

# Aerodynamic Effect on Axial Vibration of High-Speed Induction Motor

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**Abstract:** High speed Induction Motor with sleeve bearings are more prone to axial vibrations due to its weak magnetic centering forces. It results in axial movement, and rotor drifts “to and fro” from magnetic center positions. It also causes severe hunting. There are several reasons which are responsible for axial vibrations, among them actual cause is been identified, rectified and results obtained are satisfactory is presented in this research paper.

**Key Word:** Axial Vibration, Magnetic Centre, Sleeve Bearing, Hunting, High Speed Induction Motor

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Date of Submission: 15-02-2022

Date of Acceptance: 28-02-2022

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## I. Introduction

Mechanical vibrations are used to describe the movement produced in mechanical parts due to effect of external or internal forces on the parts. The amplitude of vibration is function of system parameters and severity of exciting forces. When machine is new vibration level is low since there is no looseness or wear, i.e., stiffness and damping factors are high [1].

## II. Initial Inspection

Motor was received at workshop in failed condition. On observing following points were remarked.

1. Non-Drive End (NDE) side bearing housing was in seized condition
2. Thermal bow was observed in rotor
3. Run out was observed at NDE side.

## III. Causes of Axial Vibration

High Speed Induction motor i.e., 2-pole machine is having weak magnetic forces. Axial centering forces depend on number of poles. With large number of poles magnetic forces become stronger, and axial centering forces also become stronger. The components that influence magnetic centering forces are: position of stator core end relative to the rotor ends, airgap between stator and rotor, level of the shaft, skew of rotor bars, vent ducts, line voltage, No- load current, end-ring extension of the rotor, beyond the rotor core [3]. It is important to locate axial location so that bearing is not subjected to excessive thrust. Most rolling elements experience less axial thrust as compared to the sleeve bearing. The strength of magnetic centering force is inversely proportional to the speed of motor. The magnetic rotating field rotating within stator turns the rotor, and magnetic force affects the axial position of the rotor relative to the stator core [4].

There are several causes for axial vibrations and some of them which cause more severity is discussed within this paper. If the shaft is not level properly, gravity acting on the rotor produces an axial force towards the low end [3].

Looking towards the images it can be analyzed that shaft has experienced severe thrust and which resulted into damage. The axial vibration caused shaft deteriorate and therefore it was recommended to replace shaft. But the problem still needs solution to decrease axial vibrations. So, several probabilities were addressed and from that relevant solution was achieved. When motor was received at workshop site it was observed that the direction of fan was found to be reversed than its original rotational direction.

This reverse position of fan creates unbalance aerodynamic force. Aerodynamic force is strong in two pole machines. When the aerodynamic forces resulting from opposing fans are not equal, the stronger fan pull the rotor off magnetic center. Even sometimes blocked openings can upset the balance of air flow. As the rotor is displaced in the axial direction, the force required to restore the magnetic center increases. The rate at which the required force increases, decreases with distance from magnetic center. Steep fan blade pitch increase air flow and axial aerodynamic force [5].

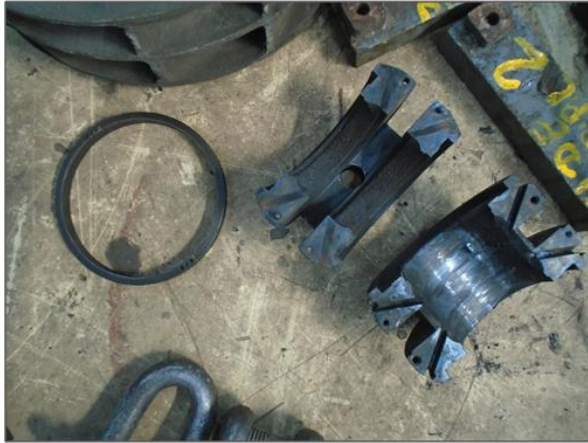


Fig. 1: Bearing Condition Before Repairs

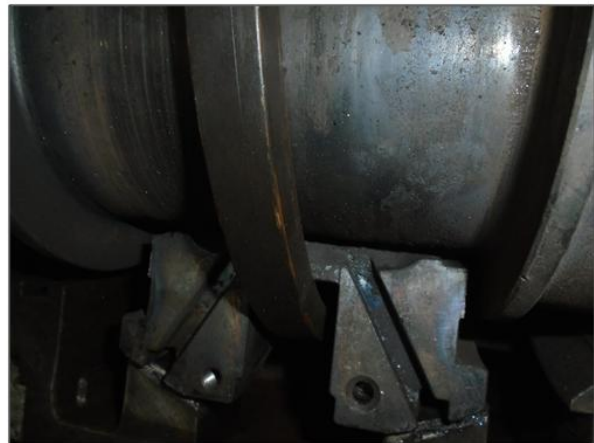


Fig.2 : Shaft Condition Before Repairs



Fig.3: Initial Fan Rotation Position

#### **IV. Design Modification**

While performing no load trial after repairs, axial vibration was observed beyond the limit. The rotor drifts away from magnetic center.

The root cause was identified and it was found the direction of external fan was not proper and it was required to be modified. The direction of fan blades was changed and again analysis was done in no load condition. Results obtained are briefed in the research article. Along with vibration air flow was also improved.



Fig.4: New Shaft



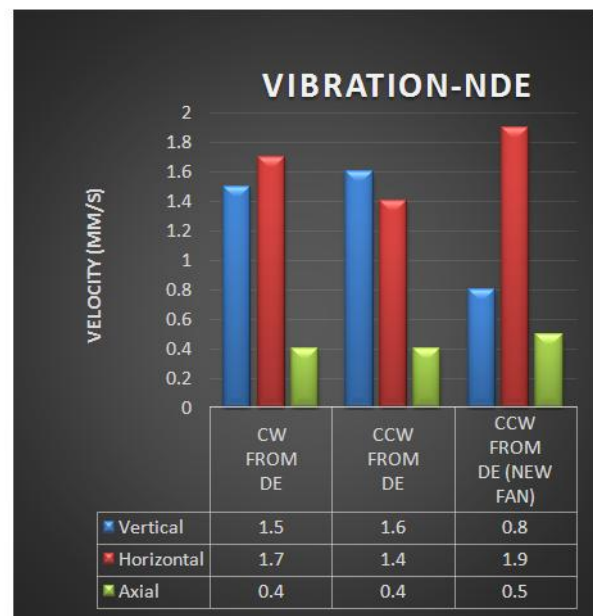
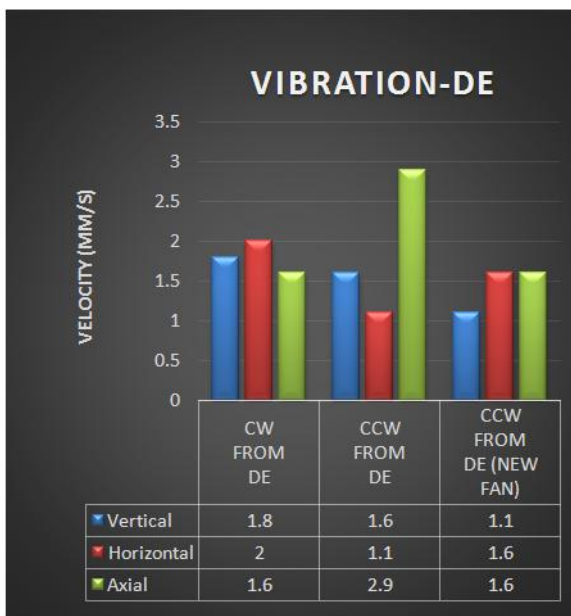
Fig. 5: Modified Fan Rotation

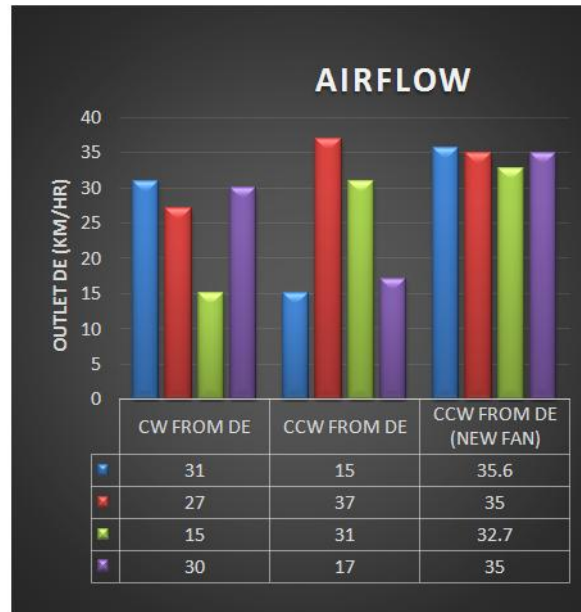
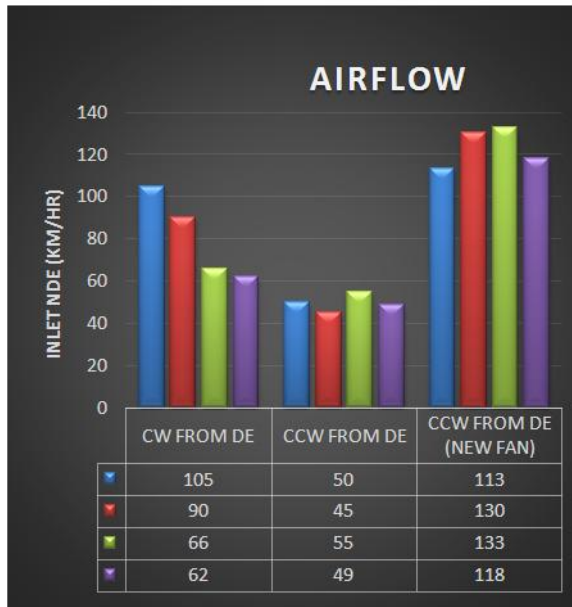


Fig. 6: Bearing Housing Assembly

### V. Result Analysis

Comparative analysis of vibration & air flow of drive end (DE) and non-drive end (NDE) is been depicted in graphical form.





### VI. Conclusion

Modification did not affect the operating parameters of motor in no-load as well as load condition. It ultimately results in vibration obtained within limits, maintained the magnetic center & air flow increased so temperature rise was also within the limits. The motor is successfully in running condition and all parameters are within normal limits.

### References

- [1]. Chuck Yung. "Axial Hunting Of 2-Pole Motors: Causes & Cures," published by Electrical Apparatus Service Association (EASA), May 2005.
- [2]. Michael J. Costello. "Understanding the Vibration Forces in Induction Motors," proceedings of the 19th turbomachinery symposium.
- [3]. Dan Patterson. "Vibration Analysis of Motors in Service center," published by Electrical Apparatus Service Association (EASA), March 2007.
- [4]. Katalin Agoston. "Fault Detection of the Electrical Motors Based on Vibration Analysis," proceedings ELSEVIER, October 2014.
- [5]. Rajendra Mistry, William R Finley & Scott Kreitzer. "Induction Motor Vibrations," proceedings IEEE industry application magazine, November 2010.

Yash Bharadwaj, et. al. "Aerodynamic Effect on Axial Vibration of High-Speed Induction Motor ." *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*, 17(1), (2022): pp. 35-38.