ISSUE 0709

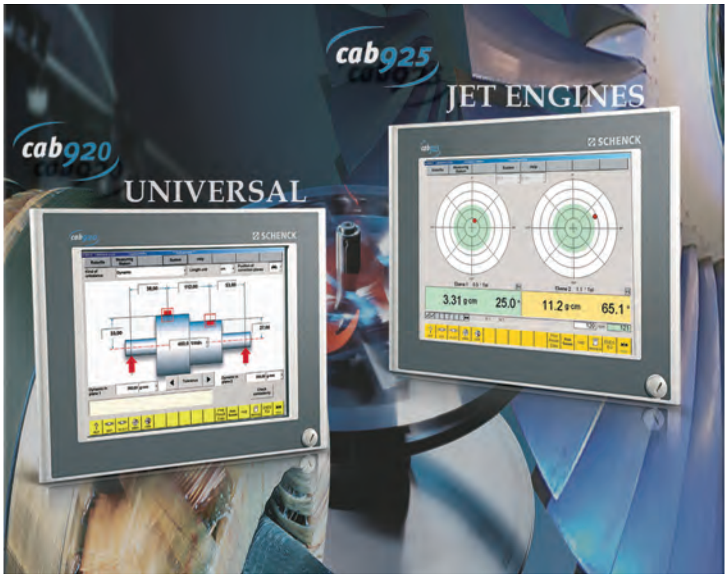
SCHENCK
Balancing and Diagnostic Systems

balancing news

Information for the quality and performance of rotating equipment - From the Schenck Balancing & Diagnostic Systems Group

Schenck Introduces CAB 900 Series PC-based Instrumentation

The CAB 900 series instrumentation is Schenck's newest PC-based balancing instrumentation. With flash drive employing embedded Windows XP as its generating environment, the CAB 900 series offers the same Windows compliant graphics user interface and software compatibility that dominates the personal computer market. Like its predecessor, the CAB 690 family, the CAB 900 series was specifically developed for the most challenging applications including jet engine balancing and flexible rotor balancing.



Featuring a 15-inch touch screen operator interface and no moving parts, the industrial PC used in the CAB 900 series is compatible with the harsh shop environment that is frequently part of a manufacturing and overhaul setting.

This industrial PC is connected to a black box measuring unit that accomplishes all the internal computations necessary to convert calibrated measurement units into unbalance measurement data, while all other user interface functions are managed by the industrial PC. The end result is a data transfer rate that permits real time screen updates for rotor-dynamic evaluation of data. Instantaneous data capture provides an informative graphic representation both on screen and on paper for a thorough rotor-dynamic evaluation of the collected data.

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Schenck Trebel Offers Educational Services

by David Fanning

Balancing Seminars in Deer Park, NY

Schenck Trebel Corporation has been providing balancing seminars for nearly 40 years. The first seminar, a 5-day course, was held in 1969 and produced 15 graduates. Looking forward, 2009 will mark the 40th anniversary of Schenck balancing seminars. Over the course of these 40 years the educational program has evolved into a multi-tiered program consisting of three levels of certification available for those who successfully complete the course requirements.

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Schenck Trebel Offers Educational Services

by David Fanning (Continued from Page 1)

The seminars now include the following primary course offerings:

- Fundamentals of Balancing - Level I
- Balancing Theory and Application - Level II
- Advanced Theory and Application - Level III
- Level I Certification - Balancing Operator
- Level II Certification - Balancing Technician
- Level III Certification - Balancing Technology

Level I,II, and III Certifications are available after each seminar and valid for two years!

The seminars focus on the principles of rotor dynamics as well as the operating principles of the balancing machine. These seminars include both classroom sessions and hands-on practical demonstrations. Knowledge and experiences are often shared across industries between all attendees.

Schenck Trebel Corporation also offers the above seminars on-site at the customer's facility. The on-site seminars use the customer's actual balancing machines for the hands-on practical demonstrations.

"I gained a good understanding of the basics of balancing. I also now understand what I further need to work on for my own self-improvement in this area. Very Informative!"

- Seminar Attendee

Topics include:

- Types of Unbalance
- Balancing Tolerances
- Machine and Rotor Setup
- Types of Rotors
- Design of Machine Types
- Causes of Errors in Balancing
- Vibration Analysis

Specialized Seminars

Industry specific seminars are also offered. These seminars provide a unique opportunity to explore the key aspects of balancing within a certain industry and include the following topics:

- Fundamentals of Jet Engine Balancing
- Advanced Jet Engine Balancing
- Pump & Impeller Balancing
- Flexible Rotor Balancing

Workshops at Schenck Technology Centers

Schenck also offers one-day on-site workshops. The on-site workshops provide an opportunity for attendees to learn about a specific area of the balancing process. Due to the reduced commitment required, the one-day workshops present a unique opportunity that may prove beneficial in allowing several employees to attend. Seminar offerings include:

- Understanding Tolerances & Speed
- Improving Measuring Results
- Addressing Rotor Configurations
- Improving Correction Techniques
- Correction & Performance Testing
- Accuracy & Responsibility
- Balancing with PMI Rotor Simulators

For more information and a complete schedule of seminars offered for the 2007 calendar year, please visit our web site at:

http://www.schenck-usa.com/serv_schedule.html

SAVE THE DATE!

Balancing Workshop IV Improving Correction Techniques
October 12, Santa Ana, CA

Balancing Workshop I Understanding Tolerances & Speed
October 19, Chicago, IL

Balancing Workshop II Improving Measuring Results
October 25, Houston, TX

Advanced Balancing Theory & Applications
November 13-15, Deer Park, NY

Balancing Technology Specialist Certification III Exam
November 15, Deer Park, NY

Fundamentals of Balancing
December 4-6, Santa Ana, CA

Balancing Operator Certification I Exam
December 6, Santa Ana, CA

See our next newsletter for the 2008 Workshop Schedule!

Balancing and Vibration Test Solutions for Air Cycle Machines

by Roland Kewitsch & Jan Dittmar

Background

Modern jetliners rely on air cycle machines to provide air conditioning throughout the passenger cabin. They are a vital component in maintaining a safe and comfortable cabin environment for the millions of passengers across 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 supported by two journal air bearings, with typical operating speeds between 30,000 to 50,000 rpm.

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

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

Small horizontal balancing machines are required for the ACM balancing tasks. Balancing of the ACMs consists of two-plane balancing of the individual components followed by the balancing of the ACM assembly. Traditionally, soft-bearing balancing machines such as the RS1 and RS2 have been used for this balancing application, but their use has been surmounted by modern hard-bearing balancing machines such as the HS10 and HS2. The RS1 soft-bearing or HS10 hard-bearing balancing machines 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 including the ACM assemblies, an RS2 soft-bearing or HS2 hard-bearing balancing machine is suitable for the balancing tasks. Service facilities may have specific balancing requirements and tolerances, so their balancing solutions must be determined based on individual needs. Through a full range of soft- and hard-bearing balancing machines, Schenck provides the balancing solutions regardless of the ACM application.

Vibration Analysis

Before an ACM is entered into service it has to pass several tests specified by the OEMs. These tests, which include pressure, break-in, performance, and balance verification are often tailored to the individual ACM. Vibration analysis is required for some of these tests, in which numerous parameters are recorded and monitored.

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Schenck Introduces CAB 900 Series PC-based Instrumentation

(Continued from Page 1)

The CAB 900 series instrumentation is available for horizontal and vertical balancing machines. Hard-bearing and soft-bearing balancing machine designs are fully supported. The CAB 900 series offers several unique features and options to maximize productivity and versatility. The CAB 900 series is supplied with a high-resolution 15-inch flat panel color monitor for display of digital and graphic data. It features a true polar vector display with simultaneous digital indication. Set-up and operation are accomplished using an operator-friendly touch screen with an optional keyboard for data input.

The display offers brightly-lit unbalance readout values with tolerance comparison and high-visibility "IN TOLERANCE" displays. The "IN TOLERANCE" displays flash when tolerances in each plane have been achieved.

Since the CAB 900 series is network compatible with available access to the internet, we can troubleshoot any issue and provide technical support from a remote location. Software upgrades are now possible via email from Schenck. While the CAB 900 is network compatible, no internet connection is required to upgrade the software of the CAB 900 series instrumentation, which ensures IT security.

The CAB 900 series is offered in two versions, the CAB 920 and the CAB 925.

The CAB 920 instrumentation is used for general industry applications such as gas turbines, pumps, impellers, armatures, generators, fans, blowers, paper rolls etc. as well as flexible rotor balancing. The CAB 925 was specifically developed for jet engine balancing tasks, also including flexible rotor balancing.

Standard Features of CAB 920 and CAB 925

- Single Compensation
- Index Balancing
- Key Compensation
- Correction of Asymmetric Components

Optional Features of CAB 920 and CAB 925

- Printer Documentation System
- Electronic Protractor
- Rotor Specific Calibration
- Measurement During Runup with Marking
- High Speed Functions
- Recalculation for Unbalance Correction
- Averaging Over Runs (marking of values)
- Weight Distribution ("WEDI")
- Unbalance Distribution ("UNDI")
- Nesting
- Runout Measurement

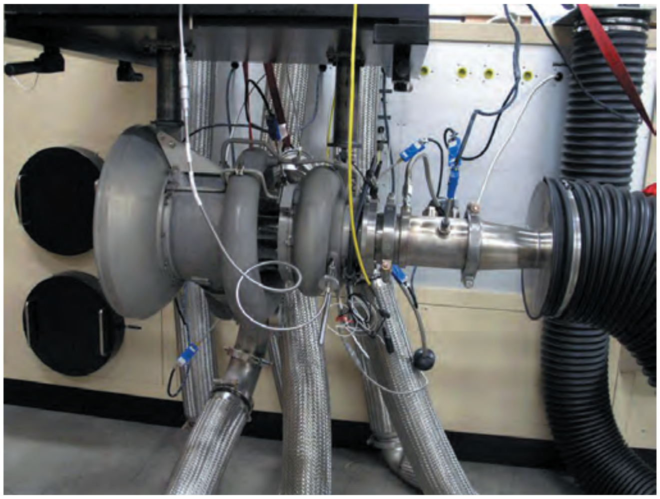
Many of these software options can be purchased together as a software package, resulting in significant savings.

For a more detailed description of the software features and software packages please visit our web site at:

http://www.schenck-usa.com/instrumentation_manual.html
or contact us at sales@schenck-usa.com

by Roland Kewitsh & Jan Dittmar (Continued from Page 3)

Vibration analysis includes the measurement of housing vibration and shaft excursion. Housing excursion can be measured using one accelerometer. 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.



ACM Test Stand Photo courtesy of Bauer Incorporated, Bristol, CT.

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 independent of 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 permitting 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.

Schenck Provides Complete Solutions

Schenck provides balancing and vibration solutions for the manufacturing and overhaul process. Our balancing machines are used for balancing of the individual components, while our portable vibration analyzers are used to perform vibration tests and trim balancing of the complete assembly. In addition, we offer a complete selection of relevant training seminars at our headquarters in Deer Park, NY, or at convenient locations throughout North America. Schenck can also offer customized seminars at your facility.

Please feel free to contact us for additional information at: sales@schenck-usa.com.

Improving Correction Errors: The Effect of Angle Error on Unbalance Correction

by Jan Dittmar

1. Measured Unbalance: 10 g @ 0° 2. Intended Correction: 10 g @ 180° 3. Actual Correction: 10 g @ 170° 4. Resultant Unbalance: 1.74 g @ 85°

During our balancing seminars we investigate many factors that contribute to errors during the balancing process. While proper balancing machine and instrumentation setups are crucial for accurate balancing results, unbalance correction errors significantly contribute to problems during the balancing process. Unbalance correction errors are caused by two factors: correction amount deviation and angle deviation. Let's take a look at how each one affects the unbalance correction results.

The balancing machine sums and displays the unbalance data in the specified correction planes using radii as dictated by the rotor file. At each correction plane, the instrumentation displays a correction angle and amount. Precise location of the angle is necessary for accurate unbalance correction.

The Problem…

Unbalance, by definition is a function of mass and radius. When the radius is increased, the required unbalance mass will decrease, and vice versa. Therefore, correcting unbalance at a radius smaller or larger than the specified correction radius will affect the effective amount of correction. This under- and over-correction can result in an increase in the number of balancing runs required, experiencing the phenomenon of "chasing readings", and possibly rejected parts due to over-correction of the rotor.

Even when an accurate correction mass and radius are used, correction angle error represents a considerable challenge during the balancing process. Missing the correct angle of correction will change the effective radius of the correction and result in an under-correction of the rotor. Additional balancing runs will be required to balance the rotor.

In addition to the under-correction of the unbalance, the angle of the resultant unbalance also changes. This behavior is difficult to identify and troubleshoot without understanding how angle error affects the resultant correction location. Figure 1. shows a typical correction angle error scenario. While the initial unbalance and intended correction angle were initially at 0° and 180°, the resultant unbalance after correction has shifted to 85°. The next correction will then be made at 265° (180° from the unbalance). The rotor has now been corrected twice at nearly 90° apart to counter the effects of an initial angle error. Similar correction angle errors will result in additional balancing runs and corrections, which results in additional time required for balancing and could ultimately result in a rejected rotor if too many corrections are made.

Angle Error (degrees)	Residual Unbalance Amount Error (% of mass)
1	1.74
2	3.5
3	5.2
6	10.4
10	17.4
12	20.9
15	26.1
20	34.8

Table 1. Angle Error vs. Amount Error

Improving Correction Errors: The Effect of Angle Error on Unbalance Correction

The scenario described in Figure 1. shows the correlation between angle error and residual unbalance amount error. From the 10g initial unbalance correction and the resultant residual unbalance of 1.74g, we can establish the relationship of 1° of error representing 1.74 percent of the unbalance correction amount. Table 1. shows additional angle error amounts and their corresponding residual unbalance amount errors.

In practice, it has been proven that the width of a marker line, commonly used in many balancing shops to align tooling arbors with rotors, can introduce enough angle error to significantly affect the unbalance correction. Figure 2. shows a small arbor with a 1.25 inch correction diameter. At this diameter, the width of the marker line, estimated at 1/8 inch, can represent a total angle error of 12°

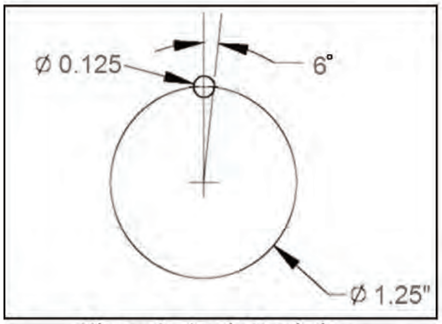


Figure 2. Angle Deviation from 1/8" marker reference line

which equates to an amount error of 20.9 percent of the correction mass. As shown in Figure 2., even the midpoint to the edge of the marker line represents a 6° angle error which correlates to a 10.4 percent decrease in the effect of the correction mass. This results in an under-correction of the unbalance.

The Solutions…

Ultimately, the key to reducing the effects of angle deviation is to accurately locate and mark the correction angle while ensuring precise alignment of rotor stages and tooling components. While careful consideration must be given to rotor alignment, we can greatly benefit from software that accurately displays the rotor angle. One such solution is Schenck's Electronic Protractor including software and encoder, which will indicate the angle of unbalance on our instrumentations' vector meter displays. When the rotor is turned to the appropriate angle, the display will illuminate indicating the angle has been reached. Schenck instrumentation can display the unbalance angle with the precision of one degree.

Also, many rotors have defined correction locations that limit the available angles for correction. In these cases, angle error seems unavoidable. Our “Components” software feature allows the operator to define the correction locations during rotor setup. The unbalance correction amount is displayed as a function of the available correction locations. For example, a rotor with 12 correction locations spread evenly 30° apart may have an unbalance vector at 10°. The correction will then be displayed as a function of different correction amounts at 0° and 30°. This software function efficiently calculates the vector components comprising the unbalance correction and saves valuable time.

In Conclusion…

Even a slight correction angle error can have significant effect on the actual correction amount and correction error. In fact, angle errors during mass correction have a greater impact on the residual unbalance than correction amount errors. It is therefore important to be aware of the effects of angle deviation on unbalance correction and its effects on the balancing process. Proper correction angle is a vital aspect of the balancing process, and a key area for improving your efficiency and balancing accuracy.

COME SEE US AT THE BIG EASY!

POWER-GEN INTERNATIONAL 2007
December 11-13, 2007

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balancing news

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BALANCING FAQ'S

Q. When calculating the unbalance tolerance (permissible residual unbalance) for my rotor, how do I properly determine the correct quality grade?

A. Balancing quality grades provide a method for classifying rotors for the purpose of obtaining a suitable and economically achievable balance equality. These classifications, or quality grades, are based on the type of machinery the rotor is used for and have been determined from practical worldwide experiences with multiple various rotor types. For rigid rotor analysis, Table 1 in ISO 1940-1 lists the quality grades assigned to the most commonly found rotor types. This table provides a basic guideline for selecting a quality grade. If your particular rotor is a non-standard, critical application, then the next better (numerically lower) quality grade can be selected. Quality grades are separated by a factor of 2.5; however, finer grading is permissible in certain special cases. It should be noted that quality grades G1.0 and G0.4 are reserved for rotors that meet certain specific balancing requirements. For additional information please refer to ISO 1940-1. This document can be obtained online at: http://www.iso.org/iso/home.htm.

Q. How do I determine the correct balancing speed for my rotor?

A. Assuming you are working with a typical rigid rotor, the correct balancing speed is the lowest speed at which the balancing machine is sensitive enough to meet or exceed the unbalance tolerance requirements for your rotor. To select the appropriate balancing speed for your application please refer to the specifications for your particular balancing machine. One of the primary concerns when working with balancing equipment is to maintain a safe work environment, and a lower balancing speed will create a safer work area.