Conclusions and Future Work

- The computer controlled bearing analyzer can perform repeatable error motion measurements accurate to 1 microinch (25.4 nanometers).
- The number of lobes on the inner race match the number of lobes of the radial error motion in the fixed sensitive direction and similarly for the outer race and the rotating sensitive direction with a combination of a two-lobed race with a three-lobed race.
- Future work includes further investigation of relationship of preload to fixed and rotating sensitive error motion measurements, the addition of a torque channel, and acoustic vibration analysis.

Applications

- Analyze and compare angular-contact rotary ball bearings through fixed sensitive and rotating sensitive radial error motion measurements and FFT-based frequency analysis.
- Investigation of inner and outer race form errors and their relationship to both fixed sensitive and rotating sensitive radial error motion measurements.
- Optimization of bearing preload at certain operating speeds.
- Quick comparison of multiple ball bearings through frequency analysis.

Components and Capabilities

- A Professional Instruments® motorized 3R Blockhead with a linear brushless DC motor, a Heidenhain® ERO 1221 (1024 counts/rev) rotary encoder, Lion Precision® capacitance gages, and a 3MBu, 12-bit National Instruments® data acquisition board.
- Piloted bearing mount and axial preload from an air bearing load cell with non-influencing coupling.
- LabWindows/CVI user interface software to control and analyze data acquisition.
- Repeatable, reliable error motion measurements with an accuracy of 1 microinch (25.4 nanometers).
- Fixed and rotating sensitive radial error motion measurements and FFT-based frequency analysis at speeds up to 10,000 RPM.

Design and Use of a Precision Bearing Analyzer

Data Acquisition Flowchart

Acquire
Clear Previous Results
Prepare for DAQ
Encoder Index Pulse
Trigger
Acquire Data based on Encoder Squarewave.
Is DAQ finished?
Yes
No
Filter Data
Remove Fundamental
Remove Thermal Drift
Scale Data to Units
Calculations:
Synchronous Error
Maximum Asynchronous
Total Error
TIR
FFT

Preload Testing – From L to R: 7 lb. (30 N), 13 lb. (60.0 N), 20 lb. (89 N)

Frequency Analysis NSK 6204 (1) (Hz)
Cage Rotation (fc) 6.42
Cage Rotation Relative to Inner Race (fci) 10.35
Ball Spin (fbs) 33.53
Ball Pass on Outer Race (fbpo) 51.48
Ball Pass on Inner Race (fbpi) 82.39
Ball Defect (fbd) 67.07
Inner Race Rotation (fi) 16.667

Frequency Analysis NSK 6204 (2) (Hz)
Cage Rotation (fc) 6.38
Cage Rotation Relative to Inner Race (fci) 10.03
Ball Spin (fbs) 33.33
Ball Pass on Outer Race (fbpo) 51.17
Ball Pass on Inner Race (fbpi) 81.90
Ball Defect (fbd) 66.54
Inner Race Rotation (fi) 16.6667

Speed Testing – From L to R: 500 RPM, 2500 RPM, 4200 RPM.

Frequency Analysis Fafnir 7204 (Hz)
Cage Rotation (fc) 6.51
Cage Rotation Relative to Inner Race (fci) 10.16
Ball Spin (fbs) 33.33
Ball Pass on Outer Race (fbpo) 71.35
Ball Pass on Inner Race (fbpi) 111.98
Ball Defect (fbd) 66.67
Inner Race Rotation (fi) 16.6667

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