www.iotech.com

Gearbox Testing
using the ZonicBook™

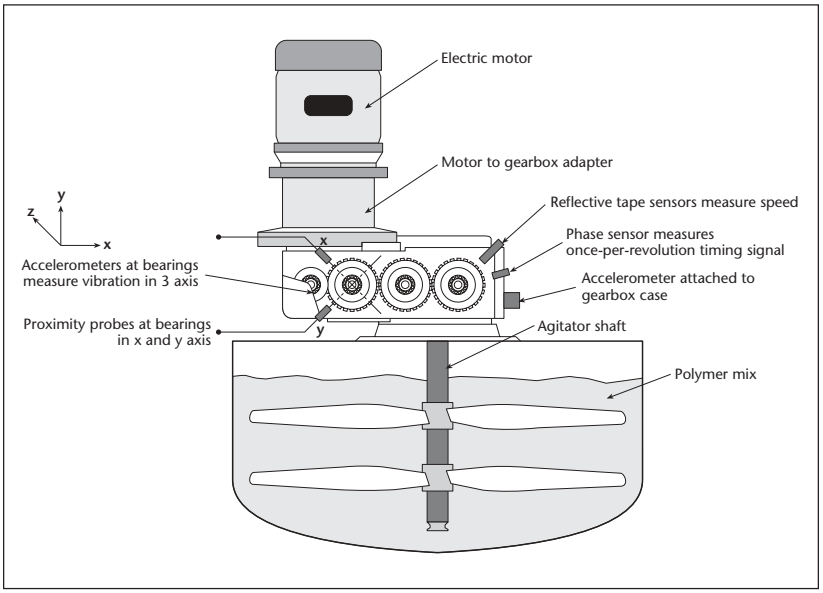
Industrial Vibration

Application Note #75

Application Summary

Chemical processing plants that produce olefin and polyolefin materials for the plastics industry employ mixers of gigantic proportions. It's not uncommon to see 2,000 hp electric motors driving speed-reducing gearboxes of similar size for mixing a batch of ethylene, propylene, or polyethylene — materials that are eventually converted to pellets for plastic injection and blow-molding machines. The heavy loads placed on the gearboxes under such conditions are reason enough to have teams of engineers and technicians forever vigilant of the sounds and vibrations these giants continually generate. Their mission is to prevent premature gearbox failures.

A reliability engineer for a large chemical company has the responsibility to monitor and analyze these gearboxes, and develop specifications for their repair and overhaul. He is a member of the machinery support group that analyzes gearbox vibrations, spent oil, and reciprocating compressors where he monitors pressures and volumes. Several large gearboxes on site occasionally need to be line-bored and completely stripped down for overhaul. But because of the high cost of the repair, it's imperative that the gearbox not be overhauled either too soon or too late. This means that reliable and accurate data must be logged continuously regarding mechanical vibrations from the gear teeth and bearings to establish a signature for both acceptable and marginal components.



Typical mixers for olefin and polyolefin materials are designed to operate 24 hours per day for as long as 10 years. But engineers at one leading chemical company are realizing longer lives because they monitor their gearboxes with an IOtech ZonicBook containing eZ-Analyst software and study vibration signatures that warn of looming failures. The data help the engineers improve gearbox designs and set up a repair schedule that prevents major failures for what they predict will be close to 30 years.

Potential Solution

The machinery support group currently uses walk-around data collectors for most of their vibration monitoring requirements. The equipment is capable of collecting long time records, but to do this, the high-frequency data must be filtered out. Unfortunately, the higher frequencies contain the information needed to completely analyze the most critical element, the gear teeth. The machinery group also has reel-to-reel tape recorders, FFT analyzers, and ordinary oscilloscopes. But the equipment is severely limited to measuring only two channels simultaneously, gathering hardly enough data to sufficiently characterize a gearbox noise or vibration issue. Also, virtually no post processing of the most critical data is possible.

IOtech's Solution

Because the cost of missing an opportunity to prevent a gearbox failure far exceeds the cost of new equipment that could predict failures, the reliability engineer looked at new data acquisition systems. He needed a monitoring and analyzing system that could provide plots of vibration data recorded simultaneously on several gears and bearings. And as a result of his search, he purchased a ZonicBook™ vibration analyzer with eZ-Analyst™ software. The eight-channel IOtech instrument has a built-in RPM/frequency port, piezoelectric accelerometer input, and anti-aliasing filters that let the machinery group monitor and analyze the output of several accelerometers attached to the gearbox case and bearing hubs. They also monitor gear and shaft speeds with tachometer signals derived from reflective tape sensors.

The test setup monitors a tachometer speed signal from each bearing and vibration in two or three directions with accelerometers. Proximity probes are placed in the X and Y-axes at each bearing location, along with a pair of thrust probes and a single key phasor that provides a once-per-revolution timing signal. The gearbox contains driver and driven elements, so four bearing and eight vibration probes are needed for radial vibration.

The biggest advantage, however, is the fact that with eZ-Analyst software, the reliability engineer can stack up the plots, one above the other synchronized in time, to see anomalies as they relate to each other. He really wanted to analyze waveforms on low-speed

www.iotech.com

gearboxes, but he needed a tool that could provide high-resolution, long time-recorded data signals. He had to analyze four or five consecutive shaft revolutions and observe events that repeated at the same point in time during every revolution. And when he tried capturing the data with a tape recorder, he ended up with a long record that let him observe only a small portion of the data at any one time. He also couldn't analyze the most critical revolutions on the small window of an oscilloscope or analyzer. But with the eZ-Analyst software, he was able to dump the data into a spreadsheet, manipulate it, and collect long time records of high frequency data.

As a result of numerous recordings with the ZonicBook, the machinery group now can gather enough information to go further than just recommending a replacement with the same kind of gearbox; they can provide design-improvement data. The reliability engineer is now working closely with the gear manufacturer, and between them, they recently executed three or four extraordinary overhauls. They dropped the noise level substantially, and expect to get 30 years out of a gearbox before it needs an overhaul.

The reliability engineer said that he found the ZonicBook easy to configure, compared to the other analyzers he has that are much more confusing to set up. He claims that software-based analyzers, like the ZonicBook, are much easier to set up and use because he can just pick and choose options from a menu. The other analyzers were purchased in the early 1980s. They lacked the ability to use a mouse, a standard keyboard, and set up an efficient configuration.

Also, the reliability engineer finds the IOtech equipment extremely durable. He even had it in areas that were dusty and humid, and never experienced a failure or problem. He also likes the portability. When he used the tape recorder, he had to carry a lot more equipment out in the field, and the analysis would take much longer. But with the IOtech ZonicBook, he can put it in a case with his laptop and then carry another small bag containing a laser tachometer, cables, and accelerometers. Now he doesn't need a cart or truck to get down to the field and start working. The new IOtech tools are a big plus over those that he had on the shelf before.

Conclusion

A leading manufacturer and user of olefins and polyolefins employs an IOtech ZonicBook with eZ-Analyst software for analyzing gearbox vibrations. The system lets engineers analyze the data collected, establish vibration signatures for the gearbox components, and develop a realistic repair schedule. The comprehensive maintenance program prevents surprise failures and considerably lowers repair costs by ensuring that the gearboxes are serviced at optimal intervals.

ZonicBook

Vibration analysis and monitoring has never been easier than with the new ZonicBook/618E™ and eZ-Series™ analysis and monitoring software. The ZonicBook leverages 25+ year experience of providing vibration measurement solutions, and this compact Ethernet-based solution adds another dimension — the *lowest cost* full-featured 8 to 56 channel analyzer available from anyone. Since software in the PC determines all of the ZonicBook's capabilities, it is easy to upgrade your system and add more capabilities over time. The ZonicBook hardware is the signal conditioning and acquisition engine, while the software in the PC defines the specific analysis and monitoring features of the system.

Features

- 8 input channels, expandable up to 56 channels
- High-speed Ethernet connection to the PC
- Five eZ-Series software packages to address a wide variety of vibration monitoring and analysis applications
- TEDS support

Software Overview

Five software packages are available for the ZonicBook, each tailored to a particular vibration measurement and analysis application. Choose the package that suits your application now, and upgrade to additional packages as your requirements evolve.

- **eZ-Analyst** provides a feature-rich multi-channel vibration analysis, including features such as overlay of previously acquired data while acquiring new data, strip charts of the throughput data files, direct export to the most popular MODAL analysis packages, ME Scope, and Star Modal.
- **eZ-TOMAS** provides on-line vibration monitoring, most commonly used for monitoring rotating machinery.
- **eZ-Balance** is used to balance rotating machinery with up to seven planes, storing the influence coefficients from each balance plane so that on future balance runs a trial balance run will not be required. The balance vectors are displayed on a polar plot so the user has a visual indication of the improvement.
- **eZ-Rotate** provides in-depth post-acquisition analysis of measurements made by the ZonicBook on rotating machinery, with special emphasis on order normalization and order tracking by re-sampling the time domain data acquired from eZ-Analyst and display order tracked waterfall, Bode plots of Phase and Magnitude, order tracks of amplitude vs. RPM and color speed spectrum maps.
- **eZ-NDT** package is exclusively used in production applications to determine the quality of composite-metal devices.