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Weight Optimization of Valve for Cost Effectiveness: Using Value Analysis

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***Abstract*: This paper concentrates on value engineering and analysis of ball valve used hydraulic systems. Principles of value engineering have been primarily applied for weight Optimization of valve for cost effectiveness as well as improvement in performance. In manufacturing industry changes observed in the product are very faster and difficult to predict its presence in comparison to earlier design due to largely changing customer demands and variety of expectation added to the changing environment. The continuous development of the technology leads to frequent changes in the design. The manufacturing industries are practicing to innovate and improve the design of product by weight optimization and improvised manufacturing process of product for cost effectiveness. Value Engineering defines a process in which the value of the product can be increased by significantly by decreasing its cost to achieve a long-term growth of the comp.**

***Keywords*: Weight Optimization, Value Analysis**

1. Introduction

The valves become prominent parts of industrial fluid power systems as the controls flow, regulate pressure & control the direction of pressurizing of 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. Valve manufacturing industries are producing various valves like Globe control valve, High-Performance Butterfly Valve; Manual operated Butterfly, Ball valve necessary for different process industries. It will not be possible to cover all the products in the research work. Hence the research work will be confined only Ball Valve. 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. weight has to be focus for the reduction in material cost. Reduction of weight can be achieved by redesigning 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. So modification in design and standardization of the valves is required which can be termed as the redesign of a valve. Due to redesign and standardization in size of the valve, it will be reduced and effects in weight reduction. Therefore, by weight reduction not only the material cost will be saved, but also the machining time and the cycle time will be reduced. Value Engineering methods are very important and useful in Cost Reduction and sustain their profitability. Value Engineering is one of the most effective techniques available to identify and eliminate unnecessary cost in manufacturing processes, design, test, construction, maintenance, data specifications and practices. Although its application to procedures, specifications and practices is less well known, its effectiveness in these areas has been proven. Value Engineering is a systematic approach to direct and analyzing the function of equipment, services, systems and supplies for the purpose of achieving their essential functions at the lowest cost consistent with required reliability, performance, safety and quality. [1] Society of Japanese Value Engineering defines as: “Value Engineering is a systematic approach to analyzing functional requirements of products or services for the purposes of achieving the essential functions at the lowest total cost and improve the value of product” [2].

2. 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. 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.

3. A Case Study

A case study is carried out in a well-known valve is known industry in recent times reveals requirement of improvement in valves. As per the data provided by the industry & comparative study with other valve manufacturing industries the reductions of the cost is required for the sustainability of the market. The detailed study of various parameters has been done which reveals the weight as the most significant parameter to be focus. So focussing on the weight optimization of the valve. Valves are integral components in piping systems and use for the various purposes. It is used as the prime device for controlling the flow, pressure and direction of the fluid flow. In engineering and chemical industries there are 20-40% piping installed for fluid handling. The identified industry has a clear and precise mission to achieve the highest level of excellence that will keep getting better and better and eventuate into a benchmark of the industry.

A. Methodology

A.Gather information of product: It is observed from the initial data that the overall cost of the valve is more as compared to the competitors due to Weight of the existing valve is more which affects the overall cost. Its effect on profitability and decreased return on investment to the concerned therefore the question arises about its sustainability and cost-effectiveness. The manufacturing process of a valve is as per conventional Job work. There is no defined cycle time for the process. The Proper approach of Value Engineering is not followed. Overall costs of valve mainly depend on three factors. The first factor is the weight of valve body; Generally, Ball valves are manufactured by casting method.

Ball valve Body Contributes considerable amount of weight in assembly (about 30% to 40% of the total weight). So for optimization of ball valve body, it is necessary to get the tensile stress pattern of the body, which is possible by using Finite Element Analysis. Second, operating torque valve by reducing operating torque proper selection of actuator.

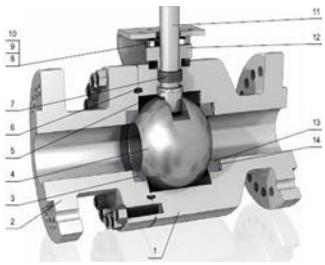

Fig. 1. Sectional view of two-piece ball valve

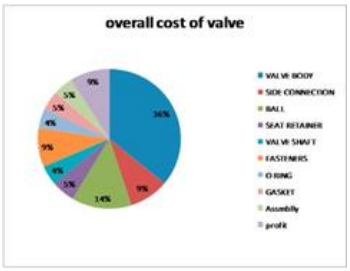

Fig. 2. Chart 1-Pie charts showing the various parts cost of ball valve

If the ball valve required more torque then required minimum torque during its operation, manual handling will be very tough. To reduce the manual effort and eliminate the use of an external device which is also affecting the selection of actuator it will affect the reduction of cost of the actuator. Third-factor manufacturing cost of the valve by reducing cycle time manufacturing process of a ball valve for defined the cycle time of assembly. By proper optimizing these factors we can reduce overall cost of the ball valve and profitability will increase as

compared with the other competitors and it will sustain in the market.

B. Functional analysis

Valves are integral components in piping systems and use for the various purposes. It is used as the prime device for controlling the flow, pressure and direction of the fluid flow. In engineering and chemical industries there are 20-40% piping installed for fluid handling.

C. Development alternate design or method

During brainstorming, ideas Were Listed for Cost Reduction of ball valve, change design of ball valve, change material, change production process, Reduce torque.

D. Evaluation Phase

For reduction of cost of valve as first ides weight of valve change by making some changes in existing design of ball valve.

Modified the outer dimensions of and shape of valve body as shown in Fig. 4 which effect on wall thickness which is reduce from 36mm to 26mm.outer. Outer shape of valve body had steps and outer shape of valve body have slope. Before Modification in dimensions of various parts drawing of 12" ball valve.

Modified in side connection as shown in Fig, 10 are i) Create slot at the place of Ball rest (trunnion) for weight reduction ii) Reduced hole at seat retainer from 24 No. hole to 16 No. Holes which reduced the drilling time and also effect on torque.

4. Results and outcomes

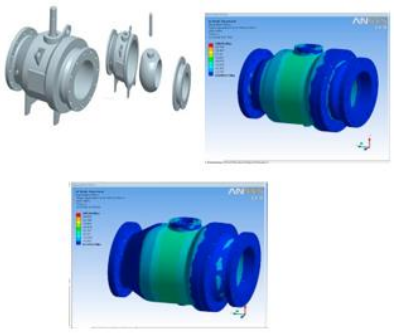

Fig. 3. Result (Ansys)

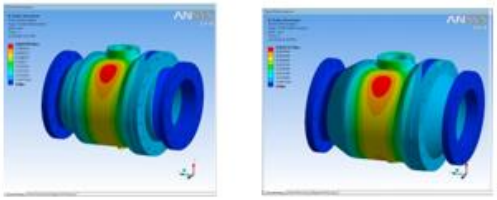

Fig. 4. Deformation in valve before & after modification

Modification in the existing model particularly body, side connection & ball has been done and respective modified parts are modelled in to Pro E & Stress & deformation analysis has carried in ANSYS. The results shown are modification in dimensions which offer reduction in weight of valve assembly by 60kg and stresses before were 100.84 N/mm^2 and after modification 105 N/mm^2 which is within acceptable limit. Also the deformation observed are in permissible limit without affecting the function of valve as depicted in fig. 4.

For validation of outcomes, Hydro and Pneumatic tests according to the Standards were conducted. The results of these tests were satisfactory and accepted. The modification in the ball valve had no effect on its functioning. This test was conducted and the results are as follows. These are certified by the authority. The actual dimension of valve part was checked and it was observed that they were according to the standard.

5. Conclusion

In this paper, an attempt has been made to optimize the overall weight of ball valve for cost effectiveness by modification in the design of valve parts using the concept of value engineering and analysis tools as per the standards of American Petroleum Institute (API-6D), all valve part has been modified and tested. For validation of outcomes, various inspection and tests according to the standards were conducted. The results of these tests were satisfactory and accepted. Efforts applied results in a reduction in weight around 12-13% due to which cost of the valve is reduced.

Besides this, different machining times were observed which would result in the reduction of cycle time. In the first part of work, the overall cost of the valve is reduced by reducing the weight with help of modification in valve design. The reduction in cycle time may also result in the reduction of overall cost of the valve.

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