DIGITAL AND ANALYTICS

ABB's ORKAN designed to test ABB Ability™ powered machines

ABB's advanced multipurpose test rig for ABB Ability™-powered machines provides capabilities in advanced control methods, condition monitoring design and evaluation of industrial compression systems – contributing to breakthrough technologies that are important for the oil, gas and chemical sector.

Piotr Lipnicki
Daniel Lewandowski
ABB Corporate Research
Kraków, Poland

piotr.lipnicki@pl.abb.com
daniel.lewandowski@pl.abb.com

Diego Pareschi
ABB BV
Rotterdam, Netherlands

diego.pareschi@nl.abb.com

Nowadays, modern manufacturing is undergoing a renaissance – the Internet of Things (IoT) – connected factory is not only linked with devices, systems, computers and humans to attain heightened levels of monitoring, information gathering, analysis, processing and communication in real-time but is also intrinsically connected to information platforms that leverage data and advanced analytics for optimization, decision - making and predictions →1. The proper interaction of all these aspects translates to improvements in efficiency, throughput and overall cost of operations for industry customers. Nevertheless, industrial equipment, which ranges from relatively simple devices to complex machines, must cope with diverse processes such as physical, electrical, mechanical as well as parts responsible for process regulation eg, controllers.

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If centrifugal compressor peak head capability and minimum flow limits are reached, instability ensues and surge will occur – a serious threat to the compressor and the entire installation.

This ever-growing interconnectivity and variety of functions that operate simultaneously mean that today's equipment function reliably and efficiently even under demanding conditions. It is no small wonder that the increase in mutual interactions causes confusion that not only results in additional costs but can lead to equipment or installation failure.

There are many modern production facilities and installations that use drivetrain systems, IT infrastructure and devices that might be susceptible to failure or disturbances originating in the power grid. In many cases, equipment that is critical for plant production processes may be also the root cause of anomalies and adversely influence the power supply itself. The cost of these power quality disturbances for a plant may be dramatic and prohibitive and have a significant adverse impact. Therefore, unplanned severe system shutdowns should always be avoided.

The ability to analyze electric systems is a prerequisite for industries to protect their equipment from grid disturbances and ensure proper functioning within complex systems. Consequently, measures must be taken to mitigate the effects of grid disturbances. Such an approach will establish the possibility of critical ride through capabilities,

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Title picture. Compressors are vital to the OGC sector: upstream, midstream and downstream.

thereby allowing installations to remain operational – a feature that assures safety and continuous profitable operation.

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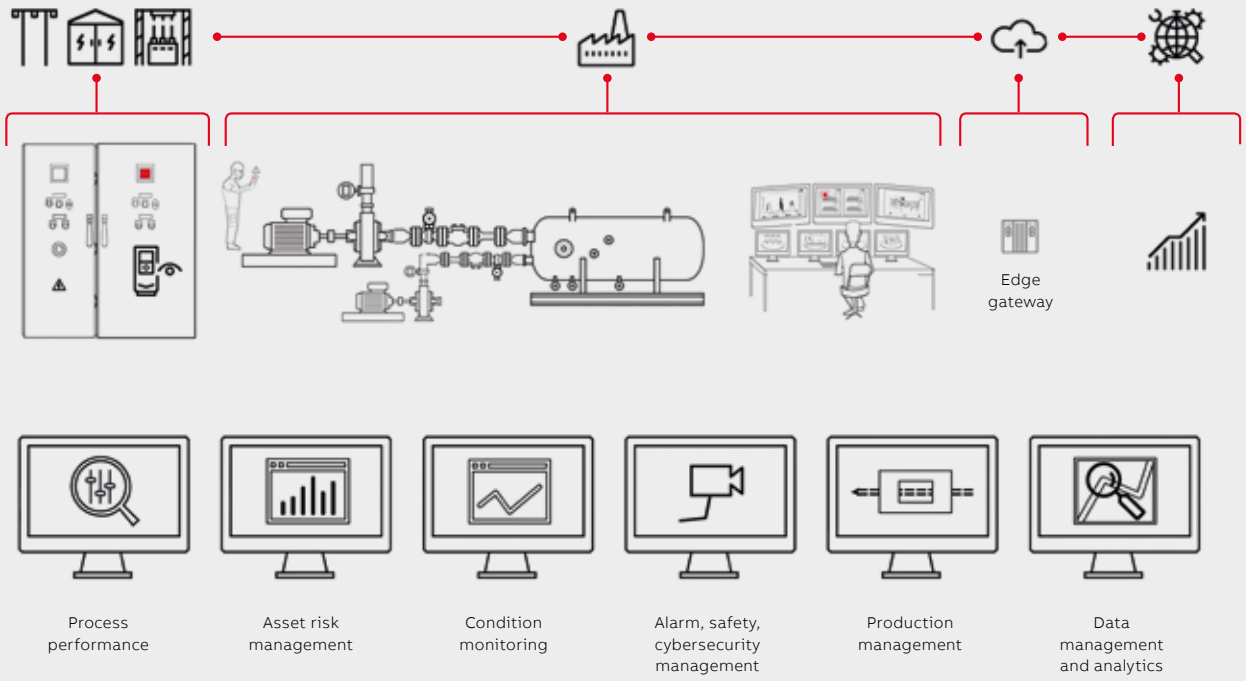
Financial losses incurred as the result of impairment can rapidly accumulate to amounts higher than the purchase price of the compressor.

ABB's pioneering technology solutions enable ABB to play an active role in the burst of innovation currently underway in the fourth industrial revolution.

By combining deep domain expertise with unparalleled experience in connectivity, ABB enables customers to know more, do more, reach more – this dedication to customer service has been a key ABB strategy since its founding more than 130 years ago.

To remain at the forefront of digital and technological innovation, ABB develops intelligent concepts that are verified by means of design review, advanced model simulations and rigorous experiments conducted under strictly controlled conditions, especially with relatively small-scale setups. The ORKAN compressor test stand is one such setup →2.



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ORKAN – compressor test stand

Oil, gas and chemical industries are reliant on the compression and transport of gas. These processes are responsible for the largest share of the energy consumed by the chemical industry. To improve efficiency, flow compressors are widely employed in many industrial installations. Due to stringent requirements on volumetric flow and pressure ratio, the design and construction of these devices are important. Also, the design performance will largely determine its energy consumption.

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ORKAN is used to test the influence of electric faults, assess stability and further develop ABB solutions that protect machines from flow disturbances.

Engineers have continuously improved construction of flow compressors since their first use more than a century ago. The advanced construction and superior reliability of flow compressors promoted their current popular use in many critical applications eg, gas pipelines. However, this ubiquitous use and reliance on flow compressors necessitate strict compressor reliability requirements.

Equipment failures must be avoided as they can lead to financial losses and safety issues. Financial losses incurred as the result of impairment can rapidly accumulate to amounts higher than the purchase price of the compressor. Therefore, a strong business case exists for the development of a robust and accurate condition monitoring system to keep these compressors fully operational.

To be helpful, any condition monitoring system requires deep knowledge of these complex machines. Centrifugal compressors operate with the highest efficiency within the stable range near the border between the stable and instable operating area; it

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01 ABB collaborative operations deliver actionable insights to optimize performance.

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02 Orkan test rigs are shown-Kraków, Poland.

02a ORKAN test stand 1.

02b ORKAN test stand 2.

is difficult to remian within this operating region. If centrifugal compressor peak head capability and minimum flow limits are reached, instability ensues and surge will occur – a serious threat to the compressor and the entire installation. The longer the compressor operates in this condition, the greater the risk of serious damage. With this in mind, the accurate control of the compressor system is the goal.

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Since 2012, ORKAN has been testing the integration of different ABB technologies with remote cloud and local solutions.

The application of a condition monitoring system yields potential rewards, with advanced algorithms offering both the promise of transformational gains in safety and additional compressor throughput. The ORKAN test rig was developed by ABB for this purpose. It features two machines to reflect multiple types of applications (eg, series and parallel operation) and to replicate operations in real-world plants →2.

The rig is used to test the influence of electrical faults occurring at the process side, assess stability for diagnostics purposes and to further develop ABB solutions that protect machines from flow disturbances. In recent years, the test rig has been successfully employed to develop and test multiple solutions including stand control modes such as grid disturbances modes, supply control modes (electric and mechanical) process control modes (basic process control, suction pressure control, discharge pressure control, and anti-surge control).

The test stand is equipped with ABB devices such as: ACS880 and ACS850 low-voltage drives, two induction motors, AC800 PEC controller, AC500 High Performance, AC500 CMS PLCs, Emax circuit breaker, and a variety of flow, pressure and temperature sensors. The inclusion of an ABB ServicePort application allows all users to view, scan and track all key performance indicators (KPIs) to enable maximum performance of the compressors and the processes involved →3.

Case studies

Since 2012, the test stand has become a pioneering platform to test the integration of different ABB technologies with remote cloud and local solutions - for example, equipment condition monitoring and diagnostic algorithms testing, and evaluation of the interaction between control and diagnostics systems. By combining control and diagnostics, ABB solutions give customers a competitive advantage. ORKAN is also used as a test bench for large-scale data gathering and for evaluating IoT and cloud solutions →4. In addition, the test stand has multiple communication protocols implemented. These key features promote versatility in connectivity engineering design, analysis and testing. The vast amount of data gathered during tests permits exploration of different methods of analysis: condition monitoring through diagnostics and prediction – a necessity for industries such as OGC.

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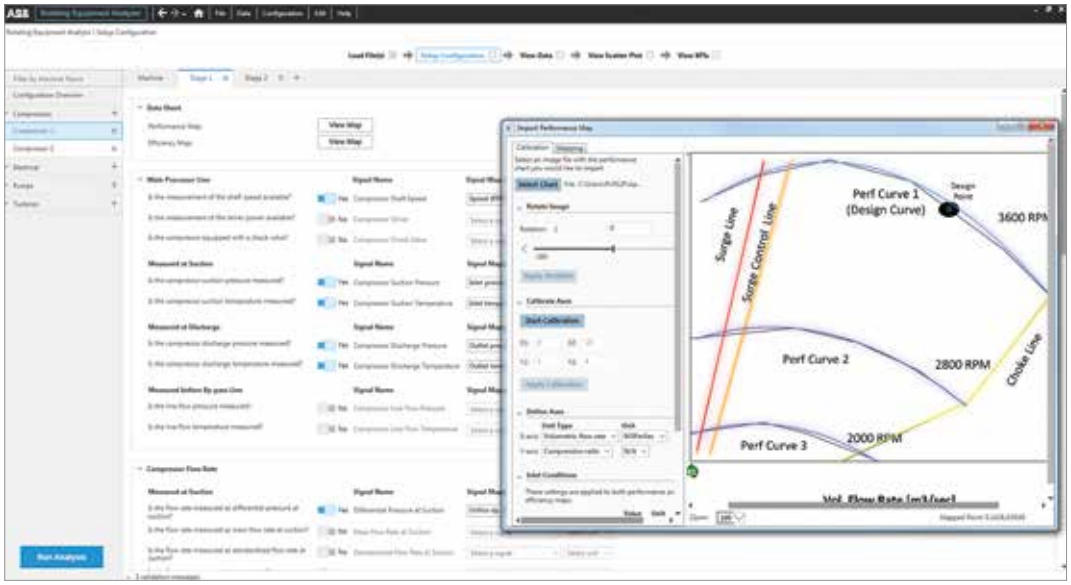

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The test stand studies include the analysis of crucial deployment strategies to answer the questions: How will the end user exploit the results of the analysis? How can the results be presented in an intuitive way? A primary goal of test stand investigations is to tailor the solutions for different use cases – end users of data such as service engineers, operators, maintenance managers; mechanical, electrical and process departments; and condition monitoring experts, among others. It is also important to obtain simple meaningful and actionable insights. These perceptions translate to: traffic light-type status indication, clear statements on current and future health and the possibility to drill down to the root cause of issues, among others.

The test stand has also been adopted to investigate the ABB Ability Rotating Machines Analytics solution, which integrates wireless sensors and compressor control systems with the ServicePort platform.

Recent activities

The development of accurate control and condition monitoring methods is dependent on much more than the use of sophisticated simulation models. Even complex simulations do not reflect the real world nor do cross-correlations of various parameters describe all processes of importance to compression systems or deliver outcomes that completely replicate nature. Moreover, the successful operation of theoretical solutions in numerical environments does not guarantee that the solutions will function in reality.

The accumulation of possible disturbances, inaccuracy of parameters and the large degree of model idealizations typically employed can make the most advanced theoretical solution completely useless in the real world. For this reason, artificial intelligence (AI) or machine learning (ML) are considered good test cases for operation verification on this test stand. In November 2016, ORKAN was first used to develop and test technologies for ML and predictive diagnostics for rotating machines, which are critical assets in the OGC sector.

Since 2017, the test stand has also been adopted to investigate the ABB Ability Rotating Machines Analytics software suite, which integrates wireless sensors and compressor control systems with the ServicePort platform and its inherent connection with the ABB Ability™ cloud →3.

Shaping the digital future

Taking a leap into the future of industry today, ABB is developing a unified, cross-industry digital capability – extending from device to edge to cloud – with devices, systems, solutions, services and a platform that interacts optimally together. ABB Ability delivers just that capability. Moreover, ABB has embarked on the next step, to create a digital representation of sensors, devices and systems – a digital twin – practically an identical copy of the physical devices.

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03 ServicePort rotating channel display shows surge potential.

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04 Display of DL400 software tool used to gather data to assess process and control system performance.

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Footnote
1) See also "ABB's Electromagnetic flowmeter digital twin drives performance", on page 58 of this issue of ABB Review.

The test rig takes advantage of digital twin capabilities. The digital twin requires a consistent data model that contains the measured variables and the mapping that leads to a digital representation. This function requires that measurements easily reach the digital twin representation, which in turn, necessitates the engineering of a communication infrastructure. To be an adequate approach, this sophisticated infrastructure must be tailored to the digital twin and its unique object. ABB fosters this approach to breakthrough digital industrial technologies at its global corporate research centers[1]. Nevertheless, to take full advantage of the rapid advances in digitization, industry would require not only a digital mirror, but a virtual representation with capabilities different from the actual physical object – a digital avatar. Like the twin, the digital avatar is a digital object that represents the real world but, unlike the digital twin, the avatar can interact within the digital world in ways that differ from how the object would typically respond in the real world. Always at the forefront of innovation, ABB is currently exploring this concept.

ORKAN is an ideal setup to embrace and incubate the disruptive technologies; to explore and test digitally transparent connected devices and systems as well as digital-enabling services.

Outlook

The birth of technological innovation is dependent on environments that promote invention, design, simulation, experimentation and the ability to deploy novel technologies and solutions. These core bench capabilities are an essential starting point that allows business to capitalize on advances in technology and compete successfully in the digital race toward the future.

The ORKAN multipurpose rig satisfies all of these requirements and more. It is an ideal setup to embrace and incubate the disruptive technologies; and to explore and test digitally transparent connected devices and systems as well as digital-enabling services. ORKAN is a part of ABB Ability – the unified, cross-industry digital capability, from device to edge to cloud. ●

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