Design and Value Analysis of Rotary Valve

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Abstract
Rotary valves are used as the gatekeepers to allow materials to flow or get transferred in the material handling equipment such as silos, ball mills, bunkers, etc. Their function is very important and there is no replacement of rotary valves as we consider it on mechanical and economical basis. The design of rotary valves is based upon which material to be handled, in how much quantity and also in stipulated time period. Design has been done for all the different components of rotary valve. There can be various reasons for not up to the mark performances of rotary valve. Analyses of rotary valves has been done and figure out the problems related to performance. Any component or equipment has its functionality and costing. Every component of rotary valve has some function to perform. So, analysis of function and economical value of components is of much significance for manufacturers and users.

Keywords: *Rotary Valve, Functional Requirement, Functional Analysis, Costing, Value*

INTRODUCTION

Techno Designs, situated in the Vithal Udhyognagar, Anand is a leading Industry in Manufacturing of Material Handling Equipment. It manufactures various material handling equipment like silos, ball mills, and bunkers, etc. Most of the equipment uses a common component that is a Rotary Valve. Rotary valve helps in transfer of material. It can handle free flowing solids like talcum powder, ash, dust, etc. falling under gravity or working under positive or negative pneumatic system. Analysis of rotary valves has been done and can figure out the problems related to performance. Any component or equipment has its functionality and costing. Every component of rotary valve has some function to perform. So, analysis of function and economical value of components is of much significance for manufacturers and users to improve its valve.

Problem Specification

Design has been done for all the different components of rotary valve. There are various reasons for not up to the mark performance of rotary valve. Analysis of rotary valves has been done based on its functional requirement.

Use of Value Analysis Technique for Cost Reduction in Production Industry

Value Analysis can be defined as a process of systematic review that is applied to existing product designs in order to compare the function of the product required by a customer to meet their requirements at the lowest cost consistent with the specified performance and reliability needed. This is a rather complicated definition and it is worth reducing the definition to key points and elements: 1. Value Analysis (and Value Engineering) is a systematic, formal and organized process of analysis and evaluation. 2. The analysis concerns the function of a product to meet the demands or application needed by a customer. To meet this functional requirement the review process must include an understanding of the purpose to which the product is used. 3. Understanding the use of a product implies that specifications can be established to assess the level of fit between the product and the value derived by the customer or consumer. 4. To succeed, the formal management process must meet these functional specification and performance criteria consistently in order to give value to the customer. 5. In order to yield a benefit to the company, the formal review process must result in a process of design improvements that serve to lower the production costs of that product whilst maintaining this level of value through function.

Materials/tools required

The paper includes Design and Value Analysis of Rotary Valve. For designing different techniques like Functional Analysis, FAST Diagram, and cost analysis has been used.

DESIGN: ANALYSIS, DESIGN METHODOLOGY AND IMPLEMENTATION STRATEGY

The rotor shaft is designed based on strength criteria

Assuming motor of 1hp power. Power given, P= 1 hp = 745.7 W

According to equation, $\frac{T}{J} = \frac{\tau}{R}$

As we know Power, $P = \frac{2\pi NT}{60}$

$$\therefore T = \frac{(60\ P)}{2\pi N} = (\frac{60\ (745.7)}{2\pi 40}) = 178.11, Nm$$

$$\therefore 178.11 = \frac{\pi}{16}\tau d^3$$

Shear strength, $\tau = 410, \frac{N}{mm^2}$

Now, τ_{all}= (0.18) (0.75) (τ)=55.35, $\frac{N}{mm^2}$

∴178.11=$\frac{\pi}{16}$×55.35×10^6×1/1.5×d^3. $[N_f = 1.5]$

∴ =29mm ≈30mm

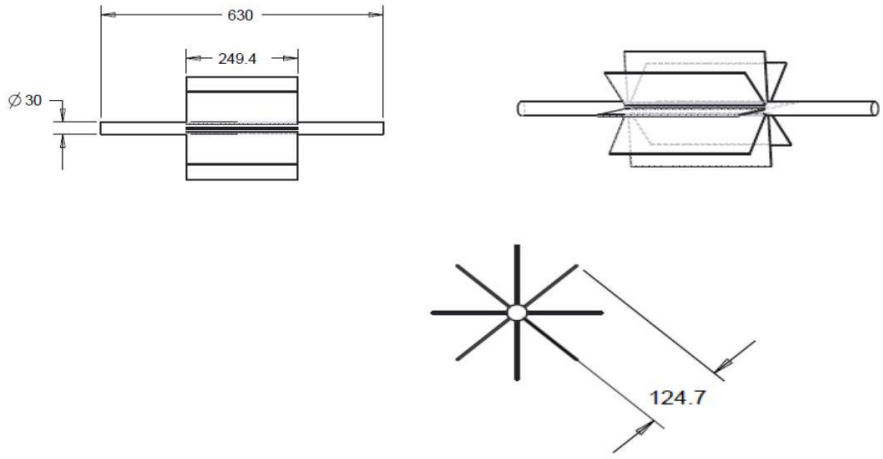

Fig. 1: *Rotary Valve*

Flow Rate Calculations

A_1=*cross section area of casing*

A_2=*cross section area of rotor shaft*

ρ=*density of material* (*talcum powder*) =0.881 *g/cc*

N=rpm of rotor

- Now, $A_1 - A_2 = 0.43964$,A_1= 0.0496025 and A_2= 0.005098
- Volume $V = (A_1 - A_2) * \text{Length} = 0.010991\ m^3$
- Flow Rate= $\rho V \frac{2\pi N}{60} = 36.5927\ kg/sec$

Casing: The material of casing is Cast iron CI 1030, It prevents spillage of material; Process: Sand Casting

Value Engineering

Value Engineering is the systematic application of recognized techniques which identify the functions of a product or a service, establish a monetary value for that function, and provide the necessary function reliability at the lowest overall cost so as to increase value of product.

Value Analysis

Value analysis comes under the umbrella of Value Engineering. Value analysis is the systematic and critical assessment by an organization of every feature of a product to ensure that its cost is no greater than is necessary to carry out its function.

Table 1: *Function Worksheet (P: Primary Function, S: Secondary Function)*

Sr. no	**Part**	**Function**
1	Casing	Protect Part(P)
		Facilitate flow(S)
		Facilitate Assembly(S)
		Enhance Appearance(S)
2	Bolt, nut and washer	Locate part(P), Facilitate Assembly
3	Rotor shaft	Transmit Torque(P)
		Support Vanes(S)
4	Vanes	Transfer Material(P)
5	Motor	Supply Power(P), Facilitate Flow
6	Gear Box	Control Speed(P), Facilitate Assembly
7	Sprocket	Transmit Power(P)
		Support Chain(S)
8	Chain	Transmit Motion(P)
9	Bearing	Reduce Friction(P)
		Support Shaft(S)

Table 2: *Bill of Material*

1	Casing	1
2	Rotor shaft	1
3	Vanes	8
4	Motor	1
5	Gear Box	1
6	Nut	16
7	Bolts	16
8	Washer	16
9	Bearing	4
10	Sprocket	2
11	Chain	1
12	Side Cover	2

FAST Diagram: FAST is a diagramming technique which reveals the relationships and inter-relationships of all known functions. It will display in logical sequence all the functions and show their dependency and priorities.

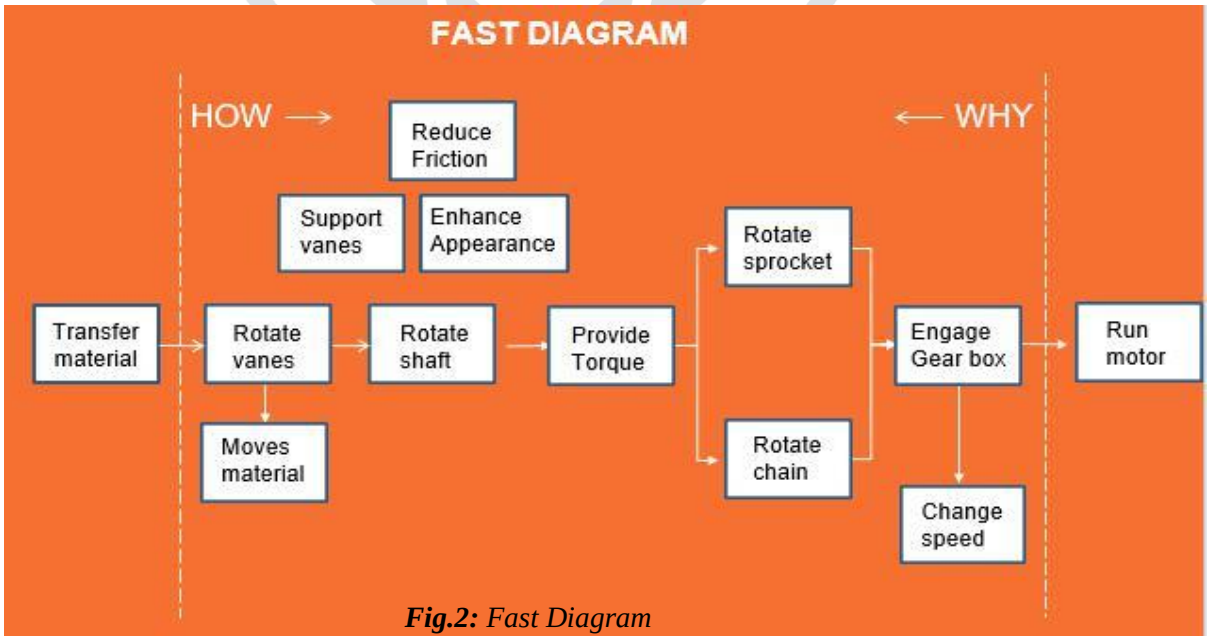

Fig.2: *Fast Diagram*

Table 3: *Cost matrix*

Components	Total Cost of Each Component	Protect Part	Enhance appearance	Locate Part	Transmit Torque	Support Views	Drill Holes	Transfer Material	Reduce Speed	Reduce friction
Casing	1900	1800	100							
Bolt, Nut & Screws	332			152			180			
Motor Shaft	188.25				188.25					
Gears	4514					4000		514		
Motor	4700				4700					
Gear Box	20000								20000	
Sprocket	600				600					
Chain	650				650					
Bearings	468									468
Total	34384									
Labour Cost	34384*0.1=34 38.4									
Final Cost	37822.4									

Table 4: *Cost from various sources*

Sr. no.	Component	Specs.	Quantity	Cost
1	Casing	Material cost(CI 1030)=Rs 75/kg Weight of Casing=20kg Casting Price= Rs 65/Kg Painting=Rs100	1	2900
2	Rotor shaft	Material Cost(MS IS 2062)=Rs 65/Kg Weight of Shaft= 3.05 kg	1	200
3	Vanes	Material Cost(MS IS 2062)=Rs 65/Kg Weight of each vane=1.07 kg	8	557
4	Motor	Crompton Motor 1hp	1	4700
5	Gear Box	Elecon Make 40:1 Speed Reduction Gear Box	1	20000
6	Nut, Bolts and Washer	Price of each set= Rs 12	16	192
9	Bearing	FAG Bearings per piece= Rs 117	4	468
10	Sprocket	Sprocket price per piece= Rs 300	2	600
11	Chain	Rollcon Chain=Rs 650	1	650

Table 5: *Modified Cost Matrix*

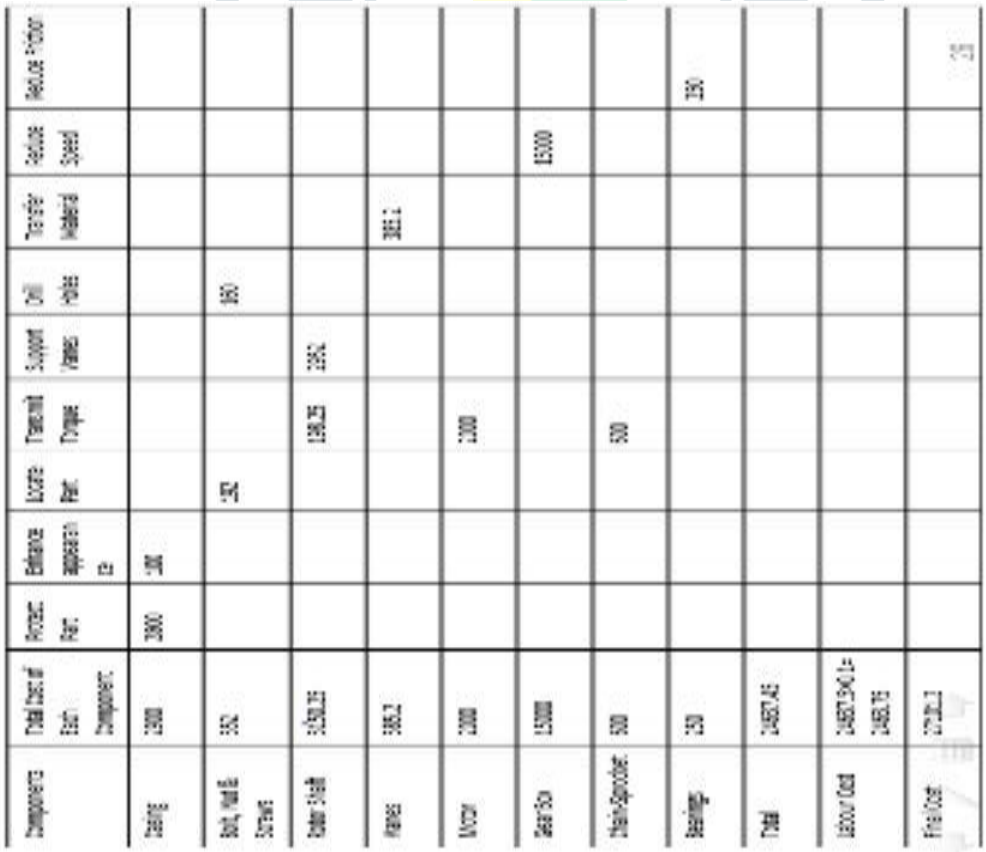

Table 6: *Modified Cost Matrix*

Sr. no.	Component	Specs.	Quantity	Cost
1	Casing	Material cost(CI 1030)=Rs 75/kg Weight of Casing=20kg Casting Price= Rs 65/Kg Painting=Rs100	1	2900
2	Rotor shaft	Material Cost(MS IS 2062)=Rs 65/Kg Weight of Shaft= 3.05 kg	1	198.25
3	Vanes	Material Cost(MS IS 2062)=Rs 65/Kg Weight of each vane=1.07 kg	6	385.2
4	Motor	Pawan Agencies 1hp	1	2000
5	Gear Box	Robus Series Helical Gear Box	1	15000
6	Nut, Bolts and Washer	Price of each set= Rs 12	16	192
9	Bearing	SKF bearings Price = 125/2 piece	4	250
10	Chain-Sprocket	Chain-Sprocket price per piece= Rs 300/piece Made by Hero	2	600

CONCLUSIONS:

After performing Functional analysis and cost analysis, we can conclude that if we replace gear box with the other economical gear box. This gives same functional performance, with this we can cut down 10181.2 Rs. of cost from the total cost without compromising the quality and functional requirements.

Actual Total Cost: Rs 37282.4
Modified Cost: Rs 27101.2
Cost Reduced: Rs 10181.2

So, the costs of various components of rotary valve were reduced by application of functional analysis and thereby the value (performance/cost) of the component has been increased.

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