

# DESIGN OPTIMIZATION AND ANALYSIS OF 12"- 600# GATE VALVE USING FEA AND STRESS ANALYSIS: A REVIEW

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**Abstract:** A gate valve is a valve which opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are planar, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired. Gate valves are used for controlling flow of fluid. Because of their ability to cut through liquids, gate valves are used in the industry. The objective of this paper is to perform a literature review on optimization of various mechanical parts of Gate valves.

**Keywords:** Gate Valves, Flow, Lifting

## I. Introduction:

A gate valve can be used for a wide variety of fluids and provides a tight seal when closed. Gate Valves are designed to suit a wide range of applications in Refineries, Petro-chemical Complexes, Fertilizer Plants, Power Generation Plants (Hydro - electric, Thermal and Nuclear) Steel Plants and Allied Industries. They are made from high quality Carbon Steel Castings and embody design features that contribute to strength and durability. Gate valves are used when a straight-line flow of fluid and minimum restriction is desired. Gate valves are so named because the part that either stops or allows flow of fluid through the valve acts somewhat like the opening or closing of a gate and is called, appropriately, the gate. The objective of this paper is to perform a literature review on optimization of various mechanical parts.

Roles of Gate valve are as follows,

Start and stop flow.

Increase and decrease of flow.

Governing the way of flow.

Control a flow and pressure of whole process.

Release pipe classification of a certain pressure.

## II. Parts of Gate Valve:

a) Gate valve body- A slab type gate valve is both direction

fluid flowing valve made up of carbon alloyed steel. These valve are commonly used in industries for maintaining the fluid flow by opening and closing. These valve operate both full open and close and often used for blocking in piping system

b) Bonnet - Bonnet are covers of the valve's body. It bids a leakage proof closure to the body. The bonnet types are screw in, union and bolted. The screw bonnet type is simple, durable, tight pressure seal. The union type is suitable for regular inspection and cleaning valves. The bolted type is application for large valve also where high pressure is required.

c) Stem- Stem positions the disk and it is an element that connects to actuator and disk. They are forged and are attached to disk. The attachment is threaded or welded joints. The seal is corresponding part of stem and required for preventing leakage, packing of stem.

d) Packing Material - For preventing leakage, the packing material is introduced among stem and bonnet. This packing material is often Flax Fibrous, Teflon and other compound materials. These materials form as a seal element or sealant among internal and external part.

## III. Literature Review:

**Chinyayev et al. [1]** In this paper safe operation of piping system depends on cavitation processes, based on analysis of cavitation processes. Authors studied the existing method of cavitation characteristics and proposed a method of experimental determination of the cavitation coefficient and developed the technique of experimental data processing when determining these coefficients and concluded about the influence of pressure before and after the tested valve and the differential pressure flow on the bandwidth characteristic and cavitation characteristic of valves. They have improved the methodology for determining the cavitation characteristics of pipelines valves.

**Zakirnichnaya & Kulsharipov. [2]** Authors studied previous research work of wedge gate valve and determine the wedge gate valves fail before the opened time. Some

cases wedge. In gate valve case to provide locking tightness. It was proved that the wedge gate valves technical resource is primarily affected by the operating parameters such as the flow rate and pipeline system pressure. The tested valves resource values are less than those indicated by the manufacturer. The results show the need to adjust the valves assigned resource taking into account the operating parameters influence on the wedge.

**Luis Alberto Breda Mascarenhas et al. [3]** Main objective of this paper time reduction to developed new gate valve and valve seat materials. It shows the workbench development process to simulate durability of valve and valve seat and a new testing method that considers the high engine operation temperatures and focuses on reducing time for the new material development and the emissions during the product usage life time.

**Pujari A. A. et al. [4]** A gate valve can be used variety of fluids and provides tight seal when closed. The objective of this paper is design optimization and analysis of gate valve body using FEA and stress analysis. In this paper they have reviewed all the parts design, optimization and their effect on the performance of gate valve. The paper also reviews various methodologies adopted in carrying out analysis and design optimization of 8" 600 class gate valves. Internal pressure acts on valve body, increase the pressure valve body stresses are also increases linearly. FEA Result a structural analysis of valve body is well in agreement with experimental result.

**M. M. Tverskoy et al. [5]** In this paper authors considered as non-global structural analogues actuators for shut-off and control ball valves with double-gate, providing exceptional technical characteristics (bandwidth and control range) in comparison with the analogues. The analytical review of existing constructive actuators solutions is conducted and the issued related to the calculation of their main characteristics are reviewed. Conclude to combination of shut-off and control functions in the ball valves in a single case they provide essential reduction in size and simplification of installation of pipeline system of different function. Circumstance is very effective use in mobile system.

**Silaskar et al. [6]** In this paper studied value engineering and analysis of ball valve used hydraulic systems. Principles of value engineering have been primarily applied for overall weight Optimization of ball valve for cost effectiveness as well as improvement in performance. Using concept of value engineering modification design of ball valve parts and analysis tools as per the standards of American Petroleum Institute. (API-6D) All valve parts has been modified and tested. Result in weight reduction around 12-13% due to overall cost of valve is reduced,

with the help of modification in ball valve design. The cycle time also reduced dew to reduction of overall cost of ball valve.

**K. H. Jatkar and Sunil S. Dhanwe [7]** According to this paper, gate valves are used for straight line flow of fluid. Main objective of this paper perform a stress analysis of the critical component of Gate Valve like Body, Gate Stem, and slab gate. It uses FEA technique to perform analysis of valve component. A model of each element of Gate Valve is developed in CATIA V5R17 and analyzed in ANSYS 11. Gate valve stress analysis is done by FEM using ANSYS 11 and validation is supported by stress analysis using classical theory of mechanics. Finally, both the result obtained from FEM software and classical analytical theories are compared approximately same.

**Shashank S. Jadhav [8]** In this paper states that during the extraction of fluid from earth's crust, the flow is under high pressure needs to be channeled. This is done through a Christmas tree structure by number of pressure valves. Thus, the requirement of the gate valves in petroleum industry is high thus the reduction of the thickness of the valve to an optimum thickness will reduce the weight and cost of the valve. This paper deals with the optimum thickness design required for the Gate valve for functioning smoothly under high pressure. Design process the valve considered in the paper for M-Type gate valve, but this process can be generalized and use for different types of gate valves. Concluded to design dimensions of gate valve are safe limits, the thickness of gate valve from calculations is less than the actual design.

**Mr. Satish M. Silaskar et al. [9]** In this paper author studied problem of valve manufacturing industry to investigate it through value engineering by comparative study of valves in various manufacturing industry to analyze the performance with respect to sustainability and cost effectiveness and overall weight optimization of ball valve by modification of dimension, as per the standard dimensions. Modified the ball valves, and thickness of the parts of valve from result calculation is less than the actual the design. Due to reduction of weight of valve, cycle time and overall cost also reduction.

**Mr. Nikhil Yashwant Katkar et al. [10]** In this paper reviewed on the design and analysis of critical components of Gate Valve. The critical components studied are Body, Gate Stem and slab gate. The main purpose of design and analysis of any valve is to determine stresses and strains developed in the valve body, which is done by using computer aided software tools. The focuses on researchers work is to design and analysis valves, and determine flow characteristics of various components. The results of computer aided tools can be validated analytically by using classical theory of mechanics.

#### IV. Findings from Literature Review:

Some authors worked on design and development of critical components of gate valve while some authors have done 3D modeling using CATIA and finite element analysis (FEA) of critical parts of gate valve. Some authors have developed new workbench development method. Some authors studied on cavitation coefficient finding.

Some authors studied gate valve working and have done weight optimization of gate valve body and also cost optimization. But no-one has worked on gate valve seat replacement.

**V. Conclusion:** In this Review paper we studied different types of Gate Valves, like slab gate valve, plug valve, ball valve etc. and their functions. Design and analysis critical component of gate valve. Valve developed CATIA V5R17 and analyzed in ANSYS 11. Thickness of gate valve is less than the actual design. Weight optimization of ball valves for cost effectiveness by modification in the design parts of valve using concept of value engineering and analysis tools as standards (API-6D) cycle time also reduced due to reduction of overall cost of valve.

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