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# Enhancing Reliability of an Industrial Blower Through Bearing Design Modification: An Industrial Case Study

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**Abstract: Industrial blowers operating under continuous service are susceptible to premature bearing failures, leading to increased maintenance costs, and reduced blower reliability. This paper presents an industrial case study on enhancing blower reliability through a bearing design modification implemented to address recurring bearing failures. Detailed vibration analysis, bearing condition assessment, and operating parameter evaluation identified the limitations of the original bearing arrangement. A redesigned bearing configuration with improved load distribution, lubrication effectiveness, and axial support was developed and implemented. Performance evaluation before and after the modification demonstrated a significant reduction in vibration levels, operating temperature, and bearing wear, resulting in extended bearing service life and improved blower availability. The study highlights the importance of integrating vibration-based condition monitoring with engineering design improvements to eliminate recurring failures. The proposed methodology provides a practical and cost-effective approach for improving the reliability and operational performance of industrial rotating machinery.**

***Keywords:*** *Blower, Mean Time Between Failures , Reliability, Inedicuate , Bearing Load Carrying Capacity, Root Casuse Analysis, Component; Formatting; Style; Styling; Insert.*

***Abbreviations:*** *MTBF: Mean Time between Failures, RCF: Rashtriya Chemicals and Fertilizers ltd ,BFW: Boiler Feed Water,TIR: Total Indicator Reading ,H: Horizontal ,V: Vertical ,A: Axial, Rms : Root Mean Square , NDE: non drive end, DE: drive End.*

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## I. INTRODUCTION

In fertilizer plants, industrial blowers play a vital role in steam generation by supplying air for degasification section of water treatment. Among the various components of a blower, rolling element bearings are particularly susceptible to failure due to excessive radial and axial loads due to inadequate bearing selection, improper configuration, along with other reasons. Bearing failures account for a significant proportion of rotating machinery downtime and frequently lead to increase in maintenance cost [1–3].

However, while vibration monitoring effectively identifies the symptoms of deterioration, recurring failures often indicate underlying design deficiencies that cannot be resolved through maintenance practices alone. In such situations, engineering modifications involving bearing arrangement, bearing type selection become necessary to eliminate the root cause of failure and achieve long-term reliability improvements [6].

Bearing design plays a crucial role in determining the dynamic behavior and service life of industrial blowers. Improper bearing configuration along insufficient static and dynamic load carrying capacity may result in excessive internal stresses, inadequate load sharing, and elevated vibration levels, ultimately reducing bearing life. Several researchers have demonstrated the importance of combining vibration diagnostics with engineering design improvements for rotating machinery. Randall [4] emphasized that vibration analysis should be integrated with mechanical design evaluation to accurately identify root causes of repeated failures. Mobley [5] also highlighted that predictive maintenance becomes significantly more effective when condition monitoring results are complemented by corrective engineering modifications rather than repetitive component replacement.

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This paper presents an industrial case study describing the enhancement of blower reliability through bearing design modification implemented after repeated bearing failures in a continuously operating process plant. Detailed vibration measurements, and failure investigations were conducted to identify the limitations of the original bearing arrangement. Based on the findings, the bearing type changed to improve load carrying capacity and bearing configuration was re-designed as per selection of bearing. The effectiveness of the modification was validated through comparative vibration measurements, operating temperature trends, and long-term operational performance. The results demonstrate that appropriate bearing design modifications can significantly improve machinery reliability, reduce maintenance requirements, and equipment availability, providing a practical methodology applicable to similar industrial rotating equipment.

## II. CASE STUDY

Two blowers are installed in the water treatment section of the new steam generation plant at RCF Trombay Unit. Both blowers are driven by electric motors through belt drives. Under normal operating conditions, one blower remains in service while the other is kept on standby. Photograph 1 shows the machinery arrangement of the deaerator blower.

Photograph1 Degasser Blower Arrangement

## III. PROBLEM

In the new steam generation plant, a deaerator (degasser) blower is used to supply air to the water treatment section. This blower had been experiencing abnormal noise and high vibration for a prolonged period. The specifications of the blower are given below.

## IV. DEGASSER BLOWER SPECIFICATIONS

The degasser blower is a cantilever-type, belt-driven blower operating at 1635 rpm. It is equipped with a 2309 EK bearing mounted on an H2309 adapter sleeve, supported in an SN 609 Plummer block. The blower shaft diameter is 40 mm**.** Photograph 1 shows the machinery arrangement of the degasser blower.

## V. IMPORTANCE OF THE PROBLEM

The degasser blower is a critical piece of equipment in the water treatment section of the new steam generation plant, where it supplies air for the water treatment process. The blower had been experiencing persistent abnormal noise and high vibration, resulting in frequent bearing failures, reduced bearing life, and poor overall reliability. An analysis of the plant maintenance history revealed that the average Mean Time between Failures (MTBF) for blower bearing replacement was only 12 months, as shown in Table 1.

Table 1 Degasser Blower Bearing Replacement History

| Sr. | Job Description | Period |
|---|---|---|
| 1 | Both bearing replaced with new | May 2009 |
| 2 | New bearing installed | July 2010 |
| 3 | Bearing modified to spherical roller bearing | May 2011 |

An MTBF of only 12 months was significantly lower than the expected bearing service life. Consequently, the blower required frequent maintenance, leading to increased maintenance costs, higher bearing consumption, and reduced equipment reliability. Under normal operating conditions, the expected bearing life should be approximately 40,000–50,000 operating hours. Furthermore, the abnormal bearing noise generated by the blower contributed to increased environmental noise levels within the plant. Because of the long-standing abnormal noise and high vibration problem, the plant management assigned the Condition Monitoring Cell to carry out a detailed root cause analysis. The objective was to identify the underlying cause of the persistent vibration and abnormal noise and implement a permanent corrective solution to improve the reliability and service life of the blower.

## VI. ROOT CAUSE ANALYSIS OF PROBLEM

Based on the analysis of the blower's high vibration and abnormal noise, four major factors that could contribute to the problem were identified:

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- Self-aligning ball bearing housing fit problems.
- Shaft-related abnormalities.
- Impeller-related abnormalities.
- Inadequate load-carrying capacity of the existing self-aligning ball bearings.
- The various possible causes associated with these factors are presented in the Cause-and-Effect Analysis Diagram as shown in fig

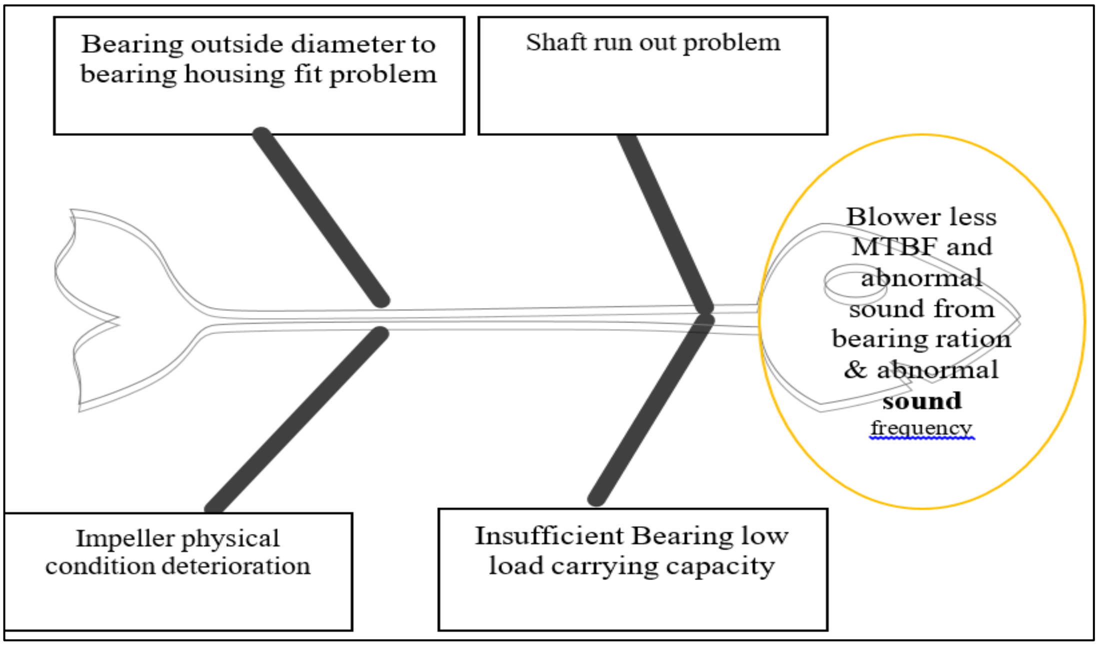

Fig 1 Cause Effect Analysis Diagram

The possibility of each contributing factor was systematically investigated. Based on the observations and inspection results, the possible causes were eliminated one by one until the root cause of the problem was identified.

The shaft runout was measured and found to be within acceptable limits. Therefore, shaft-related abnormalities were ruled out as the cause of the high blower vibration.

The fit between the non drive end and drive end bearing outside diameter with the respective Plummer block-housing bore was also inspected and found to be satisfactory as per skf bearing catalogue. Hence, the possibility of improper bearing housing fit causing the excessive vibration was eliminated.

The blower impeller was thoroughly inspected for its physical condition. As a preventive measure, efforts were made to minimize any residual unbalance through in-situ dynamic balancing. However, the abnormal noise and vibration persisted even after balancing. The impeller was also carefully inspected for rubbing, cracks, looseness, and other abnormalities. No defects were observed during the inspection.

No defects were observed. Therefore, impeller-related abnormalities were also ruled out. physical damage, imbalance, rubbing, and other abnormalities. The blower impeller was thoroughly inspected for physical condition. damage, imbalance, rubbing, and other abnormalities.

After eliminating the above possibilities, a detailed study of the load-carrying capacity of the existing self-aligning ball bearings was carried out. Self-aligning ball bearings are intended primarily for moderate radial loads and light axial loads while accommodating shaft misalignment[8]. Owing to their point-contact geometry, their load-carrying capacity is considerably lower than that of other self-aligning roller bearings. According to bearing selection criteria, both dynamic and static load-carrying capacities are important parameters for reliable bearing operation. The installed 2309 EK self-aligning ball bearing was considered inadequate for the blower operating conditions because its static load capacity was relatively low compared with its dynamic load-carrying capacity, as shown in Table 2[8].

Table 2 Self-Aligning Ball Bearing Load Carrying Capacity

| **Bearing** | **2309 EK Self-aligning Ball Bearing** |
|---|---|
| Dynamic load carrying Capacity | 63.7 KN |
| Static Load Carrying capacity | 19.3 KN |

Based on this study, it was concluded that the persistent high vibration and abnormal noise were most likely caused by the limited load-carrying capacity of the existing self-aligning ball bearings.

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Fig 2 Existing Self-Aligning Ball Bearing

To improve the bearing service life and increase the load-carrying capacity without significantly modifying the existing blower assembly, various alternative bearing arrangements were evaluated. The objective was to replace the existing bearing with a more robust bearing while retaining the existing shaft, housing, and mounting arrangement as far as possible.

After evaluating various bearing options, the 22309 EK spherical roller bearing was selected. This bearing provides the same self-aligning capability as the existing bearing while offering substantially higher dynamic and static load-carrying capacities, with identical principal dimensions. Spherical roller bearings are preferred for heavy-duty applications[8], such as industrial blowers, where high bearing life and reliability are essential. Consequently, the new bearing could be installed without requiring any major modifications to the blower assembly. Photographs of the 2309 EK self-aligning ball bearing and the 22309 EK spherical roller bearing are shown in Photographs 2 and **3** respectively.

Fig 3 Spherical Roller Bearing

Table 3 Comparison of Bearing Dimensions and Load-Carrying Capacity

| **Bearing** | **2309 EK Self aligning Ball Bearing** | **22309 EK Spherical Roller Bearing double row** |
|---|---|---|
| Width | 36 mm | 36 mm |
| Outside Diameter | 100 mm | 100 mm |
| Dynamic load carrying Capacity | 63.7 KN | 183 KN |
| Static Load Carrying capacity | 19.3 KN | 183 KN |

As shown in Table 3[8], the 22309 EK spherical roller bearing has the same bore, outside diameter, and width as the existing 2309 EK self-aligning ball bearing, allowing it to be installed without altering the existing blower arrangement. The bearing can be mounted using the same H2309 adapter sleeve and SN 609 Plummer block, thereby eliminating the need for any major mechanical modifications.

Spherical roller bearings are designed to accommodate heavy radial loads and can withstand bidirectional axial and combined loads. Owing to their robust internal geometry, they provide significantly higher load-carrying capacity than self-aligning ball bearings. In contrast, self-aligning ball bearings are primarily designed to carry radial loads and light axial loads in both directions. However, they are not suitable for carrying pure axial loads. Furthermore, the 22309 EK spherical roller bearing provides nearly three times the dynamic load capacity and almost ten times the static load capacity of the existing 2309 EK self-aligning ball bearing, making it a suitable and reliable solution for improving blower performance, extending bearing service life, and enhancing overall equipment reliability.

## VII. JOB DONE

After applying the elimination method for root cause analysis, the underlying cause of the blower's high vibration and abnormal noise was identified. The investigation revealed that the problem was caused by the insufficient load-carrying capacity of the existing 2309 EK self-aligning ball bearings. Therefore, it was recommended to modify the bearing design by replacing the self-aligning ball bearings with 22309 EK spherical roller bearings, which possess the same self-aligning capability but offer significantly higher dynamic and static load-carrying capacities.

After implementing the bearing design modification, the blower vibration and abnormal noise were reduced to normal operating levels. The blower has been operating smoothly with normal noise level and stable vibration levels since the modification. The blower casing vibration measurements recorded before and after the bearing design modification are presented in Table 4.

## VIII. BENIFIET ACHIEVED AFTER BEARING DESIGN MODIFICATION

The blower bearing design modification reduced the blower casing vibration from a maximum of 20.7 mm/s rms to 0.7 mm/s rms, bringing the vibration level within the normal operating range and resulting in acceptable noise levels. The frequent abnormal noise originating from the blower bearings was eliminated, thereby significantly reducing environmental noise pollution within the plant.

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The bearing design modification substantially increased the service life of the blower bearings and reduced bearing consumption. Plant maintenance history indicated that the average Mean Time between Failures (MTBF) of the original bearing arrangement was only 12 months. After the

Table 4 Blower Casing Vibration Trend Data (mm/s RMS)

| **Dates** | 17/03/11 | 13/05/11 | 18/06/11 | 28/08/11 |
|---|---|---|---|---|
| **Measuring point** | H/V/A | H/V/A | H/V/A | H/V/A |
| **Blower DE** | 17.4/11.4/6.8 | 0.7/0.9/1.8 | 1.7/3.1/2.9 | 1.6/1.3/1.8 |
| **Blower NDE** | 7.5/5.5/3.8 | 0.8/0.8/1.8 | 1.4/1.2/2.3 | 1.1/1.2/3.0 |
| **Remarks** | Before bearing type changed | After bearing type changed | | |
| **Dates** | 17/09/12 | 16/10/12 | 27/12/12 | 16/10/12 |
| **Measuring point** | H/V/A | H/V/A | H/V/A | H/V/A |
| **Blower DE** | 1.3/1.1/1.7 | 1.4/1.6/1.9 | 1.5/1.5/2.6 | 1.4/1.6/1.9 |
| **Blower NDE** | 1.4/1.3/2.0 | 1.3/1.3/2.6 | 1.6/1.6/3.0 | 1.3/1.6/2.3 |
| **Dates** | 27/12/12 | 13/04/13 | 19/11/13 | |
| **Measuring point** | H/V/A | H/V/A | H/V/A | |
| **Blower DE** | 1.5/1.5/2.6 | 1.9/1.8/3.1 | 2.0/1.9/3.0 | |
| **Blower NDE** | 1.6/1.3/3.0 | 1.8/1.8/3.6 | 1.8/1.6/3.1 | |

Bearing modification was implemented in May 2011; no bearing failures have been reported to date. Furthermore, no increase in vibration or abnormal bearing noise has been observed during this period. As a result, the blower MTBF increased significantly, maintenance costs were reduced, and the overall reliability and availability of the blower improved considerably.

If the blower bearings had continued to require replacement under the previous operating conditions, the annual replacement cost would have been as follows:

- Cost of two 2309 EK self-aligning ball bearings: Rs. 3,480 (Rs.1,740 ×2)
- Bearing replacement maintenance cost: Rs. 15,000
- Total cost per bearing replacement: Rs. 18,480

Therefore, by eliminating the need for annual bearing replacement, the plant achieved a direct saving of approximately Rs. 18,480 per year (approximately Rs. 1,540 per month). Assuming a service life of five years for the spherical roller bearings, the total expected saving from avoided bearing replacement is approximately Rs. 92,400 (5 × Rs. 18,480), excluding the additional savings associated with reduced downtime and improved production reliability.

The bearing design modification was successfully implemented without altering the existing blower arrangement. The existing SN 609 Plummer block, H2309 adapter sleeve, shaft, and base frame were retained. Consequently, no additional expenditure was incurred for replacing these components, resulting in further cost savings.

➢ *Payback Period:*

Investment for blower bearing modification to spherical roller = Rs 8,024

Spherical roller bearing replacement cost: Rs 15000.00

- Total investment cost for bearing modification = Rs 23024.00 (8024 + 15000)
- Total Saving by avoiding blower bearing replacement job is Rs. 92,400
- Payback back period = Total investment for bearing modification/Total saving = 23024.00/ 92,400 = 0.29 years i.e. 2.9 month
- Thus Payback period worked out to be only 2.9 months.

## IX. CONCLUSION

This industrial case study demonstrates that a systematic bearing design modification can significantly enhance the reliability and operational performance of critical process blowers. The original bearing arrangement, incorporating self-aligning ball bearings, experienced repeated failures accompanied by elevated vibration levels and abnormal noise, resulting in frequent maintenance interventions and reduced equipment availability.

A detailed failure analysis identified the existing bearing configuration as the primary contributor to the recurring failures. Replacing the self-aligning ball bearing with a spherical roller bearing provided improved load-carrying capacity, better accommodation of shaft misalignment, and enhanced resistance to the combined radial and axial loading conditions encountered during blower operation. Following the modification, vibration amplitudes and abnormal acoustic emissions decreased to acceptable operating limits, confirming stable rotor-bearing system behavior.

The effectiveness of the design modification is validated by long-term field performance. Since the implementation of the modified bearing arrangement in May 2011, until November 2013 no bearing replacement has been required, demonstrating exceptional operational reliability over an extended service period. Consequently, the blower MTBF increased substantially, while maintenance frequency, unplanned shutdowns and maintenance costs were significantly reduced.

The findings demonstrate that bearing selection based on actual operating conditions, supported by systematic root-

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cause analysis and engineering design modification, can provide a permanent solution to chronic reliability problems in industrial rotating equipment. This case study presents a practical methodology that can be applied to similar centrifugal blowers and other critical rotating machinery operating under demanding process conditions, thereby improving plant reliability, availability and overall operational efficiency. The bearing design modification also reduced acoustic emissions to within acceptable limits in accordance with industrial standards.

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