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Value Analysis on Industrial Ball Valve

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ABSTRACT: Value analysis is an essential tool used in product development to improve the profit of an organization. The value analysis is used to attack functions which are contributing the product, market. So, identifying either less contributing functions to eliminate or improving the contribution of a function by doing the same function with lesser cost. The main objective of this project is to improve the design of the ball valves used for water transportation, with special attempt to identifying and proposing solution to the major problem with its applications such as weight and cost reduction. A detailed function analysis of the valve is carried and individual component's functions are listed along with cost. FAST diagram is used to identify the functions of each components and their degree of contribution. Mostly structural component are making the value and weight is major contributor of cost. Function wise, content of valve as give controlled opening using FEA deformation at critical point measured at maximum pressure and used as one of the functional performance factor of leakage. The material failure is the other performance of structure parts. This project covers area like the analysis of the materials used for the design analysis of the design model (computer aided design CAD) using the finite element method. The structural analysis is performed on ball valve and the stress intensity, deformation, strain intensity for various materials are identified.

KEYWORDS: Ball Valve, FAST diagram, Value Analysis, Finite Element Analysis

I INTRODUCTION

The valves are prominent part of industrial fluid power systems as the control flow system, regulate pressure and control the direct of the pressurizing of the fluid. Valves are also important from safety point of view; it can be extremely expensive and complicated in design. In most of the industries, considerable quantity of fluid is transferred through pipes and for regulating purpose use of valves is unavoidable. The various parameters that can be optimized for cost effectiveness & overall performance are weight, & energy required to operate the valve. The selected valve in manufacturing enterprise is facing the problem of 10 to 15% cost escalation in the production process as compared to their other competitors. This has resulted in a loss of profitability and decreased return on investment to the concerned therefore the question arises about its sustainability and cost effectiveness. Any improvements to the methods available for monitoring the condition to the valve may yield substantial cost savings and safer working conditions. This project covers area like the analysis of the materials used for the design analysis of the design model (computer aided design CAD) using the finite element method. The structural analysis is performed on ball valve and the stress intensity, deformation, strain intensity for various materials are identified. Weight has to be focus for the reduction in material cost. Reduction of weight can be achieved by selecting the suitable material of the product. Weight optimization is the process of modifying or changing an existing design in view of the objective to improve few of the aspects of engineering design which concerns performance, manufacturing and assembly of the product.

II. VARIOUS PHASES OF VALUE ENGINEERING

The organized and systematic approach to Value Engineering (VE) Job Plan is the key to success in a value engineering study. It is the job plan that the study identifies the key areas of unnecessary cost and seeks new and creative ways of performing the same function as the original part, process, or material. It works and has been proven effective in manufacturing processes and procedures, and in the other field. The job plan allows the study team to go beyond than the usual design process. The following are the phases of value engineering for cost reduction and modifications in the product for improvement in function of product and cost reduction. A. Information Phase: During this phase clearly identify the problem to be solved and gather the possible information of the product in terms of basic function. The collect data and examine the results, in the context of the cost and find best options for weight reduction

and improvement in the value of the product. B. Function Analysis Phase: In this phase, Product is defined in terms of functional performance and expectation. 3 These functions are co-related with costs and their worth. Define a function with only 2 words: a verb and a noun. C. Creative Phase: The purpose of this phase is to create possible alternative ways to provide the best way of weight optimisation and cost reduction for improvement in function and maintain the desired quality of the product. A Brainstorming is technique is used for this type of analysis D. Evaluation Phase: The objective of the evaluation phase of the value engineering job plan is to thoroughly analyse the results produced in the creativity phase by reviewing the various alternatives to select the best idea for improvement in the value. All the ideas generated in creative phase were screened to identify and eliminate duplicate ideas. The remaining ideas were ranked by the team and ideas with the highest rank were shortlisted and taken up for further evaluation. E Development Phase: In this phase, as per the final recommendations for modification in product and development for cost reduction ideas are implemented. Testing is conducted as per standard on modified product for verification of product preformation F. Presentation Phase: It gives the best alternative method to those who have the authority for modification in design, explaining the basic ideas recommendation for cost reduction and improvement in the product value also prepared the proposal of value engineering for implantation of alternative methods. G. Implementation Phase: As per approved recommendation is design and manufacturing process of product, design team and production manager is held responsible for implementing the changes. Take the follow-up that the changes are completely applied.

III. LITERATURE REVIEW

1. **Bhosale Abhijeet T. analyzed Butterfly valve disc by FEA analysis of Butterfly valve body and weight optimization.** The weight reduction is done by changing the disc thickness. With the help of different optimization models created by changing the parameter and analyzed. Results are shows that the maximum weight reduction in different section is 2 Kg while keeping maximum stress level up to 140N/mm² which is safe for the applied load.
2. **B.Rajkumar explained the typical problems faced in the industry with the conventional globe** such as the difficult manual operation due to higher valve torque, stem bending issues in stainless steel material, packing performance deterioration by rotating stem design, galling problems at stem threads and at flange bolts and gland packing eyebolts at low temperature. FEA and CFD tools are used to optimize the body -bonnet cover flange thickness, disc thickness and flow geometry. Shows how FEA and CFD tools are used to effectively optimize the valve design.
3. **Chougule Mahadeo Annappa presented the basic fundamental of value engineering that can be implemented in any product to optimize its value.** In this case study of a Universal Testing Machine (UTM) he discussed in which the material, design of components is changed according to the value engineering methodology. For reduction of cost he selected some components from Universal Testing Machine and he applied value engineering technique for the cost reduction of these components of Universal Testing Machine.
4. **Chern Ming-Jyh. Studied experimentally the performance, flow patterns and cavitations' phenomena of a ball valve.** Various patterns of flows in and downstream the ball valves with respect to different valve openings and inlet velocities are visualized using a particle tracking flow visualization method (PTFV).
5. **Gurav Shridhar S. In this Literature review of valve work done by different researches in the area of weight optimization and experimental stress analysis technique** the result of each one showing that classical and analytical results are approximately matches with each other and that can be used for further development of the gate valve. Now a day's everywhere Optimization concept is in the focus, no doubt its fruit of the cost cutting concept.
6. **Dr. K.H Jathar & sunil S. Dhawn has worked on classical theory and finite element analysis of the gate valve.** Finite element analysis carried out by using Ansys software. Stress value of classical and finite element analysis compound and it matches approximate with each other. And that can be used for further development of gate valve.
7. **Sharma Amit Studied the best feasible solution from the available alternatives is chosen through the feasibility ranking table.** Through the application of Value Engineering profits are maximized without hindering the reliability of the product. With the effective utilization of the Value Engineering technique the various advantages have been observed in terms of cost reduction, increase in overall production, reduction in manpower, and reduction in scrap these outcomes to be a successful showcase of value engineering
8. **Sharma Amit presented the basics of value engineering and its different phases that can be implemented to a product for its optimization.** Value engineering can improve the product cost by reducing unnecessary cost associated with the product. It explores each part of the value engineering job for successful application of the technique. In A case study he has been discussed and analysis has been carried out by the process to achieve the product optimization. The results obtained after implementation of various techniques is cost of product minimize and quality of product improves.

9. Sturges Robert H stated that the Value Engineering techniques based on function have been the means to improved products and processes for several decades. It is a social design methodology that is usually episodic in application and often confused with narrow interests, such as cost cutting. He conclude that VE is neither a different nor a sufficient way to design compared with more conventional analytical and synthesis techniques. It is rather a parallel and necessary process with different inputs and outputs.

10. Jadhav Shashank S. it is stated that the optimum thickness design required for the Gate valve for functioning smoothly under high pressure. Author proposed the method to study the pressure valve is the device that is used to channel high pressure fluid and control the flow of the fluid through a pipe. 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. In this paper he deals with the optimum thickness design required for the Gate valve for functioning smoothly under high pressure.

V. METHODOLOGY

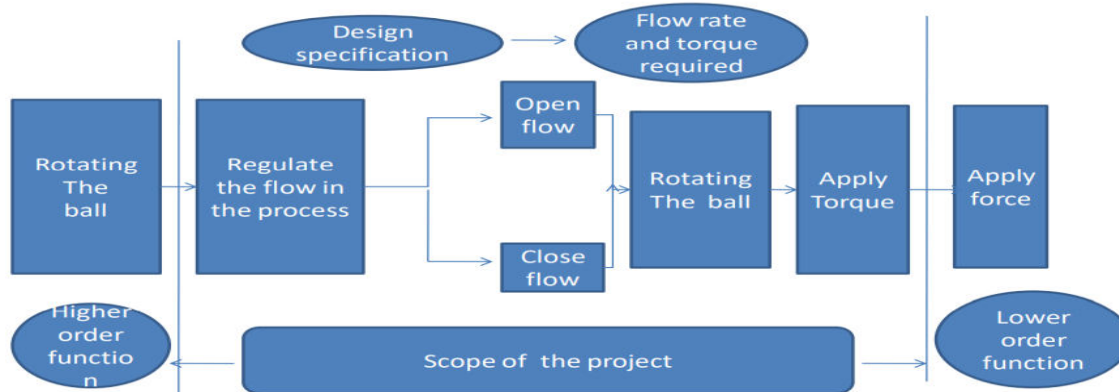
The main aim of this project is to improve the design of ball valves used in the water (inlet sizes of 24 inch), with an attempt to solving some of the major problem with its applications. The project cover areas like the analysis of the materials used for the design, analysis of the design model (CAD) using finite element method (FEM), the Finite Element Analysis will be focused on the intersection of the spherical cylindrical parts where the maximum stress concentration is expected. There is various stages of project which is discussed below

The methodologies of the project are as follows

- Literature study of the ball valve designs, assembly exist points of the ball, the problems with the design of parts of the ball valve and material selection.
- Constitutive modeling of ball valve using CREO Software
- Material selection Stainless Steel, Cast Iron, Bronze and Carbon steel
- Finite element analysis using the ANSYS Software
- Post processing and review of the results of the mode.

VI. FUNCTIONAL ANALYSIS

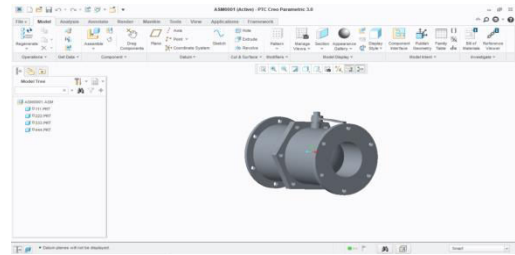
Functional analysis is the next step in the Systems Engineering process after setting goals and requirements. Functional analysis divides a system into smaller parts called functional elements, which describe what we want each part to do. In later steps we will identify alternatives, optimize them, and select the best ones to make up the complete system. The name Function comes from mathematical functions, which act on an input value and produce a different output value. Similarly, in the Systems Engineering method, functions transform a set of inputs to a set of outputs.



Functional analysis of a ball valve is done in order to find out the primary and secondary parts and assembly. The FAST DIAGRAM helps us to eliminate or changing the parts and assembly of the ball valve which results in the cost reduction of the production of ball valves. Thus after the functional analysis of ball valve, most every parts and assembly are primary which cannot be neglected for cost reduction.

VL WEIGHT ANALYSIS

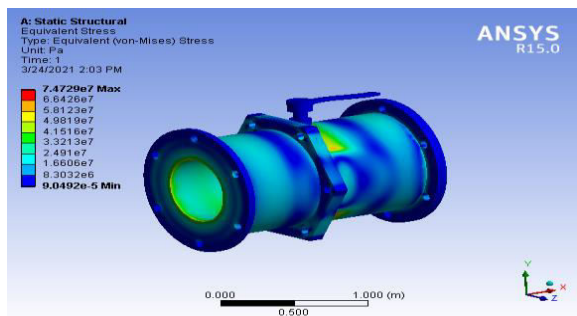
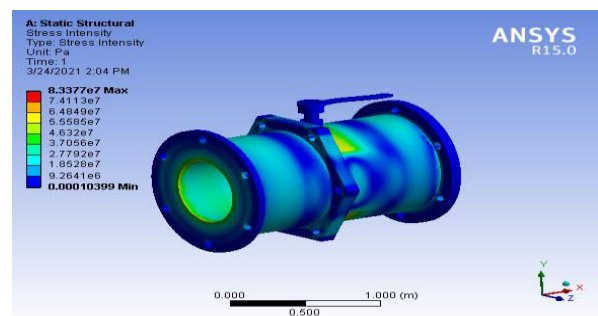
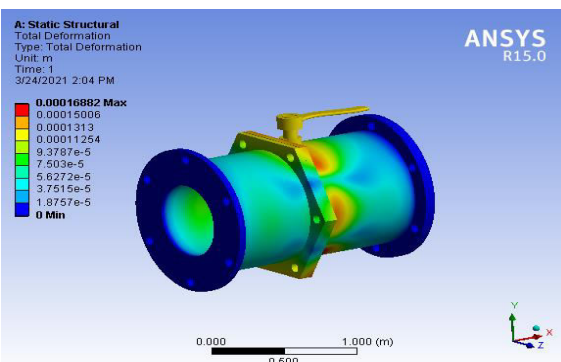
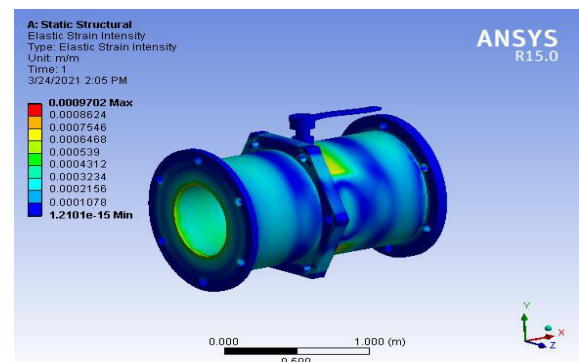
According to the dimensions of the 24'' inch ball valve, the components of ball valve such as its body, ball, handle are drawn using the CREO tool. So the component needs to be assembled in order to find out the weight of the ball valve. Then the weights of the materials of the ball valve are calculated using CREO tool

**Fig: 6.1 Weight Calculation****Figs: 6.2 Assembly of Ball Valve**

S.No.	Material	Mass (Kg)
1	Stainless Steel	6365
2	Bronze	7275
3	Cast Iron	6125
4	Carbon Steel	6452

Table: 6.1 Weight Calculation of ball valve**VII. STRUCTURAL ANALYSIS**

The structural analysis is done using ANSYS Software. The following materials are considered for structural analysis of ball valve are Cast Iron, Stainless steel, Bronze, Carbon steel.

**Fig: 7.1 Equivalent stress of Cast Iron Ball Valve****Fig: 7.2 Stress Intensity of Cast Iron Ball Valve****Fig: 7.3 Total Deformation of Cast Iron Ball Valve****Fig: 7.4 Elastic strain intensity of Cast Iron Ball Valve**



Valve

	Equivalent (von-Mises) Stress (Pa)	Stress Intensity (Pa)	Total Deformation (m)	Elastic Strain Intensity (m/m)
CAST IRON	7.4729e+007	8.3377e+007	1.6882e-004	9.702e-004
STAINLESS STEEL	7.2769e+007	8.1085e+007	9.624e-005	5.5037e-004
BRONZE	7.0962e+007	7.9006e+007	2.653e-004	1.5124e-003
CARBON STEEL	7.373e+007	8.2205e+007	9.2865e-005	5.3228e-004

Table: 7.1 Structural Analysis of Ball Valve

VIII. RESULT & CONCLUSION

The ball valve is designed and modeled using CREO software. The mass analysis of ball valve for various materials is performed. It is identified that Cast Iron ball valve has lesser mass as compared to other materials. The results showed that von-mises stress and Stress intensity are low in Bronze material and stainless steel ball valve has less deformation than other materials. Hence it is suggested that Cast Iron ball is suitable for low cost application and Bronze ball valve is suitable for low stress application.

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