Design and Analysis Simplify to the ID FAN Blade Bearing Assembly

L. Vijayabaskar[1] D. Ranjithkumar[2] S. Mohanraj[3] S. Muthu[4] K. Kalaivanan[5]
[1]Assistant Professor [2,3,4,5]Student
[1,2,3,4,5]Department of Industrial Engineering
[1,2,3,4,5]C K College of Engineering & Technology, Cuddalore, Tamil Nadu, India

Abstract— Our project is to design a fixture for assembling all parts present in the induced draft fan impeller. We absorbed the present method of assembling the various parts in the ID FAN and found out the following problems in it. (1) Delay in fitting the blade bearing shaft. (2) Heavy to lift to blade shaft because it weight about 50kg. (3) The height of the fan is too high to load various parts. To overcome this problems, we going to design a special fixture to assemble the parts. This make easier to load various components.it reduced the delay time and increases the productivity.

Keywords: Bearing, Impeller, fixture, roller.

I. Introduction

BHEL is India's manufacture of FANS, an important auxiliary, for power and Industrial application for efficient combustion and improved, drought, BHEL offers a wide range of FANS-of axial impulse, axial reaction and radial types.

The equipment supplied conforms to the latest design and technological practices - derived from the technical collaboration with M\s. KUHNLE, KOPP & KAUSCH of Frankethal \ Pfalz, Germany BHEL can also supply heavy – duty FANS for refineries, petrochemicals, steel, cement, fertilizer, palletizing and sinter plants and for ventilation applications.

FANS may be defined as rotating machines with bladed impeller, which maintains a continuous flow of air or gas. In fans, blowers, compressors, pumps, etc., the energy transfer occurs from the machine to the fluid. The may be classified as Axial flow fans and radial flow fans.

A. *AXIAL FANS*

In Axial flow fans, the main flow is parallel to the axis of rotation of the fan both at entry and exit. Axial fans may be clarified further into impulse type and reaction type fans.

In the impulse type fans, most of the energy coming out of the impeller is kinetic energy. It is converted into pressure energy at the outlet. Hence these fans are called impulse fans.

B. *RADIAL FANS*

Based on the configuration of the bladed with respect to the direction of rotation of the impeller, radial fans are classified into three categories namely, backward curved, forward curved and radial bladed impeller.

C. *NDFV FANS*

The major sub-assemblies are spiral-casting, impeller, and inlet guides are control assembly, shaft with bearing assembly and seal assembly.

D. *NDV & NDZV FANS*

The fans as a whole can be divided into some major sub-assemblies: spiral casing, Impeller, shaft, bearing, Damper.

E. *Control*

Different types of controls employed for fans can be listed as.

1) Damper control:

This is the least efficient of all the controls. A power cylinder or electrical servomotor actuates it.

2) Inlet guide vane control:

It is used invariably in Axial impulse type fans and radial fans. This is more efficient than damper control.

3) Speed control:

This is achieved either by a variable motor or hydraulic coupling. The hydraulic helps in achieving the control with the help of an external oil system.

F. *Induced Draft FAN*

In induced draft applications, the fan extracts combustion products from a boiler. Current legislation requires boilers to be fitted with emission control systems. These systems reduce the sulphur-dioxide, nitrox-oxide and, in some cases, mercury emissions from the power plant. They also have an associated pressure loss, which the induced draft fan must overcome.

Increasingly stringent legislation has resulted in emission control systems becoming progressively more complex over the last decade. This results in a market requirement to upgrade in-service fans to cope with the associated increased system resistance. Although not reported in the open literature, the author was aware that the blade bearings situated under each blade of the variable pitch in motion induced draft fans were wearing more rapidly with each increase in fan pressure developing capability. Following the most recent upgrade, it had been necessary to replace worn out blade bearings before the scheduled five year major overhaul. The author speculated that a further increase in fan pressure developing capability was likely to exacerbate an already unacceptable situation.

The cost to upgrade an existing power plants emission control system to meet current and foreseen future regulatory requirements can be as high as $500 million. Existing coal fired power plants have a finite life, and in order for the upgrade to make commercial sense, the value of generated electricity must be greater than the cost of upgrading and operating the power plant. The largest single cost when operating a coal fired power plant is the cost of coal. Perhaps counter intuitively, upgrading a power plants emission control system facilitates a move to lower quality coal. Without an emission control system or with a low specification emission control system, a power plant must burn higher quality low-sulphur coal to remain within existing emission limits. Once a power plant fits or upgrades an emission control system, it can burn lower quality, high sulphur coal as the emission control system will clean the exhaust gas.

The business case for fitting or upgrading an emission control systems is linked to a move from higher cost high quality coal to lower cost low quality coal. Low quality coal includes not only more sulphur, but also more silica. Silica is hard, resulting in increased wear in the ball-mills that grind the coal before it enters the boiler. Wear in the boiler ball-mills results in larger carbon particles that are more likely to pass through the boiler and into the induced draft fan. Consequently, the shift to low quality coal results in a shift towards an increase in the silica and unburnt carbon passing though induced draft fans. As such, an unwanted consequence of switching from high to low quality coal is to increase the rate at which fan blades erode, decreasing the fan's pressure developing capability.

The addition or upgrading of emission control equipment increases the system resistance against which an induced draft fan must operate. An increase in the fan blades' erosion rate results in the need for a further increase in fan pressure developing capability to ensure that as blades erode over the fans service life stall margin does not reduce to a point at which the fan stalls in-service. A way to increase an axial flow fan's pressure developing capability is to increase fan loading by fitting inlet guide vanes. Increased fan loading is, in practice, at the expense of fan stall margin and is therefore an inherently risky approach to increasing fan pressure developing capability in an erosive application.

Concern for maintaining a safe operating stall margin is more pressing when one places the fan downstream of an intricate duct system, as is typically the case with induced draft fans. The inlet flow distortion associated with an intricate duct system results in an "installation effect" that reduces fan stall margin. When examining the consequence of installation effect, the bulk of published works has focused on noise generation. Installation effects invariably degrade cooling fans' acoustic performance; however, acoustic considerations are not of primary concern for fans in induced draft application. We can lag induced draft fans to reduce acoustic emissions. The primary consideration for an induced draft fan is the aerodynamic impact of a non-asymmetric inflow, with a particular concern for reduced fan efficiency and stall margin.

We can configure induced draft fans with a rectangular inlet box that accepts flow coming vertically down. The box turns the flow ninety degrees and into a round and horizontal fan inlet. The study used computational analysis as a "numerical laboratory". This provided insight into the fan's actual inlet flow field. The objective was to facilitate inlet guide vane design improvement. The desired outcomes were first, an increase in fan pressure development capability and, second, an understanding of the aerodynamic mechanism that was driving the fan blade bearings' premature failure.

II. Objectives & Methodology

After detailed analysis we found that the impeller assembly and fit up activity by the earlier method was time consuming & unsafe. The cycle time required was more as per the earlier method of impeller assembly fit up in frame blade. By the alternative method, a fixture was developed which is of lighter I weight, so task performance can handle the tool easily & adjust the fixture, hence safety to the workmen is ensured. The cycle time for impeller assembly fan was been reduced drastically and the number of mans required also reduced.

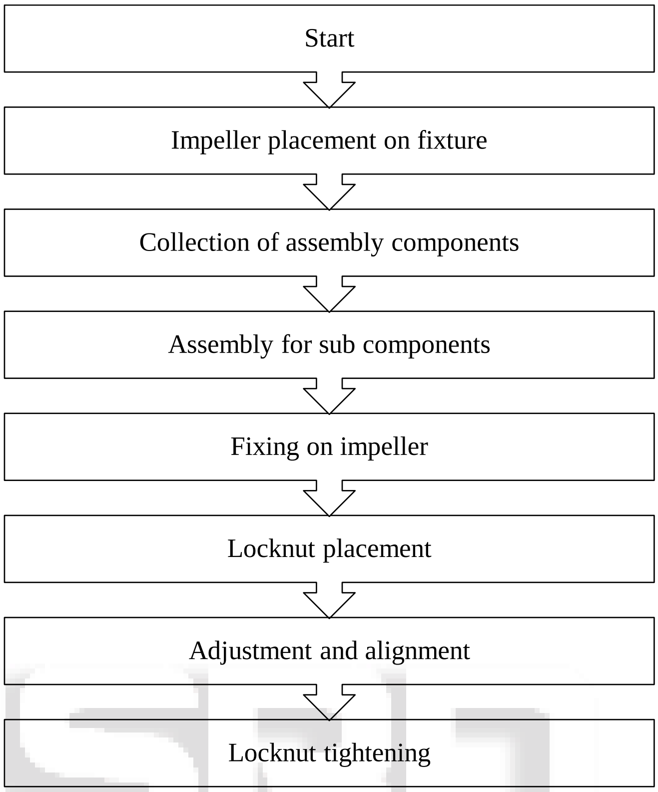

Fig. 1: Process flow of proposed method

III. Design Calculations

A. Formula

$$Stress = \frac{load}{area} \quad (1)$$

$$Factor\ of\ safety = 4 * stress \quad (2)$$

$$Bending\ moment = weight * distance \quad (3)$$

B. Calculation

$Load = 4000\ kg$

$Outer\ diameter(D) = 2m$

$Inner\ diameter(d) = 0.2m$

$Load = 4000 * 9.81 = 39240\ N$

$$Area = \left(\frac{\pi}{4}\cdot D^2\right) - \left(\frac{\pi}{4}\cdot d^2\right) = \left(\frac{\pi}{4}\cdot (2)^2\right) - \left(\frac{\pi}{4}\cdot (0.2)^2\right)$$

$$= 3.141 - 0.032 = 3.11\text{m}^2$$

$$Stress = \frac{load}{area} = \frac{39240}{3.11} = 12617.3\frac{\text{N}}{\text{m}^2}$$

$Factor\ of\ safety = 4 * 12617.4 = 50469.2\ \text{N/m}^2$

$Permissible\ limit\ of\ cast\ iron = 60000\ poi$

$Fixture\ acting\ on\ force = 50 * 9.81 = 490.5\ N$

$$Area = \left(\frac{\pi}{4} \cdot D^2\right) = \left(\frac{\pi}{4} \cdot (0.5)^2\right) = 0.19634\ \mathrm{m}^2$$

$$Fixture\ Stress = \frac{490}{0.19634} = 2498.7\frac{\mathrm{N}}{\mathrm{m}^2}$$

$$Reaction\ force\ = \ load = 50kN$$

$$Bending\ moment = load * distance = 50 * 0.5$$

$$= 25\ kN.m$$

C. Cost Estimation Details

Trying the impeller with crane = 20
Lifting the impeller = 10
Placing the impeller = 10
Blade shaft = 18

D. Seven Activities Existing System

(1) Blade shaft placement
(2) Counter weight placement
(3) Locknut placement
(4) Blade shaft entry
(5) Counterweight locking
(6) Locknut && seal assemblies
(7) Rotate the impeller for the next bore

E. Activities Proposed System

(1) Blade shaft placement
(2) Counter weight placement
(3) Locknut placement
(4) Blade shaft entry
(5) Counterweight locking
(6) Locknut && seal assemblies

The one process eliminated since rotating impeller horizontal is easy. Vertically it's difficult due to the unbalance.

F. Cycle Time

Process cycle time for existing method "*X*" is calculated by

$$X = (20 + 10 + 10) + 18 * (15 + 10 + 6 + 10 + 8 + 4 + 10)$$
$$= 1174\ min/60 = 19.57\ hrs$$

Process cycle time for proposed method "*Y*" is calculated by

$$Y = (20 + 10 + 10) + 18 * (10 + 8 + 6 + 7 + 4 + 8)$$
$$= 814\ min/60 = 13.57\ hrs$$

G. Process Cycle Cost

Process cycle time for existing method is calculated by

$= 19.57\ hrs\ *\ manpower\ cost\ *\ 4$

$= 19.57\ *\ 200\ *\ 4$

$= Rs. 15{,}656$

Where, manpower cost (M) =Rs 200/hrs

Crane time calculated by existing system

$= 20 + 18\ *\ (15 + 8 + 4)$

$= 20 + (18 * 27)$

$= 8.433\ hrs$

Crane cost is calculated by

$= 8.433 * 2 * crane\ operating\ wages\ (M)$

$= 8.433 * 2 * 251$

$= Rs\ 4233.53$

Where, crane operators wages (M) = Rs 251/hrs

Total cost for existing method is calculated by

$= 15{,}656 + 4233.53$

$= Rs\ 19{,}889.53$

Process cycle cost for proposed method is calculated by

$= 13.57 * M * 4$

$= 13.57 * 200 * 4$

$= Rs\ 10{,}886$

Crane cost calculated by crane not used so neglected crane operating cost

Cycle cost reduction for 1 impeller is calculated by

$= 19{,}889.53\ -\ 10{,}886$

$= Rs\ 9003.5$

Cycle cost reduction for 50 impeller (per annum) is calculated by

$= 9003.5 * 50$

$= Rs\ 450{,}176.5$

Percentage of reduction is calculated by

$= (10{,}886/19{,}889.53)\ * 100$

$= 69.46\ \%$

IV. Bill of Materials

Following is the bill of material used in the project.

S. No.	Description	Qty
1	Fixture	1
2	Impeller	12
3	Roller	8
4	Bearing	5

Table. 1: Bill of Materials

V. 2D Modelling and Drafting

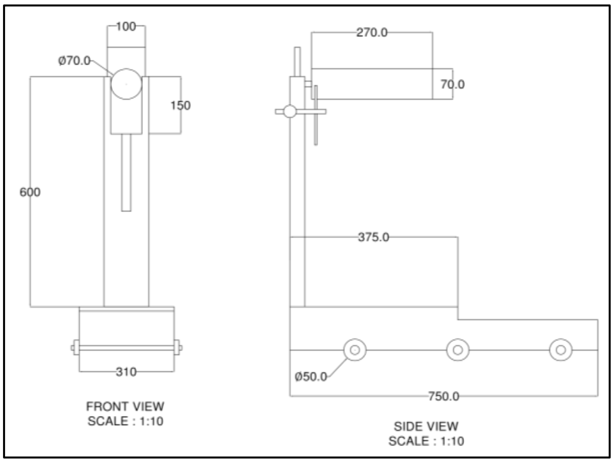

Fig. 2: 2D Modelling of Trolley Assembly

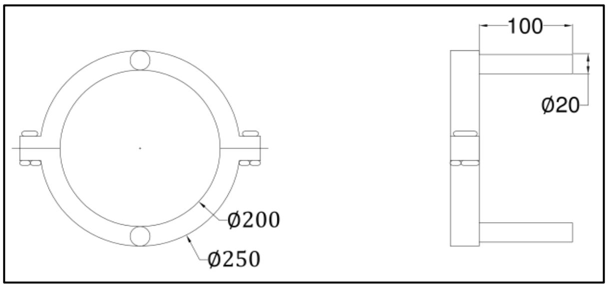

Fig. 3: 2D Modelling of lock nut tightening tool

VI. RESULT AND CONCLUSION

Our project is very simple and easy to work it when the compared to the previous method. Our project reduces the time taken to setting of jobs.

Labor work is reduced and therefore the number of the workers involved in the assembling time is reduced. This method is also found to be effective and accurate than previous method. Using these mountings we can surely avoid the disasters and fatigue of worker. Thus our project is successfully done.

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