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If you've ever flown anywhere (or plan to in the future), you'll appreciate the importance of adequate and reliable balancing and testing of this equipment

Modern jetliners rely on air cycle machines to provide air conditioning throughout the passenger cabin. Not only is this provision available on the ground, where outside tarmac temperatures can reach well over 100 F, but also in flight at altitudes reaching over 30,000 feet and temperatures reaching below -30 F. Air cycle machines are a vital component in maintaining a safe and comfortable cabin environment for millions of passengers around the globe. This means big business for OEMs and overhaul facilities worldwide.

The air cycle machines (ACMs) consist of three main components: fan, compressor and turbine. These three components are mated to a single shaft and support by two journal air bearings, with typical operating speeds between 30,000 and 50,000 rpm.

Schenck can provide an ideal machine for the balancing of ACM rotors

The problem

Each rotating component contains an element of unbalance. Unbalance— an uneven weight distribution—is caused by factors in the manufacturing and assembly processes. This unbalance causes vibration that can lead to stress, fatigue, noise and, ultimately, bearing damage during operation. Therefore, ACMs must be carefully balanced and undergo vibration analysis before entering service to ensure long life and reliability.

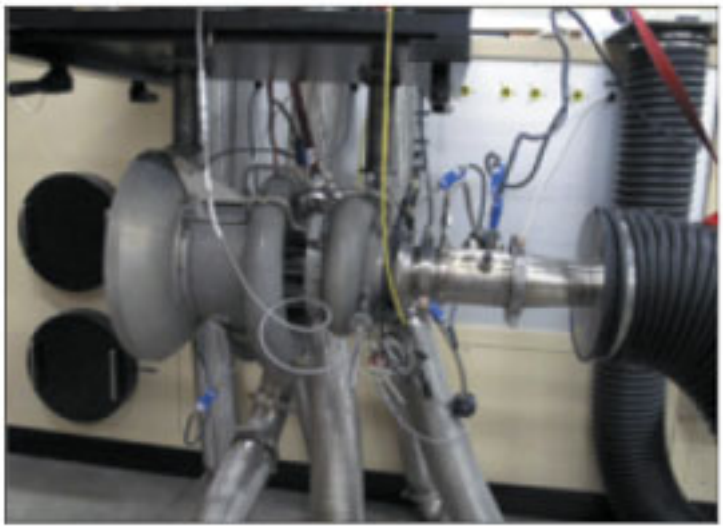
Balancing

Balancing of the ACM components requires a small horizontal balancing machine. The

compressor, turbine and fan components are balanced individually using tooling arbors. (Editor's Note: Schenck's RS1 soft-bearing balancing machine can accommodate a majority of the ACM components, including the shafts, and provides flexibility for a service facility to balance other smaller components. For larger components with lower tolerances and those using tooling, an HM2 balancing machine is suitable for the balancing tasks.) Service facilities may have specific requirements and ACM models, so balancing solutions must be determined based on individual needs.

Vibration analysis

Before an ACM is entered into service, it has to pass several tests specified by the OEMs for the individual ACM, including pressure tests, break-in tests, performance tests and balance verification tests. During the tests, numerous parameters are recorded and monitored. Some of the tests require vibration analysis for which Schenck also provides testing equipment.



An ACM test stand *(photo courtesy of Bauer Incorporated, Bristol, CT)*

Vibration analysis includes the measurement of housing vibration and shaft excursion. Housing vibration can be measured using accelerometers. Shaft excursion, also called relative shaft vibration, is measured using two non-contacting displacement pickups (Eddy Current Sensors). Displacement sensors must be installed with a slight shaft clearance perpendicular to each other. The sensitivity of the sensors is dependent upon shaft material and shaft dimensions, so this has to be determined for each type of ACM.

OEM manuals require the monitoring of two components of the shaft excursion signal: synchronous vibration, the component related to the running speed of the rotor, and non-synchronous vibration, vibration not related to the running speed. To provide these readings, the vibration measuring unit uses a tracking filter. A reference signal for speed and

phase is provided by laser if the shaft end of the inlet fan is accessible. Should the shaft end be inaccessible, the use of a magnetic sensor is possible providing that the shaft material is steel and incorporates a keyway or other trigger feature. Synchronous vibration is caused primarily by the residual unbalance of the rotor or misalignment, where the components are not mounted concentric and perpendicular to the shaft. If the synchronous vibration exceeds a certain limit, the assembly must be trim balanced.

Synchronous vibration readings (amplitude and phase) are taken at different running speeds. From these readings, an “optimization” procedure is used to calculate the correction weights to minimize the vibration for the complete speed range. Corrections are then performed at the shaft ends. Non-synchronous vibration is an indication of bearing instabilities. In this case, vibration that exceeds tolerance requires the unit to be disassembled and checked. **MT**

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Providing Complete Solutions…

Backed by over 100 years of balancing experience, Schenck Trebel provides a complete line of vertical and horizontal balancing machines for the production, maintenance and repair of any rotating component—from a fraction of a gram to over 600,000 lbs. The company offers a range of vibration analysis equipment, including field balancing machines, balancing tooling and condition monitors for precision rotor performance. Schenck’s nationwide Balancing Technology Centers also provide rotor balancing services and various on-site services, including predictive maintenance and on-line condition monitoring services for critical equipment. But, that’s not all.

Schenck’s total support program goes beyond balancing to provide equipment and technical services, balancing certification, on-site and off-site seminars and in-house balancing services.

With more than 60,000 machine installations worldwide, Schenck can offer the right solution. For details, visit: www.schenck-usa.com