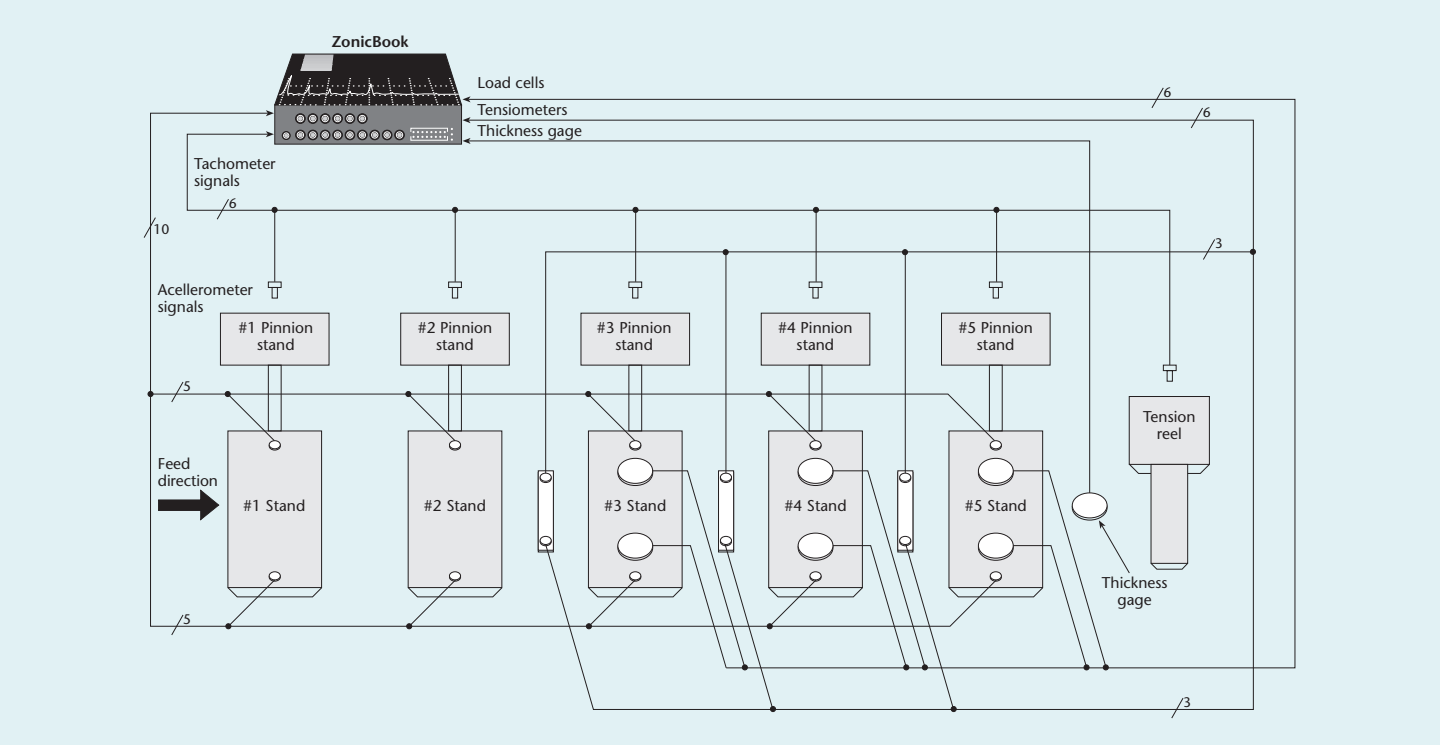
Steel Mill Monitoring & Vibration Testing

using the ZonicBook

Application Summary

Continuous casting process lines used for manufacturing steel, all around the world, contain components that undergo extremely high pressures and temperatures, and they often run for weeks without stopping. When the molten steel is ready to leave the furnace, it goes into a water-cooled mold and forms a slab. The slab comprises a solid outside layer that surrounds a molten core. The metal then cools further as it passes through several water spray stations.

Typically, several pairs of rolls arranged in segments on a 65-foot radius contain the slab while it solidifies. During this time, each pair of rolls must maintain a gap tolerance of 0.040 inches. As this takes place, a dedicated data acquisition system continuously monitors the processing equipment for certain variables such as temperature, cast speed, and mold behavior. After the slab completely solidifies, it is cut into lengths according to the customer's order. The next step takes it to a hot strip mill. Here, the slab passes through a furnace where it is reheated to a uniform temperature before it runs through a processing line composed of a series of rolling stands. The hot slab is descaled and run through a roughing mill to further reduce its thickness. The slab gradually reforms into a long bar, runs through a series of finishing stands, becomes a sheet of steel, and finally reaches a thickness specified by the customer, typically less than 1/8-inch. The steel sheet is then coiled at a high rate of speed and either shipped to the customer or sent to a cold-rolling mill for further processing.



Each pinion stand and the tension reel in a series that services the cold rolling mill line contains tachometers to measure the speed of the steel strip. Tensiometer rolls containing tension sensors are located between the pinion stands. The stands contain load cells, thickness gages, accelerometers, and tension sensors, as well. This sensor arrangement lets the ZonicBook capture all critical signals in order to characterize the system dynamics and display the parameters in a waterfall representation. The waterfall display shows the frequencies of the complex array of vibrations, which helps locate problems on the line.

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Each step in the process is monitored to ensure that all the mechanized equipment remains within operating tolerances, which guarantees that a quality product is formed in the hot-mill finishing stands and remains so as it runs through the cold mill where high-speed rotating rollers form the strip. One common but serious problem that often shows up in a roller stand is a vibration that causes it to lose its ability to maintain critical thickness accuracy of the steel coil.

Potential Solution

Most mills employ one or more of a variety of permanent, distributed data acquisition systems that continuously monitor temperature, vibration, force, displacement, and speed. In addition to the permanent data system, a portable system is used to process vibration and speed information from accelerometers and tachometers located on the rolling stands when certain

ZonicBook/618E

Vibration analysis and monitoring has never been easier than with the ZonicBook/618E and eZ-Series analysis and monitoring software. The ZonicBook leverages 30+ years of experience providing vibration measurement solutions. The ZonicBook hardware is the signal conditioning and acquisition engine, while the eZ-Series software in the PC defines the specific analysis and monitoring features of the system. The ZonicBook's architecture makes expansion beyond the eight built-in channels less expensive than other suppliers. You can expand the ZonicBook in 8-channel increments up to 56 channels, and each additional 8 channels are approximately one third the cost of the first 8 channels. *All* channels in a ZonicBook system are measured synchronously, providing 1 degree phase matching between channels.

Features

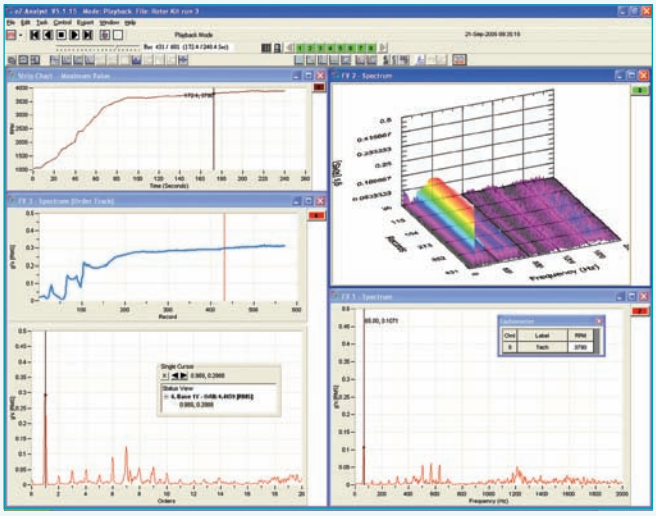
- Eight dynamic input channels, expandable up to 56 channels
- Four tachometer channels for rotational measurements
- High-speed Ethernet connection to the PC for continuous recording
- Four eZ-Series software packages address a wide variety of vibration monitoring and analysis applications
- TEDS support for accelerometers

The ZonicBook/618E with eZ-Series software and your PC makes a real-time, portable vibration analysis monitoring system

Software Overview

Four 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 real-time multi-channel vibration analysis, including overlay of previously acquired data while acquiring new data, strip charts of the throughput data files, cross channel analysis, and direct export to the most popular MODAL analysis packages, ME Scope and Star Modal.
- **eZ-TOMAS & eZ-TOMAS Remote** are highly sophisticated, yet easy-to-use tools for the monitoring and analysis of single or multiple machines, which allows the user to assess the reliability and operation of his process, and the critical machines pertaining to his process.
- **eZ-Balance** is used to balance rotating machinery with up to seven planes. A balance toolkit, including Split Weight calculations, supports the balance process. The balance vectors are displayed on a polar plot so the user has a visual indication of the improvement. Time and spectrum plots show detailed vibration measurement during the balance process.
- **eZ-NDT** package is exclusively used in production applications to determine the quality of composite-metal products at production rates of 1 part per second.



eZ-Analyst adds real-time continuous and transient data acquisition in the time, frequency, or order domain

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problems crop up. They measure roll speed and vibrations at each reducing stage that might be caused by faulty rollers and roller bearings. The data acquisition system measures and analyzes these vibrations along the process line to help pinpoint the source of the problem. Resident software then defines the source of any abnormality in the process line, such as worn rolls, faulty bearings, and interstand tensiometer problems.

IOtech's Solution

An independent consultant from Ohio, who visits numerous steel and tin mills every year, measures anomalies that can eventually cause serious quality and maintenance problems. Although he occasionally uses the onsite data equipment, usually he finds it limited and prefers to use his own IOtech ZonicBook for measuring vibration and speed from his customer's accelerometers and tachometers. He finds the ZonicBook convenient to carry on trips to different facilities and easy to set up with his laptop computer anywhere in the plant.

"Vibrations at one stage on the line can upset the roller calibration not only at that stage, but also at another stage downstream from it," says the consultant. "I place capacitive type accelerometers next to the screws located on top of the mill that can measure very low frequencies." Vibration and tachometer measurements are synchronized and correlated using an FFT algorithm with a waterfall presentation. "This maps out a graph of events that defines the rolling coil of steel. I record this high-speed information for two to three minutes, then I use special software to process the data and highlight the critical frequency information for the bearings and the mesh frequency of the gear teeth," he continues. The ZonicBook also takes information from the thickness gages at the end of the mill. The system tracks the tachometer and thickness perturbation data from each rolling stand in a specific order. After the consultant analyzes the accelerometer signals he can identify the rolling element on the stand that produced the thickness variations.

"Some of the data we gather with the ZonicBook are quite revealing," he says. "For example, we had a problem with one line in a tin mill that repeatedly yielded substandard surfaces. We discovered that the spindle gears were generating a 161 Hz forcing function that produced 5th octave chatter." The geared couplings contain as much as 0.020 in. of slop. The consultant had the geared spindles replaced with universal joints at that location and eliminated the chatter and increased the tin mill's quality. By comparison, the universal joint slop is typically only 0.002 in., a 10 times improvement.

"The eZ-Analyst software from IOtech is easy to use and presents the data in a number of formats that is convenient and useful," says the consultant. "In addition, I use third-party software to insert the cursors and calculate critical frequencies. I examine the waterfall presentation and use a color format to highlight the vibration intensity."

Conclusion

An independent consultant, uses the IOtech ZonicBook to measure vibrations and analyze problems on cold and hot-strip rolling mills as well as continuous casters. He finds the ZonicBook fast and easy to set up and use. The software also provides him with a variety of data presentations that help him pinpoint the source of the problem. The FFT algorithm and waterfall presentation combined with eZ-Analyst software are extremely helpful to him in diagnosing faults.

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