DESIGN & ANALYSIS OF PRESSURE SAFETY RELEASE VALVE BY USING FINITE ELEMENT ANALYSIS WITH FINAL RESULT

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ABSTRACT

In chemical processing industry the pressure inside the vessel is increase due to many reasons. An important responsibility of a chemical plant designer is to make sure that a plant under design, can be operated safely, it is provided with primary, secondary safety arrangement. One of the dangerous situations that can be arises during operation inability of a system to a pressure higher than that for which it was designed. With designing pressure safety release valve for inside vessel pressure, we are giving priority to mechanical systems to release inside pressure. The reasons are many for increase/exceed inside pressure.

The fulfillment for such condition is done using spring loaded nonreclosing pressure relief devices with clip ON arrangement. For instant opening of pressure safety release valve for chemical processing vessel, the inside pressure which is force to plate and release the inside pressure is not sufficient, so, at back side of plate required special stretched spring arrangement which can pull the plate after breaking of clip ON, clip ON is used to hold the plate with stretched spring positions. To design the clip ON is the concentrated work because if internal pressure goes beyond set pressure then the pressure safety release system should allow to release exceed inside pressure. To turn in emergency safety release system category valve should open in less than 2 second. Pressure safety release valve system design for 0.14 MPa. Other components also designed and checked which should not fail before the clip ON.

KEYWORDS : FEA, linear and non linear analysis, design by analysis, clip ON design, Ansys 14.5 etc.

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1 INTRODUCTION

1.1 Background

The Environmental Protection Agency (EPA) is issuing this dutiful as part of its ongoing effort to secure human health and the environment by preventing chemical accidents. We are determined to learn the causes and contributing factors allied with chemical accidents and to prevent their reappearance. Major chemical accidents cannot be prevented exclusively through regulatory requirements. Rather, understanding the vital root causes, widely broadcast the lessons learned, and integrating these lessons learned into safe operations are also required. EPA publishes Alerts to increase awareness of possible hazards. It is important that facilities, State Emergency Response Commissions (SERCs), Local Emergency Planning Committees (LEPCs), emergency responders, and others appraisal this information and consider whether extra action is needed to address the hazards.

Pressure vessels store energy and as such, have inbuilt safety risks. Many stages began to enact rules and regulations regarding the construction of pressure vessels. The several catastrophic accidents that occurred at the turn of the twentieth century that resulted in large loss of life. By 1911 it was noticeable to manufacturers and users of boilers and pressure vessels that the lack of promptness in these regulations between states made it difficult to constructs the vessels for interstates commerce. A group of these interested parties appeals to the council of the American Society of Mechanical Engineers to assist in the formulation of standard specifications for steam boilers and pressure vessels. After years of development the first Code rules for pressure vessels, entitled Rules for the construction of unfired pressure vessels in 1925. The ASME Pressure Vessel Code, in Par. UG-125, states that all pressure vessels must be provided with a means of overpressure protection.

In process industry, a process is continuously, further optimized to operate more efficiently closer to its mechanical limits such as its maximum allowable operating pressure. Besides the organizational and process control measures to maintain safe plant operation, the last stage of protection of a process apparatus against excess pressure is often through the use of a mechanical operated pressure regulating valve a piece of equipment.

Figure-1.1 Pressure vessels with the opening (pressure regulating valve)

An important responsibility of a chemical plant designer is to make sure that a plant under design can be operated safely, it is provided with primary, secondary safety arrangement. One of the unsafe situations that can be arise during operation inability of a system to a pressure higher than that for which it was designed with help of sensor or actuator, in such circumstances we rely on mechanical system. The region for increase/exceed inside pressure of pressure vessels are by filter tube clogging (instrument failure), mal-operation, external fire, thermal expansion or some other regions. If the system is not protected, the excess pressure may be lead to failure causing mechanical indemnity, loss of costly material, emission of toxic chemical and maybe loss of life. Therefore pressure safety relief systems are wanted to protect personnel and equipment from the unwanted consequences of excess pressure.

In self-regulating pressure valve, have a plate which is placed with spring in a stretched condition against the inlet pressure of the pressure vessels & hold these plate within the valve body along with the spring. Along with this valve, pressure safety release valve. When the pressure rises inside the vessel, the force generated on the surface of the plate increases and, depending on the pressure safety release valve set point pressure for clip ON , the force due to pressure rises, overcomes, the set pressure (force) causing the plate to rise upward side breaking the ‘’clip on’’ which is provided at back side of the plate and then overpressure generated inside the pressure vessel is release through the nozzle, so, line reducing the pressure level inside the equipment.

With the development of self-regulated pressure valve the next focus has been to develop a pressure valve which is equally robust. The main idea remains same, safety of the system, and prevention of vessel bursting due to pressure overload. Traditional safety valves work on the outlet side, wherein if a particular pressure is reached the valves burst open, resulting in a pressure relief and prevention of bursting. Electronically actuated pressure regulating valves are used to regulate inflow into vessel, wherein if pressure is reached to critical pressure, it fully or partially shut off flow of liquid. However if the gas is toxic, release should be the last option. The idea is then to regulate inflow into the vessel, once a critical pressure is reached. To tackle this problem, idea of Self-Regulated Pressure Valve controlled by using purely mechanical actuation is put forward. This valve will be an additional fail safe, in case the electronic control fails, wherein if a particular pressure is reached the valves open resulting in a pressure safety relief and prevention of bursting of pressure vessel. The idea is applicable into the vessel, when critical pressure is induced. Here in case of vessel pressure safety valve, we are not implies on the inside pressure pushes to the plate against spring. In this case the pressure relieve when inside pressure exceeds the value of stiffness of spring, but we are stretched the spring, in this case if the inside pressure exceeds than the stress resisting capacity of clip ON of safety valve, they break-down and instant pressure release due to plate raised because of exceeds inside pressure and also stretched spring go to its original position with the plate which is attached at the free end of the spring. Ultimately, this type of safety release system is one time usable safety system in pressure vessel, after break up the clip ON there is need of replacement of other pressure safety release valve.

To install Self-Regulated Pressure Valve in vessels or for providing sight glasses, manholes, drainage, for inserting shaft of the stirrer, etc. so, Process vessel must be provided with the multiple openings of various dimensions at different parts., While the openings are essential for operating the vessels, these weaken the vessels parts due to development of discontinuities. So, reinforced pads also provide around the nozzle which is attached to the self regulated pressure valve shell which is attached to shell of vessel.

The dependable functioning of a pressure vessel and its safety systems depends upon the foresight of the user and the information the user gives to the designer and the fabricators. If the process involved in corrosive environment like chemicals, crude oils etc handling. Most pressure vessels and relief valve shells are subjects to deterioration by corrosion or erosion, or both. The effect of corrosion may be pitting or grooving over either localized or large areas. Some of many causes of corrosion are inherent in the process being used, but others are preventable. Vessels containing corrosive substances as mentioned like chemicals, crude oil etc. If the corrosion is local, it may not appear serious at first; as the metal thickness is reduced ,however, the metal becomes more extremely stressed, even under normal pressures, so at the time of determination of valve thickness by ASME Code section VIII, Division 1 corrosion allowances and the applicable code references of vessels are referred. Pressure safety release valve shell thickness keep equal to pressure vessel thickness.

2 Literature Review

Mr.Nilesh Jadhav, Prof. Sunil Bhat has described Pressure valves are critical components of any process equipment, especially while handling toxic or flammable materials. In such cases it is very critical that the pressure in the system is well regulated and there is minimum risk of system explosion or leak due to excessive pressure in storage vessel. They have focused on to design, and optimize a pressure vessel valve, which will incorporate a feedback loop from the storage vessel, and regulate the flow, and if need be close the flow based on the magnitude of pressure. The feedback loop and in general the operational features of the valve are mechanical in nature, conceptualized using a combination of spring stiffness, and sliding parameters. At the time of simulate such a process, they experienced FEA is an extremely convenient tool which has reduced both the design costs and times to deliver the product. They explains the strategies used in the design of the valve and results of the operational simulation in FEA. In process industry, a process components are continuously further optimized to operate more efficiently closer to their mechanical limits such as its maximum allowable operating pressure, yield stress limits, fatigue limits etc. Besides the organizational /management and process control equipments measures to maintain safe plant operation, against excess pressure is often through the use of a mechanical self-actuated device, relief valves etc. In these valves, a spring loaded restrictor plate is used. It will be so calibrated that it will connect to the vessel where pressure is to be regulated. When system pressure exceeds the operating pressure, Restrictor plate pushed against the spring load which results into snap shut the fluid flow hence pressure regulation is achieved. [1]

M. R.Mokhtarzadeh-Dehghan, N. Ladommatos, and T. J. Brennan (Department of Mechanical Engineering, Brunel University, Uxbridge ,UK) describes a finite element study of laminar flow of oil through a hydraulic pressure-relief valve of the differential-angle type a variable compression ratio piston of an internal combustion engine. The model simulates an experimental setup use to obtain the performance characteristics of the valve under steady-state conditions. The velocity and pressure distributions through the valve and the magnitude of the lift forces on the plunger are obtained under a constant inlet pressure condition for various plunger lifts. Comparisons are made with available experimental and analytical data. The details of flow through the valve are predicted with good degree of accuracy. The results provided an improved understanding of the way in which opening forces on the valve plunger are generated at various plunger lifts and are thus helpful to the design process. The complex flow fields generated resulted in the formation of recirculation zones and modified the minimum flow areas, thus affecting the pressure distribution and the force on the plunger. [2]

Mohinder L Nayyar, P.E. (ASME Fellow) explained related Safety Valves and Pressure-Relief Devices Safety valves and pressure-relief valves are automatic pressure-relieving devices used for overpressure protection of piping and equipment. Safety valves are generally used in gas or vapor service because their opening and reseating characteristics are commensurate with the properties and potential hazards of compressible fluids. The valves protect the system by releasing excess pressure. Under normal pressure, the valve disc is held against the valve seat by a preloaded spring. As the system pressure increases, the force exerted by the fluid on the disc approaches the spring force. As the forces equalize, fluid begins to flow past the seat. The valve disc is designed in such a way that the escaping fluid exerts a lifting pressure over an increased disc surface area, thereby overcoming the spring force and enabling the valve to rapidly attain near-full lift. An added benefit to the safety-valve disc design is that the pressure at which the valve reseats is below the initial set pressure, thereby reducing the system pressure to a safe level prior to resealing. The ratio of the difference between the set pressure and the resealing pressure to the set pressure is referred to as the blow down Pressure-relief valves are used primarily in liquid service. These valves function in a way similar to safety-relief valves, except that as liquids do not expand, there is no additional lifting force on the disc and, therefore, the valve lift is proportional to the system pressure. Also, the valves reseat when the pressure is reduced below the set pressure. Relief valve opens when line pressure exceeds preset loading on the spring. A third type of pressure-relieving valve is a safety-relief valve, which can be used with both compressible and incompressible fluids. It combines the design features of a safety- and a relief-valve into one. Therefore, when it is used with compressible fluids, such as steam or a gas, it pops open to release the overpressure, and when used with incompressible fluids, such as water or other liquids, it opens gradually, proportional to the increase in pressure over the set pressure, to safeguard the vessel, tank, heat exchanger, piping, or other equipment. [3]

Ron Darby* (Chemical Engineering Department, Texas A&M University, College Station, TX 77843-3122, USA) set the Mathematical model of the dynamic response of pressure relief valves in vapor or gas service, Upon opening a pressure (or safety) relief valve can, under certain conditions, respond in an unstable manner. This can be manifested as a rapid unstable opening/closing ("chatter"), low amplitude "flutter", or a low frequency cycling. The unstable response can often be severe enough to damage or severely impair the operation of the valve. The "3% Rule" recommended by the API is intended to prevent unstable response, or chatter, by limiting the irreversible (frictional) pressure drop in the inlet line to no more than 3% of the valve set pressure. This is based upon the fact that, under steady state conditions, a valve will open at the set pressure and will re-close when the pressure falls, typically, by about 7% below the set pressure (i.e. the blow-down pressure). Thus, if the irreversible losses upstream of the valve during maximum flow are always less than the blow-down (e. g. less than 3% of set pressure, or about half of the blow-down), the valve should not re-close and hence would exhibit stable behavior. This 3% "re-closure" guideline is based upon steady state flow conditions, and has been found to be inadequate as a rigorous indicator of conditions for stable or unstable operation. Since valve chatter is typically a high frequency (dynamic) phenomenon, it is also influenced by the dynamic (time-dependent) stability response of the valve. These two effects may be interrelated, however, because they are both a result of the dynamic forces acting to open and close the valve, and the factors that determine these forces. The result is a complex nonlinear interaction between the many factors that can affect the valve dynamic response. [4]

Xue-Guan Song, Young-Chul Park, Joon-Hong Park (Department of Mechanical Engineering, Dong-A University, Busan 604-714, Republic of Korea) studied the Blow down prediction of a conventional pressure relief valve with a simplified dynamic model A pressure relief valve (PRV) is a pressure relief device designed for the automatic release of a substance from a boiler, pressure vessel, or other system when the pressure or temperature exceeds preset limits to protect a pressure vessel and/or system. Of many types of PRVs, the conventional PRV is one of the most important types. In spite of the high development status of the conventional PRVs and the progresses in the fields of simulation technology, there is still significant research demand on the investigation of the conventional PRVs, since they are the most used final independent devices for protections of life, environment and equipment. For in-depth research of conventional pressure relief valves, the traditional experiment method shows the disadvantages. It requires a number of equipments, times and funds, and it is difficult to observe the flow transient characteristics through the valves since the fluid flow through a pressure relief valve is very vertiginous and complex. In addition, the experiment method only can be conducted after the real products have been manufactured. As the advancement of high-performance computer during the past decades, simulations of a PRV with a dynamic model and the CFD method become more and more reliable and popular. In 1978, Ray formulated a nonlinear dynamic model of a relief valve in state-stage form from fundamental principles of rigid-body motion and fluid dynamics. The transient response of the nonlinear model is obtained by digital simulation. Results indicated that the opening time of the valve is linearly related to the dimensionless parameter given by the ratio of orifice length to its radius. In the study, two-phase flow and sub cooled water blow-out tests with model valves were performed in order to evaluate the valve's characteristics and performance. Analytical study was performed using the two-phase flow model in the valve. [5]

Stefan Gassmann, Lienhard Pagel (University of Rostock, Faculty of Computer Science and Electrical Engineering, Institute of Electronic Appliances and Circuits, Germany) focused on magnetic actuated pressure relief valve The protection against overpressure in the fluidic system is not only for micro systems a very important task. When an overpressure occurs inside the channels sensitive elements can be destroyed or bonds can break and the fluidic system becomes defective. Various reasons for dangerous overpressure are possible, e.g. syringe pumps or pumps that try to deliver a constant flow even at high pressure; thermal expansion of liquids inside a closed system or wrong setup of external pressure sources. Devices that prevent a system from dangerous overpressure should work without the supply of energy. Only if these devices work independently an efficient protection can be assured. Such elements are pressure relief valves or safety valves. An inside generated overpressure cannot be relieved. A silicon based pressure relief valve was fabricated by NanoSpace AB. It is used as a safety element in a cold gas micro propulsion system for small satellites. The set pressure is

>10 Bar. Passive check valves with one opening to the environment could also be used as safety elements. But normally they are designed to work with a minimal opening pressure that is not desired for safety valves. Spring based safety valves are widely used in pneumatic macro systems. These are the standard implementation of a safety valve. Due to the size and the difficulty to build valves with the set pressure < 1 bar they are often not suitable for MEMS devices. The here presented solution consists of permanent magnets and simple sealing elements. Using this structure the set pressure can be defined in a very large range. The valve is easy to assemble; self aligned and has a better pressure relief characteristic than spring based valves. The reported solution is the first pressure relief valve for MEMS using permanent magnets, a patent has been granted .In the following the solution is described in detail. Since the structure is build using a fluidic PCB technology a short introduction is given to this technology. [6]

M. R. Mokhtanadeh-Dehghan, N. Ladommatos, and T. J. Brennan (Department of Mechanical Engineering, Brunei University, and Uxbridge, UK) stated Finite element analysis of flow in a hydraulic pressure valve. They come to know Engines are normally designed to run at maximum efficiency at one operating point. This means that when the engine is not running at or near this load and speed, its efficiency may be substantially reduced. Many engine parameters, such as fueling rate and fuel injection timing nowadays can be controlled electronically. However the cylinder gas pressure cannot be controlled in such a manner and can have a significant effect on the engine performance. Ideally, when an engine is running, it is best if the average or peak gas cylinder pressures remain relatively constant as this allows better control over the combustion process. In addition the maximum cylinder gas pressure must remain below the peak value decided by the strength of materials and construction of the engine. There have been various suggestions for the control of cylinder pressure, such as the use of variable compression ratio (VCR) pistons, '-' but none have found their way into commercially available engines. Tests on VCR pistons over the past 25 years have demonstrated the feasibility of their use in both petrol and diesel engines. In recent years, there has been more interest in VCR pistons because of the increased need for better fuel economy in petrol engines and gradually increasing levels of boost pressure used in diesel engines. The key element of any VCR piston control mechanism is the hydraulic pressure-relief valve, which is the subject of this paper. This type of valve is quite small and readily becomes blocked with carbonized oil and debris. Various types of poppet valves have been used in this application. A poppet valve is a seating-type valve in which the moving element or poppet, usually spherical or conical in shape, moves in a direction perpendicular to the axis of its seat. This type of valve is used because it is relatively easy to manufacture, has minimum leakage and, compared to other designs of pressure-relief valves, is capable of self-cleaning if it becomes blocked. The present work uses numerical modeling in order to obtain a better understanding of the fluid flow behavior in this type of valve. A number of previous studies have applied numerical techniques to flow in valves. '-" Pountney et al.' carried out a simulation of steady turbulent flow through a servo-valve orifice, based on the k-e turbulence model. The results were discussed for a number of valve gaps. Although the importance of comparison with experimental data was noted, no direct comparisons were made. Kuo and Chang' performed three-dimensional and unsteady computations of the gas flow and fuel injection in an engine intake port. In this study also, no comparisons with the experimental data were carried out. [7]

J. Phillip Ellenberger: Pressure Vessels: The ASME Code Simplified, Eighth Edition. Design for Safety, Chapter (McGraw-Hill Professional, 2004 1993 1984 1977 1960 1958 1956 1954), Access Engineering under Mc Graw Hill Education publication explained the importance of pressure relief devices in the safe operation of pressure vessels cannot be overemphasized. Improper functioning can result in disaster both to life and equipment. The ASME Pressure Vessel Code, in Par. UG-125, states that all pressure vessels must be provided with a means of overpressure protection and that the number, size, and location of pressure relief devices are to be listed on the manufacturer's data report. At times, vessels designed for a system are properly protected against overpressure by one safety valve. If this is the case, the vessel manufacturer may add the

Statement, "Safety valves elsewhere in the system." The item on the data sheets for safety valves should never be left blank or should it contain a statement that no overpressure protection is provided. It is the manufacturer's responsibility to see that vessels are fabricated according to the ASME Code and that they meet the minimum design requirements. Simply because the customer did not indicate the size and location of the safety valve opening on the purchase order or drawing does not relieve the vessel manufacturer of this responsibility. The safety devices need not be provided by the vessel manufacturer, but overpressure protection must be installed before the vessel is placed in service or tested for service, and a statement to this effect should be made in the remarks section of the manufacturer's data report. The user of a pressure vessel should ensure that the requirements of the pressure relief devices, be they pressure relief valves (Code Par. UG-126), nonreclosing pressure relief devices such as rupture disk devices, or liquid relief valves, are designed in accordance with the ASME Code requirements and so stamped in accordance with Code Par. UG-129. Rupture disk devices shall be marked by the manufacturer as required in Code Par. UG-129 in such a way that the marking will not be obliterated in service. Safety valves must be installed on the pressure vessel or in the system without intervening valves between the vessel and protective device or devices and point of discharge (see also Code Appendix M). To prevent excessive pressure from building up in the pressure vessel, a safety valve is set at or below the maximum allowable working pressure for the vessel it protects. Safety valve construction is important in the selection of safety relief valves. By specifying that the construction must conform to ASME requirements, proper fabrication may be ensured. Before a manufacturer of relief devices is allowed to use the Code stamp on a relief device, the manufacturer must apply to the Boiler and Pressure Vessel Committee in writing for authorization to use the stamp. A manufacturer or assembler of safety valves must demonstrate to the satisfaction of a designated representative of the National Board of Boiler and Pressure Vessel Inspectors that the manufacturing, production, testing facilities, and quality control procedures will ensure close agreement between performance of random production samples and the capacity performance of valves submitted to the National Board for capacity certification. (For capacity conversion formulas, see Code Appendix 11.) Escape pipe discharge should be so located as to prevent injury to anyone where it is discharging. It is important to have the discharge pipe of the relief device at least equal to the size of the relief device. It must be adequately supported and provisions must be made for expansion of the piping system. No pressure vessel unit can be considered completed until it is provided with a properly designed safety valve or relief valve of adequate capacity and in good operating condition. All safety devices should be tested regularly by a person responsible for the safe operation of the pressure vessel. [8]

In ASME section VIII Div.1 Par.UG-126 titled Pressure Relief Valves explained (a) safety, safety relief and relief valves shall be of the direct spring loaded type. (b) pilot operated pressure relief valves may be used, provided that the pilot is self-actuated and the main valve will open automatically at not over the set pressure and will discharge its full rated capacity if some essential part of the pilot should fail. (c) The spring in pressure relief valve shall not be set for any pressure more than 5 % above or below that for which the valve is marked, unless the setting is within the spring design range established by the valve Manufacturer or is determined to be acceptable to the Manufacturer. The initial adjustment shall be performed by the Manufacturer, his authorized representative, or an Assembler, and a valve data tag shall be provided that identifies the set pressure capacity and date. The valve shall be sealed with a seal identifying the Manufacturer, his authorized representative, or the Assembler performing the adjustment. (d) the set pressure tolerances, plus or minus, of pressure relief valves shall not exceed 2 psi (15 kPa) for pressures up to and including 70 psi (500 kPa) and 3% for pressures above 70 psi (500 kPa). Par. UG-127 Non Reclosing Pressure Relief Devices explained for various type of safety valves (a) Rupture disk devices (1) general. Every rupture disk shall have a marked burst pressure established by rules of UG-137(d) (3) within a Manufacturing design range at a specified disk temperature and shall be marked with a lot number. The burst pressure tolerance at the specified disk temperature shall not exceed ±2 psi (± 15 kPa) for marked burst pressure up to and including 40 psi (300 kPa) and ±5% for marked burst pressure above 40 psi (300 kPa). (2) Relieving capacity.Rupture disk devices certified using the flow resistance method shall be use (a), and rupture disk divices certified using the coeffient of discharge method shall use (b) below. (a) the rated flow capacity of a pressure relief system that uses a rupture disk devices as the sole relieving devices. (b) the relieving capacity of the pressure relief system that uses a rupture disk devices as the sole relieving devices shall be determined by taking into consideration the certified capacity marked on the device and the characteristics of the system fluid and system components upstream and downstream of the rupture device. [9]

K. Dasgupta, R. Karmakar (1- Department of Engineering and Mining Machinery, Indian School of Mines, Dhanbad 826004, and India 2-Department of Mechanical Engineering, Indian Institute of Technology, Kharagpur 721302, and India) studied related to Modeling and dynamics of single-stage pressure relief valve with directional damping. He explained Hydraulic circuits are used in many automatic types of machinery. Almost every hydraulic system is equipped with a pressure relief valve to maintain the working pressure of the system at a pre-determined level. It protects the hydraulic pump and in turns the prime mover from overload by rapidly expelling the fluid to sump in case the system is subjected to overpressure. Therefore, dynamic characteristics of such a valve in conjunctions with other hydraulic components are important in designing the hydraulic control system. The basic single-stage pressure relief valve is dynamically undesirable due to relatively low viscous damping that causes the high frequency oscillations to exist. This problem is overcome by introducing a directional damping. Such a valve provides low damping during upward movement of the spindle, whereas relatively higher damping while the spindle moves downwards. In practice, this results in the extremely stable single-stage valve capable of handling high flow rate. So far, while many studies on the direct type relief valve have been made, the single- stage pressure relief valve with directional damping has scarcely been analyzed. Watton [1] conducted a study on such a valve without detail valve modeling. The system equations were linearised and several simplifications were made to use the transfer function formulation technique. The simulation study ignored many details of the elements of the valve assembly, like dynamics of the flapper–damper assembly, the flow forces acting on the main spindle and the flapper. In his study, only the damping coefficient of the valve was evaluated from the overall system structure through theory and experiment. The work presented in this article deals with the detail modeling of the system performed through Bond graph simulation technique [2]. An accurate non-linear model of the system explaining the physical characteristics of each element of the valve assembly based on the physical laws has been developed. The effects of various significant design parameters of the valve on its dynamic response are investigated. The simulation results are also compared with the earlier studies conducted by Watton. [10]

Paul W.H. Chung, Shuang-Hua Yang and Chao-Hong He worked on Conceptual design of pressure relief systems they noticed an important responsibility of a chemical plant designer is to ensure that a plant under design can be operated safely. One of the hazardous situations that can arise during operation is the subjection of a system to a Pressure higher than that for which it was designed. This can be caused by maloperation, instrument failure, external fire, thermal expansion or some other reasons. If the system is not protected, the excess pressure may lead to a catastrophic failure causing mechanical damage, loss of valuable material, emission of toxic chemicals and possibly loss of life. Therefore, pressure relief systems are needed to protect personnel and equipment from the undesirable consequences of excess pressure. The design of a pressure relief system consists of two stages: conceptual design and relief system sizing. The Design Institute for Emergency Relief Systems has carried out systematic and comprehensive studies of relief system sizing, particularly for reactors and two-phase relief (Fisher, Forrest, Grossel et al., 1992; DIERS 1995, 1998). However, for conceptual design, there have only been some guidelines, and recommended practices, together with regulations, codes and standards (API RP 520, 1990; API RP 521, 1990; API STD 2000, 1992). Due to differences in detail and coverage, the application of the different guidelines may provide different results for an identical situation. A prudent approach would be to review all applicable guidelines, codes, standards, etc., prior to choosing a design basis. It will be very helpful if appropriate decision trees can be built according to existing guidelines, codes, standards, etc. Parry (1994) proposed a decision tree for deciding whether to use safety valves or bursting discs. The decision tree is also presented in CCPS (1998) with Slight modifications. In our work, we have identified that the decision tree requires further revision and additional decision trees are needed for the other steps in the conceptual design stage. This paper presents four decision trees for different purposes in the conceptual design stage. For the sake of simplicity we focus our attention on pressurized systems without explosion risk, i.e. without gas/vapor/dust/condensed-phase explosion risk. Also we consider only the relief of positive pressure, i.e. not vacuum, in pressure vessels. [11]

Leonardo Motta Carneiro, Luis F. G. Pires, Marcelo de Souza Cruz and Luis F. A. Azevedo , Author Affiliations studied Dynamic Behaviour of Spring-Loaded Pressure Relief Valve. They also put Numerical and Experimental Analysis for the same. The majority of oil and refined-product pipelines in Brazil have their protection system designs based on spring-type pressure relief valves. Thus, the proper design and operation of these valves is essential to ensure the safety of transport pipelines and loading/unloading terminals during any abnormal operation conditions that generate a surge pressure. In simple terms, these valves have a disk which is pressed by a spring against the inlet nozzle of the valve. When the pressure rises, the force generated on the surface of the disc increases and, depending on the pressure relief valve set point, the force due to pressure overcomes the force exerted by the spring, causing the disk to rise and discharge the fluid through the outlet nozzle to the relief line, reducing the pressure level within the pipeline. Despite its importance, most commercial applications do not present a specific model to simulate the transient (sudden) behaviour of pressure relief valves. This paper presents an experimental study aimed at determining the dynamic behaviour of a commercial spring-type relief valve. The valve was installed in a pipe loop instrumented with pressure and flow transducers. The transient motion of the valve disc was measured with a fast-response displacement transducer. The transient in the flow loop was generated by the controlled closing of a block valve positioned downstream of the relief valve. The recorded transient data for disc position, upstream and downstream pressures, and discharge flow rates were used to compute the discharge coefficient as a function of opening fraction and the opening fraction as a function of time. Simulation models based on a spring-mass damped system were developed and implemented in a PID-actuator-control valve system. The systems were implemented in a commercial pipeline simulation program modelling the experimental loop employed in the tests. The numerical and experimental data of the block valve closure transient were compared displaying good agreement. Simulations results employing a generic relief valve model frequently used in simulations were also obtained revealing problems associated with this approach. [12]

J. Cremers, L. Friedel *, B. Pallaks studied Validated sizing rule against chatter of relief valves during gas service criteria are described for the different assumed reasons for the valve disc oscillation. In this case, sizing of the valve inlet piping has to be performed in such a way that the pressure loss in the inlet piping, calculated with a presumed stationary flow through the fully opened valve, should not exceed 3% of the set pressure.

Validation experiments by Kastor (1986) and Schmidt and Giesbrecht (1997) seem to allow for the conclusion that this rule is conservative and that the allowable pressure loss in the inlet pipe may be up to 8 or 12% in the case of a valve reseating pressure difference of about 10% and moderate pressure increase rates. Indeed, in these experiments among others, the pressure drop was generated locally by a flow restriction in the inlet pipe, an arrangement which is not common. Additionally, the actual flow losses were introduced in the recalculation instead of the values, which would be obtained when using the recommended fitting loss coefficients. The sizing of pressure relief systems against chatter can be performed by numerical simulation of the flow during the transient pressure release process. While the 3% pressure loss rule is independent of the relief valve type and behaviour, this numerical simulation also requires specific information on the valve characteristics. For example, the fluid force induced by the flow acting on the safety valve disc is required and may have to be determined by additional experiments. Also, although a variety of codes exists, no standard for quantification of valve stability is available. A practical approach for using the results of such a numerical simulation is presented by Fo¨llmer (1981) in the form of a valve stability diagram based on the so called KDT number as a result of a parametric study, Fig. 1. The valve opening and closing is expected to be stable for a value equal to or less than the allowable KDT number. It is a function of the ratio of the inlet pipe cross section and the effective valve relief area, the KAD number, which stands for the sum of the opening and reseating pressure difference related to the set pressure, and the quotient of the back pressure and the set pressure. According to the so-called pressure surge criterion, a valve is expected to operate in a stable manner, resp., not to chatter if twice the transmission time tw of the expansion wave in the inlet pipe, generated by the abrupt valve opening, is shorter than the total opening time topen of the valve. In this case the stable valve opening will be supported by the returning compression wave, produced by reflection of the initial expansion wave at the vessel inlet. [13]

2 Methods

To go through the overall design components of self regulated pressure valve need refer ASME codes, IS codes, Ansys 14.5 software, mathematic equations etc.

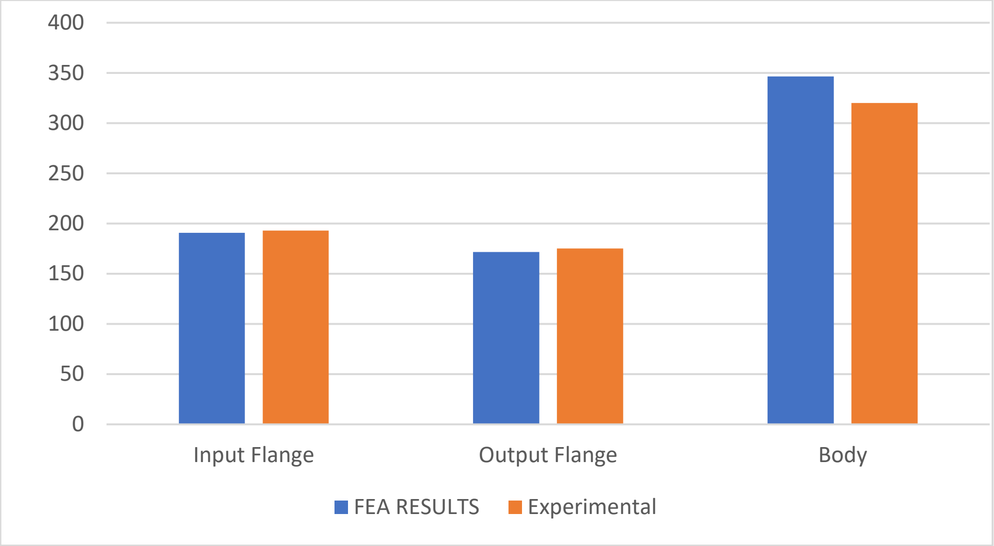
3 Results and Discussions

RESULT

As we have done the finite element analysis in ansys v15 software and experimental analysis. If we compare that result of FEA with the actual our experimental analysis then we have found that the result we have obtained our within the permissible limit. (less or within the 10 %)

	FEA RESULTS	Experimental results
Input Flange	190.73	193
Output Flange	171.46	175
Body	346.56	320

Table 5.1 Showing comparison FEA Results & Experimental Results



Graph 5.1 Comparison between FEA result & Experimental results

CONCLUSION

Failure due to stresses are prevented by increasing thickness of the reinforcement pad, because of contact stresses are developed in between nozzle diameter and reinforcement pad, so to accommodate this type of failure reinforcement pad thickness increased.

In theoretical design the spring stiffness were designed based on the sliding distance calculations, however while designing the spring following parameters are ignored. The friction in between sliding plate and jacket wall.

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

4. In order to observe performance characteristics of the valve transient structural analysis is done over valve assembly. This analysis shows maximum stress developed is 171.5 Mpa which is within the permissible safety limit.

5. By introducing non linearity (geometric) more realistic simulations were achieved. More ever these simulations gave complete idea about the operation of the valve enabling us to predict any parameters that might not have been considered during the theoretical design.

4 Future Work

The design of different components is become possible with help of Finite Element Analysis without taking the actual test over the components one can predict the failure possibility of the components. The static, fluidic, heat exchange etc problem can solve by FEA. Design by analysis is one of the best methods with which very complicate, huge, or any other particular shape can design.

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