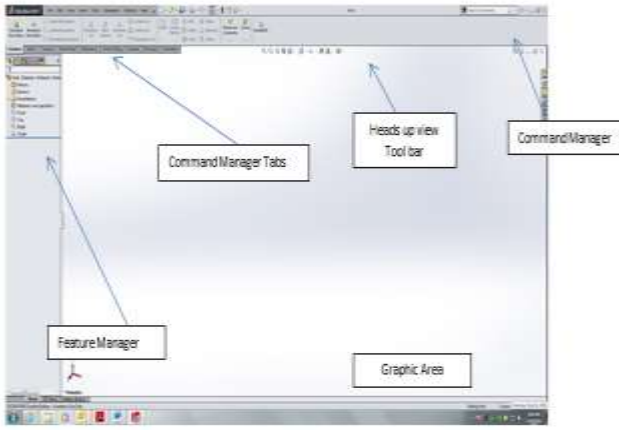
Brief Idea About Solid works:

Solid Works mechanical design automation software is a feature-based, parametric solid modeling design tool which takes advantage of the easy to learn

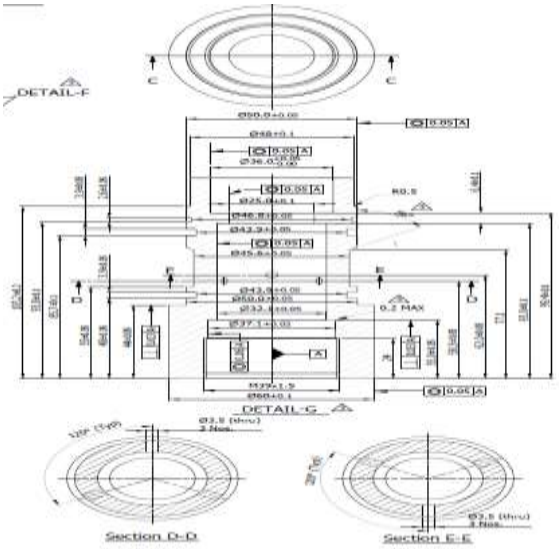
Windows™ graphical user interface. You can create fully associative 3-D solid models with or without constraints while utilizing automatic or user defined relations to capture design intent.

1. Being a solid modeling tool, it not only unites 3D parametric features with 2D tools, but also addresses every design-through-manufacturing process. Besides providing an insight into the design content, the package promotes collaboration between companies and provides them an edge over their competitors.
2. In addition to creating solid models and assemblies, the 2D drawing views can also be generated easily in the Drafting environment of Solidworks.
3. The drawing views that can be generated include orthographic, section, auxiliary, isometric, and detail views.
4. The model dimensions and reference dimensions In the drawing views can also be generated. The bidirectional associative nature of this software ensures that the modifications mode in the model are reflected in the drawing views and vice-versa.
5. In Solidworks, you can create sketches directly in the Modeling environment.
6. The Solidworks for Engineers and Designers textbook has been written with the intention of helping the readers effectively use the solid modeling tools in Solidworks.

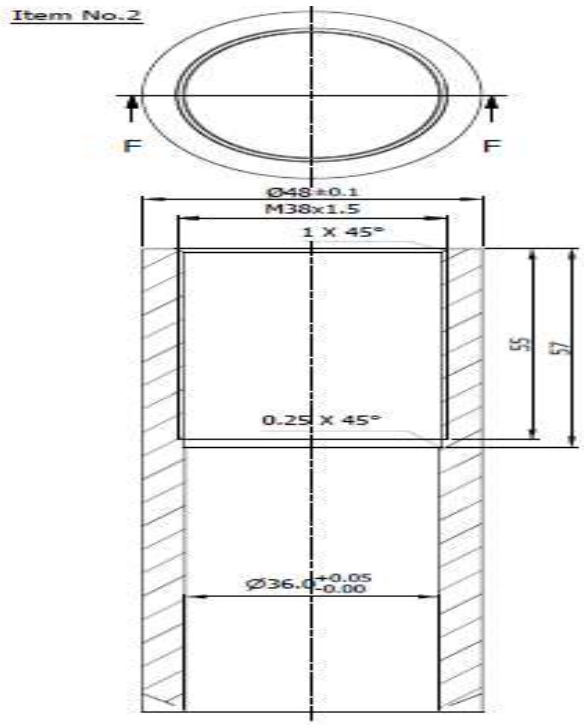
Solid Works Window description:

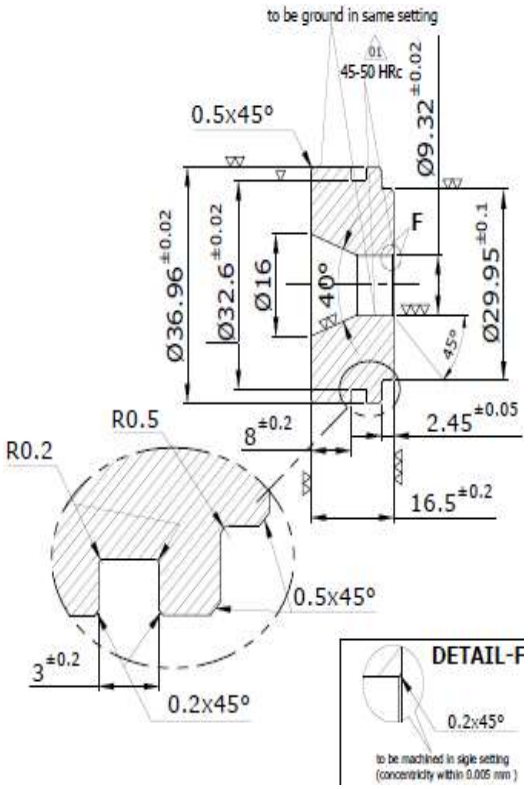


Designing of the full-lift relief valve:

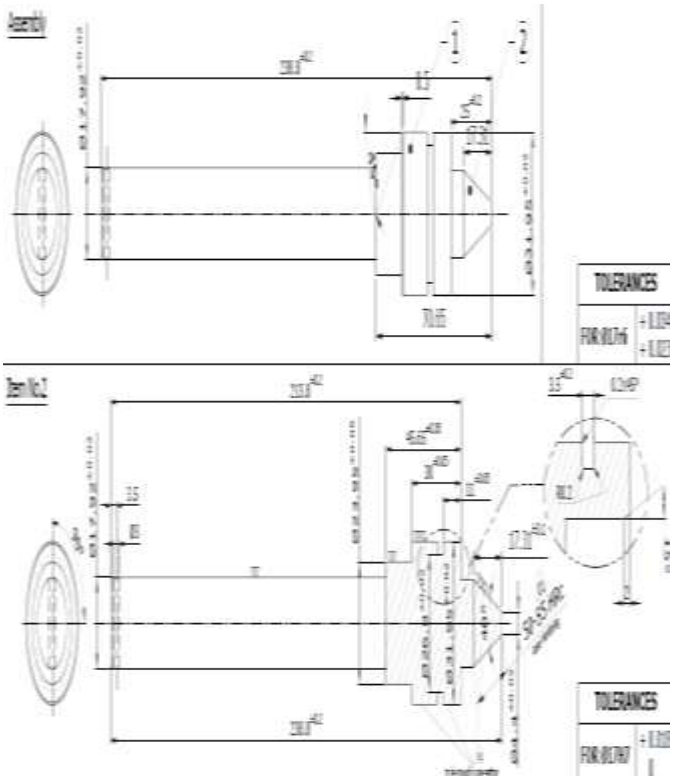


Detailing of valve housing

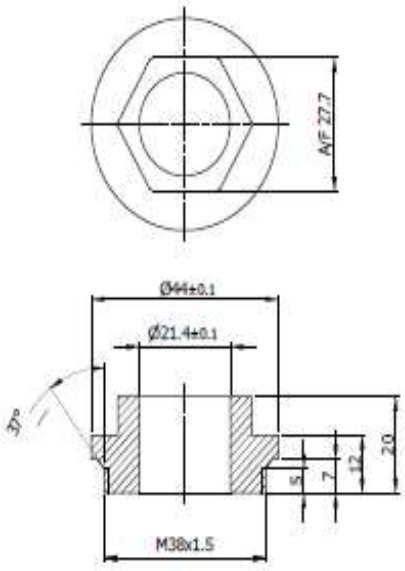




Detailing of Spool and valve seat



Detailing of top tip and shaft



Detailing of top screw

View of full-lift relief valve
Section view of full-lift relief valve

Isometric view of full-lift relief valve

IV.ANALYSIS OF FULL LIFT RELIEF VALVE WITH SOLIDWORKS AS TOOL

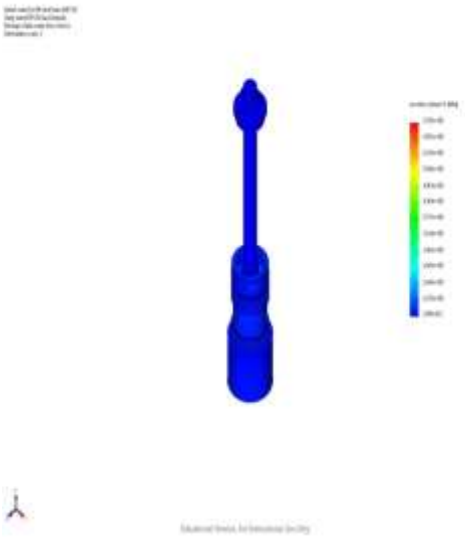
Result Analysis:

The full lift relief valve is analyzed for the pressure range of 200 to 260bar. The analysis is done by considering the pressure of200, 225, 250, 255 and 260bar respectively. The different results are obtained for different pressures, the results are as followed.The model considered for the analysis part is as shown below it consists of valve housing, tip & shaft and Screw. Meshing of the analysis part is done separately in Solid Works and then results are obtained.

Model Analyzed

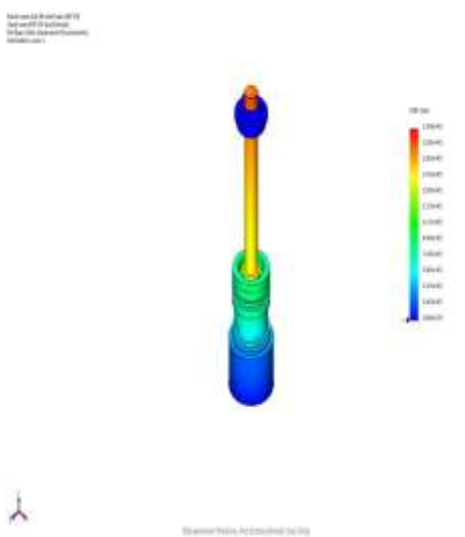
Meshed component

Three different types of studies namely Stress, Strain and Displacement are considered in analysis part, when the operating pressure of 250 bars is applied the effect onvalve housing, tip & shaft and Screwis studied.VonMises Stress is studied during which the pressure housing undergoes minimum stress of $2.908e^{-012}$ N/mm2 on the node 3743 and maximum stress $7.475e^{+002}$ N/mm2 on node 22042 is developed.



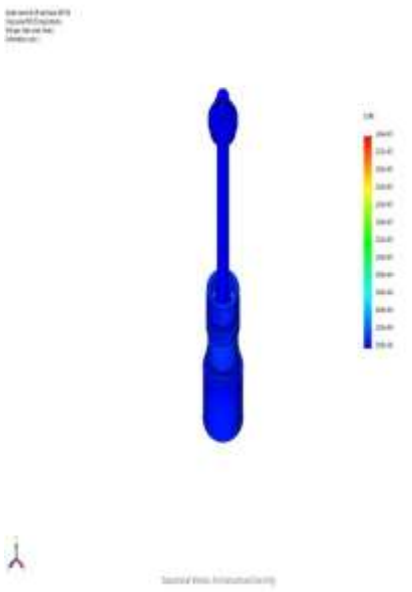
250-bar stress Analysis

Displacement effect is studied during which the pressure housing undergoes minimum displacement 0 mm on the node 6435 and maximum displacement 0.02354on the node 171 is developed.



250-bar Displacement Analysis

Strain effect is studied during which the pressure housing undergoes minimum stress of $5.65007e^{-018}$on the element 1960 and maximum strain 0.002420 on element 4757 is developed.

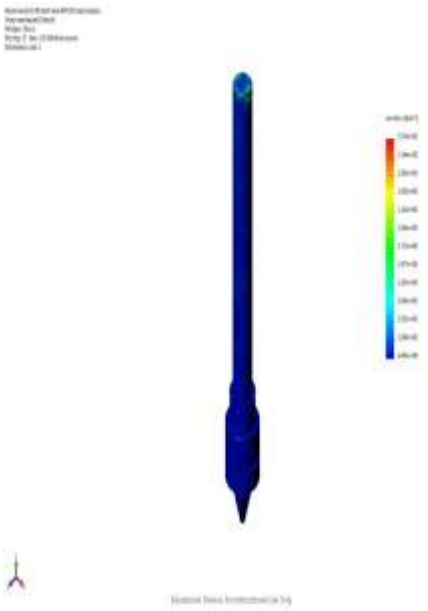


250-bar Strain Analysis

Impact Analysis:

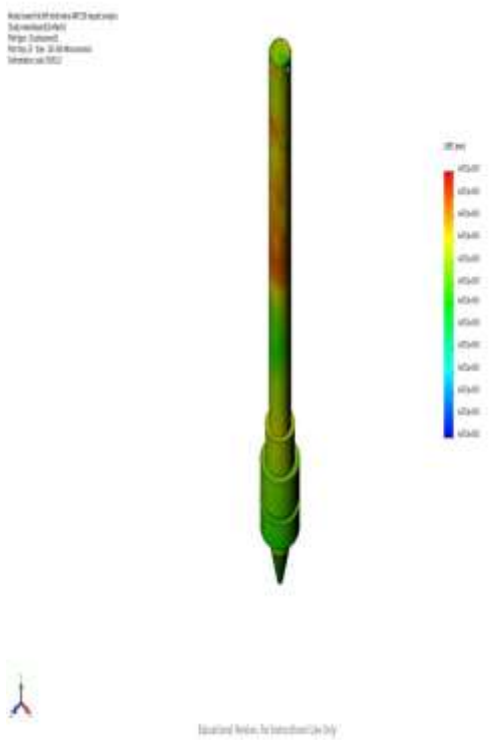
Model for Impact Analysis

Mesh model for Impact Analysis



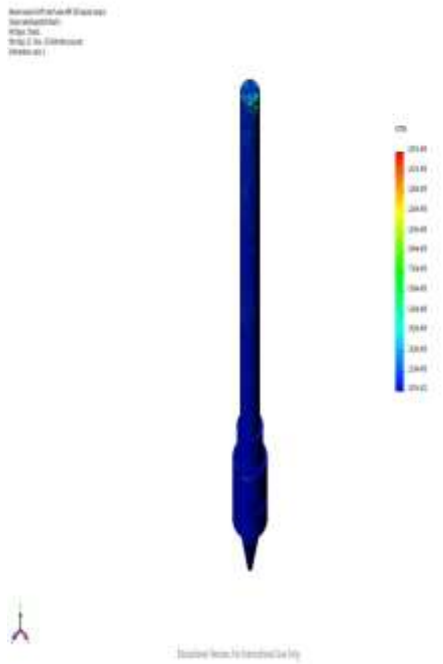
250-bar Stress Analysis

Von Mises Stress is studied during which the piston base undergoes minimum stress of 4.48033 N/m^2on the node 4148 and maximum stress 3538.75 N/m^2 on node 30 is developed on the top portion of the tip and shaft body.



250-bar Displacement Analysis

Displacement effect is studied during which the piston rod undergoes minimum displacement 0.00467105 mmon the node 12471 and maximum displacement 0.00467109 mm on the node 777 is developed ontip and shaft body.



250-bar Strain Analysis

Strain effect is studied during which the piston base undergoes minimum stress of $2.93711e^{-011}$ on the element 4548 and maximum strain $1.55685e^{-008}$element 2333 is developed on the piston rod.

V.CONCLUSION

The tip & shaft when undergoes for the operation it is subjected to the impact force, this force mainly imparts on the rod so the impact effect on the rod is obtained as the results shown above. The stress obtained when it is dropped from the height of 0.0235mm shows that the node 4148 undergoes minimum stress and node 30 undergoes maximum stress similarly node 777 and 12471undergoes minimum and maximum strain respectively also the node 4148 and 30 undergoes minimum and maximum displacement respectively. Earlier tip and shaft were two separate part for which we will maximum deflection So we have replaced the design while making that as a single part and can withstand at elevated pressure.

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