

A REVIEW ON WEIGHT OPTIMIZATION OF PRESSURE RELIEF VALVE FOR EMERGENCY RELIEF OPERATION

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ABSTRACT

Pressure relief valves are designed to provide protection from overpressure in steam, gas, air and liquid lines. An overpressure event refers to any condition which would cause pressure in a vessel or system to increase beyond the specified design pressure or maximum allowable working pressure. In many systems, the key requirement of process is to relieve this pressure rise in no time. Conventional valves are unable to fulfill that requirement. This paper focuses on the review on design, analysis and weight optimization of pressure relief valve by using transient finite element analysis. There are many authors work on this pressure valve. This paper includes study of various papers related to pressure valve.

Keywords: Asme , Fea, Pressure Relief Valve Design, Transient Dynamic Analysis.

I. INTRODUCTION

A relief system is an emergency system for discharging fluid during abnormal conditions, by manual or controlled means or by an automatic pressure relief valve from a pressurized vessel or piping system, to the atmosphere to relieve pressure in excess of the maximum allowable working pressure. In below figure, pressure plate is pressured by a spring against the inlet pressure and this plate is held with the help of failure inserts i.e clip. When pressure rises above maximum allowable working pressure the clip breaks and overpressure generated inside the equipment is relief through the nozzle, so pressure inside the equipment reduce. .

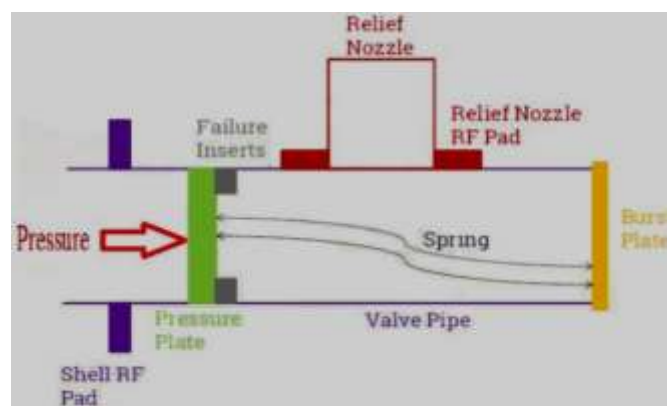


Fig.1 Pressure relief valve for emergency relief operation

Pressure relief valves must be designed with materials compatible with many process fluids from simple air and water to the most corrosive media. They must also be designed to operate in a consistently smooth and stable manner on a variety of fluids and fluid phases. From above literature review it is shown that thickness optimization of gradual flow reducer valve had been done by using finite element analysis, the same technique is applied to the pressure relief valve and the valve will be redesigned with the buffer chamber and at the same time weight optimization will be carried out.

Problem Definition:

Project deals with emergency relief valve, in which successful design and implementation of the relief operation is achieved. However the current design is bulky and operational installation is proving difficult. Elaborate arrangements need to be made to install the valves.

The current design sends the relief to open air, which is not possible for toxic gases. Hence a new design is proposed wherein the relief will take place to a buffer container so that sufficient warning is given before the gases are released to open air.

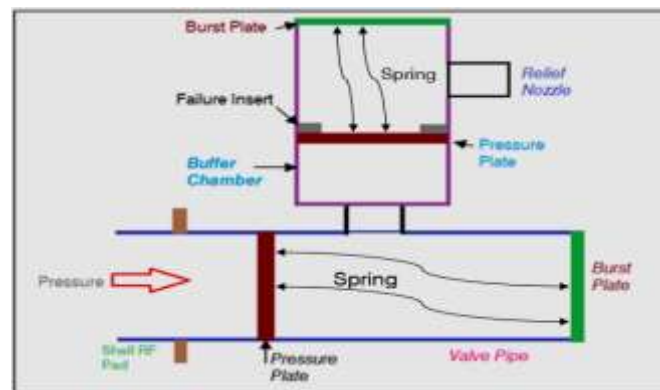


Fig.2 Buffer Relief Valve

Objectives:

The objectives of the project are-

- To study the current valve design and its performance aspects.
- To explore new material replacements that will make the valve light weight.
- To create buffer design and two stage valve design.
- To validate the simulation results with experimental work.

II. LITERATURE SURVEY

Jadhav S.G. et al. (2015) [1] designed pressure relief valves to provide protection from overpressure in steam, gas, air and liquid lines. An overpressure event refers to any condition which would cause pressure in a vessel or system to increase beyond the specified design pressure or maximum allowable working pressure. He focused on the review on design, analysis and weight optimization of pressure relief valve by using transient finite element analysis.



Aniket A. Kulkarni et al. (2014) [2] focused on a review of a structural analysis and optimization of pressure vessel to identify the existing work made in the analysis of pressure vessel and to form a theoretical foundation for understanding the recent developments, then to gain some insight into which domains are relevant in order to position the research. Pressure vessel has several functions apart from holding the gas pressure. Also it appears that pressure vessel can be designed using experimental, analytical and numerical techniques.

A.R. Champneys et al. (2014) [3] Summarized and extended recent scientific investigations into the mechanisms of instability in pressure relief valves (PRVs) and considers their implications for practical operation. The overall aim was to develop a new comprehensive understanding of the issues that affect valve stability in operation, in order to influence a new set of design guidelines for their operation and manufacture. They focused specifically on direct spring-loaded PRVs in gas service, particularly considering the combined effect of the valve dynamics with acoustic pressure waves within its inlet pipe.

Prof. Vishal V. Saidpatil et al. (2014) [4] carried out detailed design & analysis of Pressure vessel used in boiler for optimum thickness, temperature distribution and dynamic behavior using Finite element analysis software. They designed a cylindrical pressure vessel to sustain 5 bar pressure and determine the wall thickness required for the vessel to limit the maximum shear stress. Geometrical and finite element model of Pressure vessel was created using CAD CAE tools. Geometrical model was created on CATIA V5R19 and finite element modeling was done using Hypermesh. ANSYS was used as a solver.

M. V. Awati et al. (2014) [5] focused on design of an emergency shut of valve. Non-linear analysis is carried out to obtain the results. Stresses and deformations are within permissible values. Additional reinforcement pad is attached to nozzle part to avoid failure. From the results we can say valve performs functionally well. Non linear analysis gives more accurate results regarding the stresses.

Sushant M. Patil et al. (2013) [6] designed “gradual flow reducer valve” with available data on field. The thickness optimization of this gradual flow reducer valve had been done by using finite element analysis. The optimum thickness of the valve was finalized as 2mm. After finalizing the optimum design, same design had been taken for the further analysis. A basic model of the valve suitable for design purposes and optimization had been developed.

C. Bazsó et al. (2013) [7] presented detailed experimental results on the static and dynamic behaviour of a hydraulic pressure relief valve with poppet valve body, with a special emphasis on the parameters influencing the valve instability. A systematic experimental study was presented on relief valve instability for slightly compressible fluid (hydraulic oil). The experimental system consisted of a positive displacement pump, a simple direct spring loaded valve and a hydraulic hose connecting them. Pressure and displacement time histories were recorded for a large number of flow rates and set pressures.

Arindam Kundu et al. (2012) [8] investigated the flow through valve at different valve opening and different pressure drop were presented. Flow through a spool type valve at different opening corresponding to pre-set pressure difference had been considered. The commercial code FLUENT was found to aptly model the complicated flow processes inside the domain of interest. That involves compressible flow with high level of turbulence. An axisymmetric 2-D formulation was found to perform reasonably well in comparison with resource intensive three-dimensional mesh.

B.S.Thakkar et al. (2012) [9] determined the performance of a pressure vessel under pressure by conducting a series of tests to the relevant ASME standard. They observed that all the pressure vessel components were selected on basis of available ASME standards and the manufactures also follow the ASME standards while manufacturing the components. So that leaves the designer free from designing the components.

Qin Yang et al. (2011)[10] conducted three-dimensional numerical simulations to observe the flow patterns and to measure valve flow coefficient and flow fluctuations when stop valve with different flow rate and uniform incoming velocity were used in a valve system. The spectra characteristics of pressure fluctuation on the flow cross section were also presented here to investigate the wake induce of the valve part. These results not only provided people with the access of understanding the flow pattern of the valve with different flow rate, but also were made to determine the methods which could be adopted to improve the performance of the valve.

J. Ortega. et al.(2009) [11] developed computational model of a direct acting spring loaded pressure relief valve. A simplified two dimension model was built based on the valve geometrical and constructive characteristics. Further, a dynamic equation, which defines the valve disc position, was implemented. From the solution of the transient form of the conservation equations, the velocity and pressure distributions were obtained, allowing the determination of the discharge coefficient versus valve opening under its transient state. Comparisons with one-dimensional integral approach model were performed to evaluate the model.

From above literature review it is shows that thickness optimization of gradual flow reducer valve had been done by using finite element analysis, the same technique is applied to the pressure relief valve and the valve will be redesign with the buffer chamber and at the same time weight optimization will be carried out.

III. CONCLUSIONS

All the above paper were related to design and FEA of pressure valve and optimization concept. Understanding the transient behaviour 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. Pressure vessel has several functions apart from holding the gas pressure. Also from literatures it appears that pressure vessel can be designed using experimental, analytical and numerical techniques.

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