IMPROVING ROTOR PERFORMANCE WITH THE HIGH-SPEED BALANCING BUNKER

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Centrifugal compressors and steam turbines operate at incredibly high speeds under immense loads every day. These units are used in manufacturing, construction, oil and gas, mining, chemicals, petrochemicals and power generation industries. Even though high-speed rotors are designed to be flexible, stress can, overtime, cause them to naturally warp and bend, creating imbalances. If these imbalances go unchecked for too long, they can lead to expensive field repairs, delayed plant production, unplanned downtime costing millions of dollars and, in worst cases, catastrophic damage.

To prevent this, rotors are routinely high-speed balanced once every 4 yrs–5 yrs.. A rotor must be low-speed balanced after it is manufactured, repaired or has conducted long-term service before it is put back in service. In balancing, rotors are spun at operating speed, and the effects of the leftover unbalance are studied to improve its behavior. However, to truly minimize potential failures caused by rotor vibration, rotors should undergo high-speed balancing.

The author's company's state-of-the-art high-speed balance bunkera is designed to simulate rotor responses to unbalance at operational speed. Being only seven years old, it is the newest of the three bunkers currently in use in the U.S. Gulf Coast. The bunker has variable input torques, ramp rates and specialized software designed to handle the most difficult of balancing challenges when other methods are insufficient.

ANALYZING PROBLEMS AND DEVISING SOLUTIONS

A customer brought their 38-yr-old extraction-condensing steam turbine to the author's company. There, they performed a visual inspection, dimensional inspection, runout inspection, non-destructive evaluation (NDE) inspection and low-speed balance check. They found no relevant damage or indicative flaws within the turbine. Then, they balanced the rotor with the high-speed balance bunkera. The rotor received a high-speed balance per API 687 requirements

After the rotor was balanced, they found a balance repeatability issue. The non-repeatable balance behavior revealed itself after passing the first critical speed at above 7,000 rpm. The team assessed the possible cause(s) of the issue and determined the cause was a changing mass unbalance because of loose rotor parts. To remedy this, the assembled blades had to undergo a dimensional inspection. They conducted a gap measurement between the interlocking integral shroud bands (ISB) and found gaps up to 0.008 in. The acceptable gap size is smaller at only 0 in.–0.002 in., as seen in **FIG. 1.** They determined the excessive gaps were caused by wearing on the shroud contact surfaces leading to material removal.

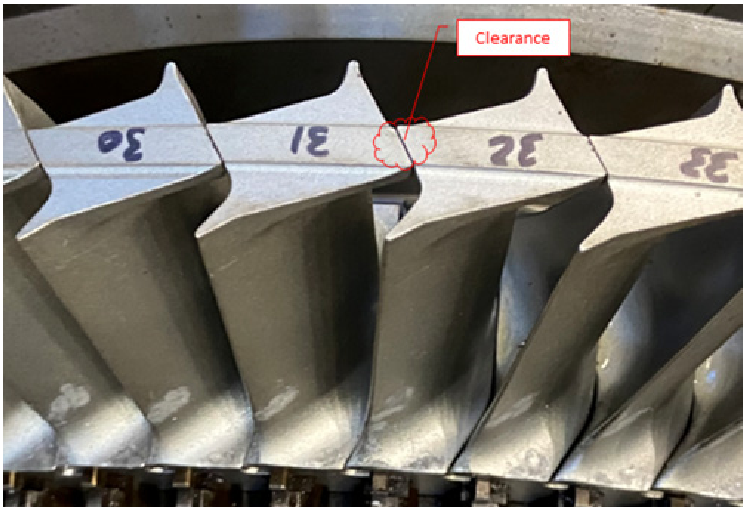

FIG. 1. Interlocking, integrally-shrouded blades.

The team disassembled the blades from the rotor and performed another high-speed balance check. This confirmed repeated rotor balance behavior. They concluded that a gap check should be a standard inspection for affected turbine rotors. In this case, the high-speed balance test was extremely useful in assessing the blade assembly condition and helped the client avoid a potential catastrophic blade failure event.

ASSESSING CONDITIONS AND AVOIDING FAILURE

Another client brought in an 8-yr-old steam turbine rotor used for driving an ethylene gas compressor to the author's company. The team ran several high-speed balancing checks and found a similar vibration repeatability issue caused by snubber blades, as shown in **FIG. 2.** The team discovered excessive interlocking blade snubber gaps on stage six blades up to 0.011 in.

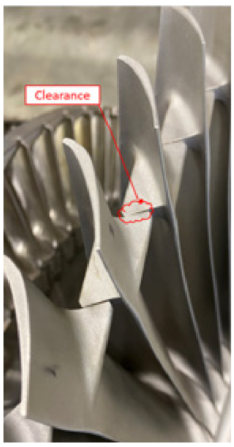

FIG. 2. Snubber type blades.

They conducted a finite element analysis (FEA) of the blade snubber using actual turbine service data to see how the blades would respond under different amounts of physical force. From the analysis, the team determined the steam's dynamic force exceeded the contact force between the blade snubbers. This was due to excessive snubber wear and fretting damage. Without high-speed balance testing, obscure rotor issues, such as these, would go unnoticed and negatively affect turbine performance.

TAKEAWAYS

The high-speed balance bunker[a] serves as a critical resource for maintaining the performance and reliability of high-speed rotors in turbomachinery. Key features, including its variable ramp rates, tilt pad bearings and influence coefficient software, make the bunker ideal for assessing complex rotor dynamics. By simulating real-world operating conditions, it allows users to find targeted solutions for vibration and imbalance issues. With these capabilities, the bunker minimizes risks tied to imbalances, reduces downtime and improves the operational stability of essential equipment.

The bunker's recent case studies illustrate the value of high-speed balancing in diagnosing subtle mechanical issues, such as excessive blade gaps and resolving inconsistencies in rotor performance. This process not only prevents costly failures and unplanned shutdowns but also provides critical insights into rotor health and structural integrity. With detailed testing and data, the high-speed balance bunker supports the safe and sustainable operation of turbomachinery in oil and gas, refining and petrochemicals.

NOTES

[a] Mitsubishi Heavy Industries' high-speed balancing bunker

FOR MORE INFORMATION

To learn more about ourHigh Speed Balance Bunker, visit our website:
https://www.mhi.com/group/mcoi/

Scan or click the QR code below for access to our full catalog of information on our products and services.

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