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Reducing product cycle time and costing using screwed Yoke design for industrial globe valves

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Abstract

The objective of this project is to using screwed yoke design instead of existing welding design to the reducing product cycle and cost of an Industrial Globe Valves starting from marketing, getting the order from customer, manufacturing and supplying to customer, find the bottlenecks and suggest solutions to optimize the product cycle time and reduce cost of this valve with customer satisfaction. We used screwed yoke instead of welded yoke of the valves to perform the main objective of this study.

Keywords: Welded Yoke; Screwed Yoke; Screwed Bonnet; Collar cut; Explosion hazards

1. Introduction

A globe valves is important device in utility boiler as well as industrial boiler which is play major role. It is also used for regulating flow or pressures as well as complete shutoff of flow. It may also be used sometime as a pressure relief valve or as a check valve.

Globe valves are types of valves that regulate the flow of different gasses or liquids. They can also start or stop the flow. Globe valves have different parts such as disc, plug, ring seat, etc. and there are also different Globe valve types in the market such as y type globe valve, Z globe valves and angle types that are designed for specific purposes to serve diverse flow control needs and provide different globe valve functions.

There are several key parts that all globe valves contain: body, seat ring, cage, bonnet, stem, plug (disk), yoke, yoke nut, back seat, packing, and valve Actuator.

In that yoke is an important part of the globe valves. A Yoke connects the valve body or bonnet with the actuating mechanism.

The top of the Yoke holding a Yoke nut, stem nut, or Yoke bushing, and the valve stem passes through it. A Yoke usually has openings to allow access to the stuffing box, actuator links, etc. Structurally, a Yoke must be strong enough to withstand forces, moments, and torque developed by the actuator.

In the modern market scenario of manufacturing the utility boiler, customer has insisted to manufacturer to supply the material in stipulated time and also, they are very much concern about cost of the product. Also, they concern about good quality product.

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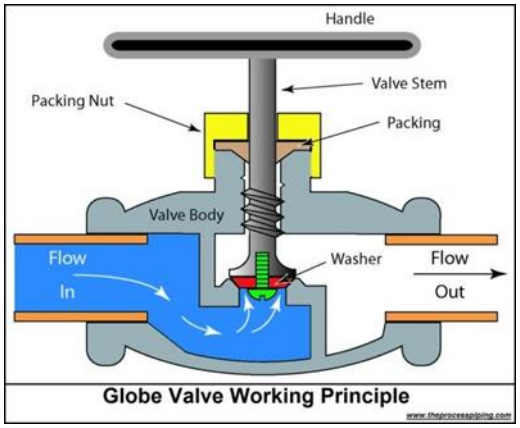

Figure 1 Globe Valve Working Principle

Sr No	Globe Valve
1	Body
2	Bonnet
3	Disc
4	Disc nut
5	Body seat ring
6	Stem
7	Back seat
8	Gland follower
9	Gland flange
10	Yoke nut
11	Handwheel
12	Handwheel nut
13	Stud bolts
14	nuts
15	Stud bolts
16	nuts
17	Bonnet gasket
18	Packing

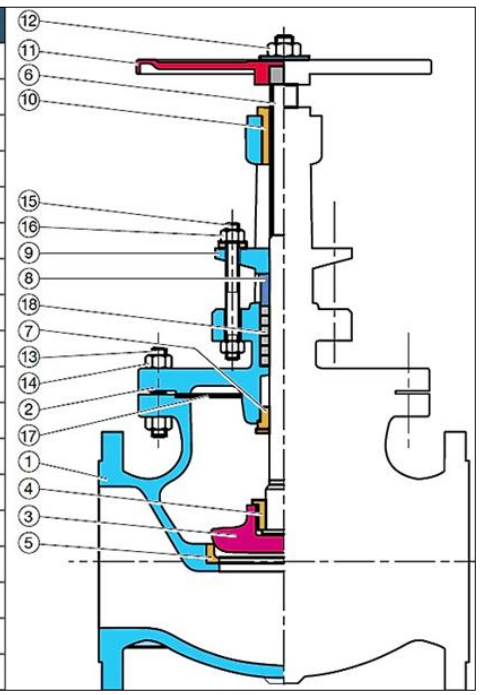

Figure 2 Parts of Globe Valve Existing type (Welding Yoke)

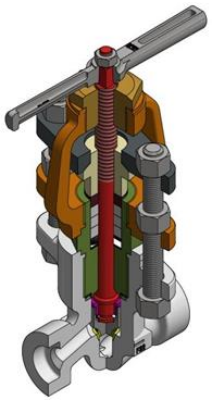

Figure 3 Cross sectional view Globe Valve

Figure 4 Globe Valve Existing type (Welding Yoke)

2. Materials and methods

2.1. Problem

- In the modern market scenario of manufacturing the utility boiler, customer has insisted to manufacturer to supply the material in stipulated time and also, they are very much concern about cost of the product. Also, they concern about good quality product.
- Manufacturing company like Bharat Heavy Electricals Limited is very renowned and they try to maintained it at any extend. BHEL is comprising its many areas to satisfy its quality. When manufacturing a globe valve with welding design model (yoke welded with body bonnet), facing several difficulties is a major issue. Several valves are rejected in manufacturing time itself. To reduce such type of problem we are going to introduce screwed yoke design instead of welded yoke.
- It a power plant there are about 2000 thousand small type of Globe valves is required. Repairing the non-functioning of welding yoke type of Globe valves is facing difficulties as well as time consuming.
- If the seat develops crack after Heat Treatment of Body, Body-Yoke Welding is Rejected
- Backseat Leakage
- Much noisy environment at Assembly section due to use of pneumatic tools
- Safety related issue has come due to welding operation.
- More cycle time in conventional method.
- Cost to organization is more due to using welding electrodes consumed.
- Quality issue has come due welding operation
- After quality inspection, if reworks occur, then for doing rework extra manpower and materials are required.

Figure 5 Screwed Yoke Type Globe Valve

2.2. Methodology flow chart

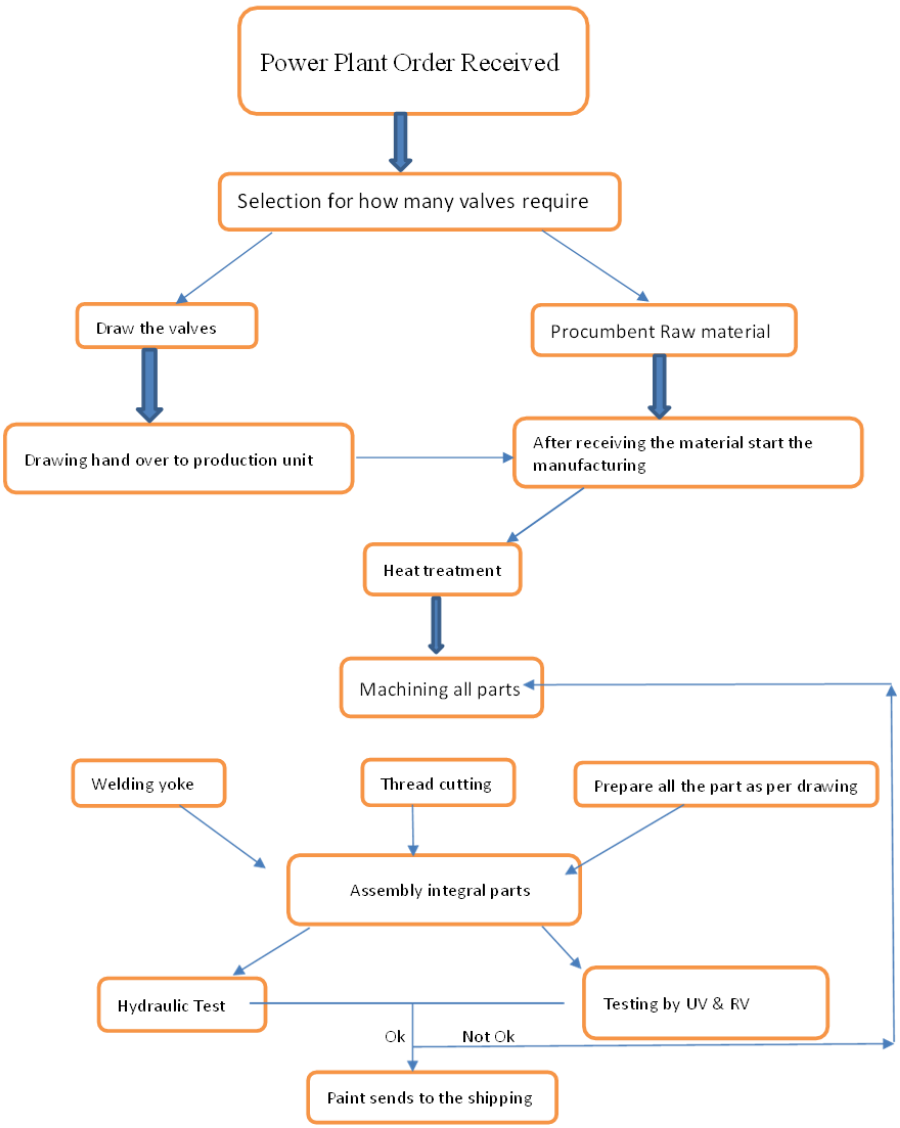

Figure 6 Flow chart of the production of valve

2.3. Design criteria/material details

Existing procedures of manufacturing Globe valve:

2.3.1. Cast Method

The cast method can be summed up by looking at the illustration below. Note that this is not the complete process.

- Body

An initial pre-shaped material cleaned. A turning process is done after cleaning. Turning is the method of removing excess material by cutting using a

lathe or a turning machine. It involves attaching the pre-shaped body to a mount and to the turning machine. This machine rotates at a high speed. While it rotates, a single-point cutter cuts the body into the desired and specific shaped. Other than that, turning can also create grooves, holes, among others.

The next step is to add a plating metal, usually, copper to different sections of the body. Copper plating ensures complete and proper sealing of the body.

The next step is the polishing of the body. Then, technicians create the threads that allow attachment of certain valve parts to other components or the pipes. Valves need holes so holing also happens after this. Take note that each valve has different hole sizes, depending on the requirement. This is where regulations and standards come into play.

Technicians then paint the valves with Teflon or other types of elastomers. After painting, baking ensues. Teflon bonds with the body through baking.

- Seat

The seat undergoes the same process as the body. Since the seat is inside the body and as part of its valve function- for better sealing- it needs perfect fit to its attachment. Whereas the body only has Teflon, the seat as an additional rubber wrapping to ensure tight fitness.

- Stem

As in the case of the stem, it does not need to have much manufacturing. Rather, cutting these in the right dimensions is important.

2.3.2. Forged Method

The forged method can be summarized in this process below. Similarly, the process below only highlights what the forged method is.

Cutting and Forging

After the selection of the material, the next process is to cut them into the required lengths and widths. The next step is to forge each part by partially heating them to a certain degree.

- Trimming

The next step is trimming. This is where excess material or the burr is removed. Next, the body is flashed to mold it in the right valve shape.

- Sandblasting

Sandblasting is the next step. This makes the valve smooth and clean. The size of the sand used depends on customer requirement or standards. The valves are initially sorted out to remove the defective ones.

- Machining

Machining further enhances the sizes and shapes of threads, holes and the likes, again, depending on the design and requirements of the customer.

- Surface Treatment

The valve undergoes some treatment of the surface using certain acids and the likes.

Figure 3 shows the conventional method of Globe valve process in which one employee are doing machining operation for the making the Globe valves. is doing turning operation. After complete the machining work at the time of assembly the yoke is made by welded design type. Which is very time taken precious job. Skilled labours are required.

Also, many risks are associated with this activity. It requires more power supply will be required. The operator fatigue is more due to more rejection is occur in the existing working method.

Figure 7 Conventional Globe valves manufacturing method

Table 1 Material used in existing Globe valves

Parts No.		**Material used in existing Globe valves**				
	Parts Name	**WCB / Trim 1**	**WCB / Trim 8**	**WCB /Trim 5**	**CF8 / Trim 2**	**CF8M / Trim 10**
1	Body		A216 WCB		A351 CF8	A351 CF8M
2	Seat Ring	A105+13Cr	A105+STL	A105+STL	A351 CF8	A351 CF8M
3	Disc	A216 WCB+13Cr	A216 WCB+13Cr	A216+STL	A351 CF8	A351 CF8M
4	Stem		A182 F6a		A182 F304	A182 F316
5	Disc Nut		A216 WCB		SS304+Graphite	SS316+Graphite
6	Bonnet Nut		A194 2H		A351 CF8	A351 CF8M
7	Bonnet Bolt		A193 B7		A351 CF8	A351 CF8M
8	Gasket	SS304 Sheet +Graphite				
9	Back Seat		A182 F6a		A182 F304	A182 F316
10	Bonnet		A216 WCB		A351 CF8	A351 CF8
11	Packing	Graphite / PTFE				
12	Eyebolt Pin		A36		SS304	SS316
13	Gland Eyebolt		A193 B7		A193 B8	A193 B8M
14	Gland		A182 F6a		A182 F304	A182 F316
15	Nipple		A216 WCB		A351 CF8	A351 CF8M
16	Gland Flange		A194 2H		A193 8	A193 8M
17	Stem Nut	A439 D2				
18	Handwheel	Ductile Iron				
19	Hand wheel Nut	Carbon Steel				

3. Result

3.1. Experimental Details

In the above existing procedures to make the Globe valve the cycle time is 3 months as mention above. It is required to reduce the cycle time as well as customer satisfaction on account of supply, service after sell. The entire product cycle was critically analyzed and in given in the bar chart. As seen in the bar chart, procurement takes highest lead time. For production point of view due to rework, rejection more time is consumed. If this time is reduced or advanced considerable reduction in product cycle time is possible.

Table 2 List of existing activities to be carried out to complete the product

SL NO.	ACTIVITY	Cumulative days from start Target									Target Days
		10	20	30	40	50	60	70	80	90	
1	Marketing Dept.										10
2	Engineering Dept.& Q/c Dept.										25
3	Purchase Dept.										15
4	OP& C Dept.										10
5	Production Dept.& testing										15
6	Shipping Dept.										5
7	Commercial Dept.										10

Table 3 Rework data/annum

Sl.No	Problem	No of Valves
1	Backseat Leak	2129
2	Seat Leak	350
3	Centre Out Problem	253
4	Improper Machining	127
5	Yoke Thread Problem	59
	Total	2918

Percentage of rework = 11%

Figure 1 Data analysis of valves rework

Table 4 Rejection data/annum

RT & UT FAILURE DATA – 2022-23					
MONTH	**Size-1/2"**	**Size-1"**	**Size-1-1/2"**	**Size-2"**	**TOTAL(No)**
JUNE	5	10	0	1	16
JULY	1	0	1	3	5
AUGUST	5	6	3	10	24
SEPTEMBER	3	0	15	16	34
OCTOBER	9	19	1	0	29
NOVEMBER	2	1	0	0	3
DECEMBER	7	38	2	0	47
JANUARY	8	18	0	2	28
FEBRUARY	0	59	2	24	85
9 MONTHS					271
9 MONTHS					30
PER ANNUM					360

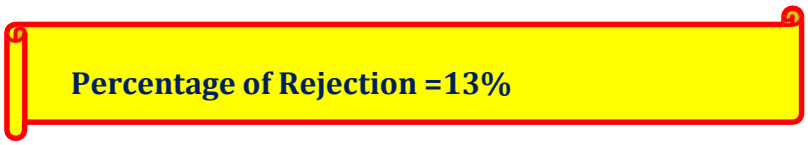

Figure 2 Data analysis of valve rejection

Table 5 Electrode utilization in existing welded design

PRODUCTION DATA-GLOBE VALVE-660MW Power Plant								
OPERATION	**SIZE**	**CATEGORY-MATERIAL**				**TOTAL**	**No of Electrode consumption/valve**	**Total electrode consumption**
		A105	F22	F91	SS			
HO	1/2"	200	168	31	59	458	4	1,832
	1"	100	487	197	41	825	5	4,125
	1-1/2"	120	29	2	0	151	6	906
	2"	80	97	20	0	197	6	1,182
TOTAL		500	781	250	100	1631	21	8045
MO	1"	15	10	27	0	52	5	260
	1-1/2"	8	12	6	0	26	6	156
	2"	18	20	26	0	64	6	384
TOTAL		41	42	59	0	142	17	800
GRAND TOTAL		541	823	309	100	1773	Total Electrode Required	8845

3.2. Procedure

In the above existing procedures to make the Globe Valves the cycle time is 3 months as mention above.in this project we show how to reduce the cycle time to make the same.

Optimizing Marketing Point of view: -From getting an enquiry to receiving PO from customer takes minimum 10 days. We can optimize here through management skill to convinced the customer to fulfill their requirement.

By Enhancing interaction with customer through;

- Video conference
- Telephonic talk

We can reduce this procedure to 5 days

3.2.1. by using Optimizing Engineering Point of view:

In that area main time-consuming part is technical clearance taken from customer. Existing process is taken 25 days to get the technical clearance like, Design, Data sheet approval, Drawing etc.

- Here we change the existing design to new developed design that is screwed yoke instead of welded yoke
- We can optimize that process using Change the existing design. Developed the new design which is more user friendly
- Other optimizing area under engineering head is:
- Experience personnel
- Video conference
- Telephonic talk
- Close interact with customer
- Automation of drawing
- Automation of data sheet

By using above process cycle time can reduce by 10 days.

3.2.2. Optimizing Purchase & Planning point of view:

This is the important point to optimizing the whole process. once enquiry in negotiation stage simultaneously inform to purchase department to floating an enquiry to vender (approve vendor of customer) for standard item.

In that existing process after receiving the order enquiry is float. After technical clearance, quality clearance etc. the order placed to the vender .it will take 25 days from enquiry float to order placed.

We can reduce the time if, once we are assured of securing the order, we will start talking action on standard sub-delivery items e.g., Limit Switches, packing gasket try to reach up to ordering point. Once we receive the advance immediately order can be placed.

This will reduce cycle time up to 15 months

3.2.3. Optimizing Production Point of view:

Existing procedure the total time taken to in assembly and testing is 15 days.

As we have planned change to existing welded design to screwed yoke design, it helps to optimizing the cycle time of production point of view. Also minimize the reduction and rework activity help to reduce the cycle time.

It can reduce cycle time by 10 days.

3.2.4. Optimizing Commercial & Shipping Point of view:

Existing procedure take 15 days to shipping the product to customer. In that procedure main drawback for delay are customer inspection, testing of product, rejection by customer

When the material is ready commercial personnel should inform to customer for inspection as soon as possible to avoid delay of supply using proper communication skill and proper follow-up of each concern department activities.

Once material is inspected by customer immediately inform to Shipping department to arrange the transporter to supply the material. simultaneously commercial personnel arrange the particular state 'Road Permit Form'.

Arranging transporter is a critical task for Shipping. Because sometime transporter wants for full load. Part load they are not accepted. We can reduce the whole procedure by following method. Once material is inspected shipping department Personnel arrange immediate the transporter. Commercial personnel arrange road permit form prior to 15 days.

Good relation with transporter it can reduce cycle time by 10 days

3.2.5. Final Result

List of activities to be carried out to complete the product after optimizing the whole process and changing the existing welded yoke design to screwed yoke design.

Table 6 List of revised activities to be carried out for reducing the product cycle

SL NO.	ACTIVITY	Cumulative days from start Target										Target Days
		5	10	15	20	25	30	35	40	45	50	
1	Marketing Dept.	→										5
2	Engineering Dept.& Q/c Dept.		→	→								10
3	Purchase Dept.				→	→						10
4	OP& C Dept.						→					5
5	Production Dept.& testing							→	→			10
6	Shipping Dept.									→		5
7	Commercial Dept.										→	5

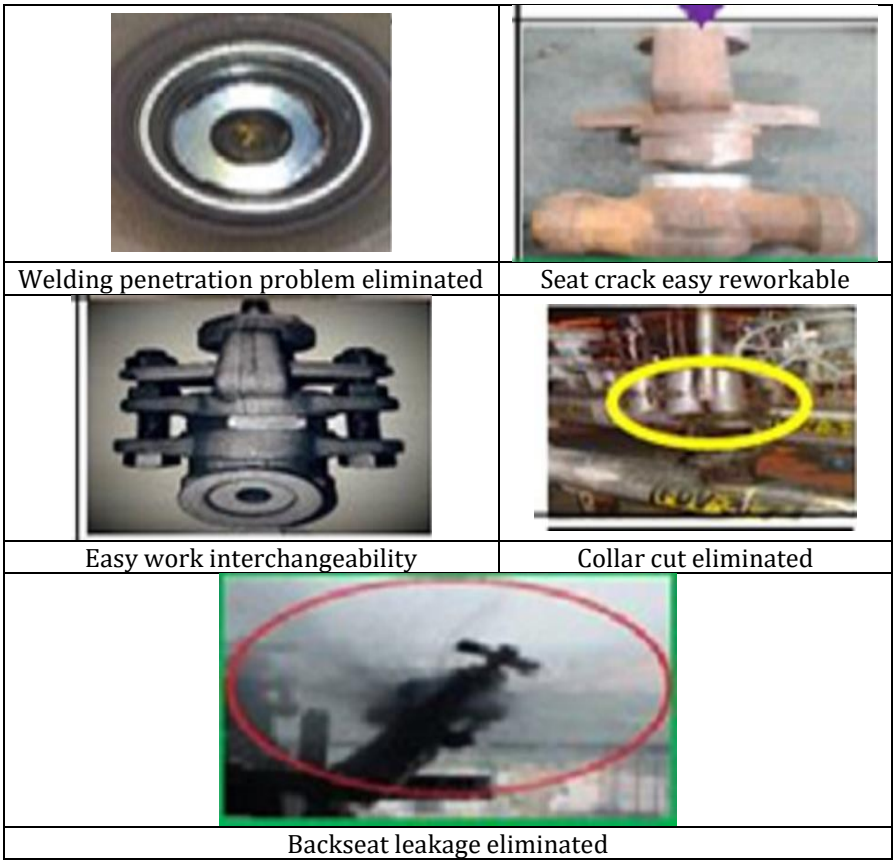

Figure 8 Some Pictorial view about this project we have done

4. Discussion

4.1. What we have done Through this project:

- Productivity is increased
- cost of valves reduces to 30%
- Seat crack Rework able easily.
- Customer complaint Backseat leakage is eliminated
- Cycle Time reduce to 50%
- Welding facility is not required
- Testing Facilities is not required
- Welding Penetration is eliminated
- Yoke Interchangeability is easily possible
- Manpower is reducing
- Customer complaint on Collar Nut is eliminated
- Easily serviceable at working area(site)
- Skilled Operator for assembly is not required
- High Skilled welder is not required
- Inspection for RT & UT is not required.

4.2. Ultimate aim of this project for customer satisfaction regarding optimizing the supply tome, costing of valves reduced and easy to service of valves at site is achieved.

Welding elimination leads to safe environment:

Following hazards contributed in the welding process are completely eliminated by the elimination of welding between the body and yoke in the new method of manufacturing.

- Burn injuries
- Electric shocks
- Heat effect
- Eye injuries: UV and IR rays is very harmful which damage the human eyes
- Fire and explosion hazards

Environmental aspect

Air pollution causes following hazards for human being:

- Chromium: Causes irritation deep ulceration of nose and skin
- Fluorides: Causes ulceration conjunctivitis, coughing and eosinophilia
- Molybdenum: Causes irritation to the mucous membrane
- Manganese: Causes adverse effects on the central nervous system
- Nitrogen dioxide: Breathing trouble, effect of Lungs

5. Conclusion

In this paper focus given on the optimization of cycle time of a product by the new method implementation in engineering point of view. Improvement in the productivity achieved and elimination of non-value-added activities has been done. The cost of operation is reduced considerably. Optimization of cycle time study is helpful for low-cost automation and bench marking activity at industry production improvement level.

Benefits

- Cost of process is reduced.
- Total cycle time reduction achieved 90 days per Globe Valves to 45-50 days per Globe valve.
- Increased customer satisfaction.

Scope for further studies

The simplified method can be implemented to all the essential items of a Thermal power station in future with minor modifications in existing product cycle times. Also, similar study might be exercised in reducing the cycle time to achieve the business excellence

Compliance with ethical standards

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