

New Automatic Engine Balancing Technology Controls NOx and CO Emissions

Operators of slow-speed, integral engines have a new option to help reduce emissions, cut fuel consumption, decrease wear and improve overall machine availability. All of these benefits result from a properly balanced engine - and can now be achieved using a recently introduced system from Windrock (a Dover Company). The technology, called the AutoBalance™ system, automatically maintains optimal balance on engines 24/7.



Integral engine equipped with Windrock AutoBalance system (above)

Windrock's AutoBalance system provides continuous, peak-pressure balancing for large-bore natural gas fired engines. The system is designed for slow-speed, integral engines such as Cooper-Bessemer, Clark/Dresser, Ingersoll-Rand, Worthington, and other two- or four-stroke engines with individual cylinder fuel adjustment valves. Typical applications for these engines include natural gas gathering, transmission, processing and storage.

“Engine operators in these applications face increasing pressure to reduce emissions,” says Steve Follmar, VP\ General Manager of Windrock. “Although the exact impact of upcoming emissions regulations remains to be seen, we anticipate a broader range of large, stationary engines will be required to comply with increasingly stringent emissions restrictions”.

“Manual engine balancing is labor-intensive, time-consuming and, in most cases, is not performed frequently enough to guarantee the units are always in compliance with their permits. Tighter emissions regulations will only add to the burden as operators are forced to balance engines more frequently in an attempt to remain in regulatory compliance. To date, the only other option has been auto-balancing using high-pressure fuel injection systems, which are extremely expensive.

“The Windrock AutoBalance system was developed to be a more practical alternative. Compared to high-pressure fuel injection systems, an AutoBalance system is economical and easy to install. And unlike manual balancing, it maintains constant engine balance over extended periods without any human intervention.”

System Description

Components of the system include:

- Stepper-motor actuated fuel valves (replacing manual valves)
- Pressure sensors on each cylinder
- Windrock E-Guard on-line pressure monitor
- AutoBalance module to control fuel valve positions

All components are Class 1, Div 2 rated. The AutoBalance system is easy and inexpensive to install. The system incorporates self-diagnostics and requires no maintenance other than semi-annual, on-engine sensor calibration during normal unit operation.



Windrock AutoBalance module

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Principle of Operation

The AutoBalance approach mimics traditional engine balancing, except that it is performed on a continuous basis instead of a regular time interval (manual balancing intervals may vary from weekly, to month or quarterly, depending on operating company policies). The objective is to adjust fuel flow to each power cylinder in order to maintain peak firing pressures to $\pm 5\%$ of engine average.

The E-Guard module measures peak firing pressure (PFP) statistics and angles for each power cylinder. Proprietary balancing algorithms utilize PFP feedback and combustion statistics to control fuel valve changes. These changes not only balance peak firing pressures, but also optimize the consistency of combustion. Peak pressures are continuously maintained at a consistent level across all power cylinders of the engine.

Results

Eliminating unbalanced operation across all operating conditions enables the engine to run with the minimum possible NOx and CO emissions for the engine configuration. The AutoBalance system has demonstrated $>25\%$ reduction of NOx emissions (compared to standard controls), with emissions maintained at $\pm 5\%$ of average, despite differing ambient conditions, varying speeds and changing loads.

By maintaining optimum mechanical operating condition, the AutoBalance system practically eliminates

detonation and uneven load distribution, dramatically improving reliability and reducing mechanical wear. Precisely maintained PFP balance also improves fuel economy from 1% to 5%.

Combining Windrock's AutoBalance system with improved air-fuel ratio control and/or pre-combustion chamber retrofits, allows emissions to be reduced to levels approaching high-pressure fuel injection systems, but at a significantly lower cost.

As emission regulations tighten and companies look for more environmentally responsible ways to operate, Windrock's AutoBalance system offers a practical solution.

About Windrock

Windrock, Incorporated, provides monitoring and diagnostic equipment for reciprocating machinery in the oil, gas, marine and power generation industries. Founded in 1989, Windrock is based in Knoxville, Tennessee.

Windrock engineers, manufactures and distributes portable analyzers and online systems. The company also provides technical support services with extended service contracts. Windrock analyzers and systems collect and process a variety of information, such as dynamic engine/compressor pressure, vibration, ultrasonic data and other parameters. This information is used to assess the mechanical condition of machinery and optimize maintenance practices.

Motor actuated fuel valves (right)

