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**Innovation in compressor technology improves energy saving and  
cost of ownership for power generation sector.**

*Air and gas compression is an essential service within power generation plants worldwide and operators place a premium on reliability as a compressor breakdown can have a significant impact on overall plant performance. Yet the total cost of ownership, especially in energy costs and maintenance, is an increasingly important factor. Now, the latest developments in compressor technology, with centrifugal compression assemblies, provide an impressive technical solution.*

**Rob Hall, CompAir SA**

Compressed air is used extensively in the power generation sector in a number of applications, for example providing instrument air, supporting plant auxiliary services or for turbine cleaning after a fuel change.

Power generation plant operators are understandably most concerned about the reliability and consistency of the air compressor plant performance. Anything that can prevent the power generation operating efficiently has to be eliminated.

However, at a time when energy prices are under intense scrutiny, generator plant operators also need to ensure they are achieving the lowest cost of ownership, accounting for initial purchase and installation, in life maintenance and the energy cost required to run the compressors.

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Obviously quality and safety issues are a 'sine qua non' for any equipment operating in a potentially hazardous environment and operator safety is also a key consideration.

The leading compressor manufacturers are constantly seeking new ways to balance this need for optimum reliability with lowest cost of ownership and a number of compressor designs ranging from, piston, screw and vane types all offer different features and potential drawbacks.

For example the dry screw design can offer good reliability, however these installations face high maintenance costs, especially when an air end may need replacement after 24,000 hours operation.

This search for the optimum combination of reliability and cost has recently seen a major breakthrough with the introduction this year of the new Quantima compressor by CompAir, which is based on an innovative centrifugal compression technology.

Before discussing this new technology in more detail it is worth setting the scene by looking at a typical modern power generation plant and establishing where air compression is most likely to be required.

A typical example can be seen at AES Cartagena, a combined cycle gas turbine generation (CCGT) plant in Spain, which began full commercial operations in December 2006. The 1,200 MW CCGT facility is located on Spain's southeastern coast and has the capacity to generate enough energy to power approximately 300,000 homes in the country.

In this US \$920 million project AES Cartagena buys gas from and sells power to GDF International (GDFI), a subsidiary of Gaz de France, under a 21-year energy agreement.

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The plant normally operates on natural gas but is also commissioned to operate on oil when the natural gas supply is interrupted. When normal supplies are resumed, the turbines and pipes require thorough cleaning to remove any oil residue before the gas can be put back into the system, requiring a large volume of compressed air.

International specification for electricity plants dictates that oil-free compressed air must be used, to avoid contamination, and in this installation the requirement was achieved by using six high-pressure Reavell H5236s compressors operating at 24 bar.

In addition, Dryclon compressors for plant auxiliary services and two D37 H units for instrument air were selected, with the entire system specified to produce a maximum air capacity of 3400 Nm<sup>3</sup>/h, all controlled by a Delcos 5000 monitoring system. The complete package was supplied as one project including all necessary air dryers, filters and storage tanks.

The Delcos control system monitors the air station continuously and selects the best combination of compressors to provide the appropriate volume of air across the entire plant.

Rotating compressor usage in this way minimises component wear, reduces maintenance concerns and extends equipment life to improve overall cost of ownership.

With the single-stage DH compressors, for example, the traditional oil system has been replaced with simple water lubrication, meaning that there are no filters to be changed, no waste oil to dispose of and no condensate to treat.

The instrumentation plant compressors are water lubricated which reduces air temperature for near isothermal compression and, the direct drive motor, with no gears or belts, helps to optimise power transmission.

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It is this philosophy of minimising the moving parts in a compressor, both to improve efficiency of operation and to reduce maintenance costs, that led to the five year, multi-million rand investment programme in developing the high-speed centrifugal compression drive at the heart of the new Quantima unit, launched in South Africa in May 2008 by CompAir SA.

At the heart of the new compressor is the Q-drive, centrifugal compression assembly. This high-speed motor, incorporating direct-driven compression impellers, operates with the rotor levitated by active electromagnetic bearings and spinning at up to 60,000 revolutions per minute.

Unlike conventional compressors, this drive assembly has only one moving part, the rotor shaft, which has no contact and no wear, spinning in a magnetic field. In addition, the induction motor design and high frequency inverter mean that no gearbox is required and that the compressor can operate without any oil lubrication.

This results in a package that consumes far less power and which is approximately half the weight and physical size of equivalent compressors, meaning that it can be sited easily into existing plant rooms.

Typically a 300 kW compressor will have noise levels around 74 dB (A) and above, whereas this new unit is housed in a modular acoustic canopy, resulting in low noise levels at just 69 db(A). This allows the compressor to be installed at the point of use and not in a separate building and enables operators to work comfortably without any ear protection.

The combination of these features results in a fundamental shift from the oil-free compressor technology currently in use today – there is not a single drop of oil where existing technology includes complete oil systems; no gears where other compressors have seven; just four bearings where other compressors have nineteen; and only two seals where others have seventeen.

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This simple construction means that there is no performance degradation over the life of the compressor, unlike other standard technologies where degradation of coatings and friction between multiple moving parts can compromise efficiency and lead to a reduction in airflow.

One critical aspect of the design is the ability to minimise off-load running and to ensure highly efficient operation at all times. The variable-speed drive matches air output automatically to plant requirements, meaning that precisely the right amount of air is being produced at any one time.

However, even when the unit has to run off-load, it still provides very low power consumption, at just 2.5% or 7 kW for a 300 kW compressor, helping operators to limit energy use when the process does not require compressed air.

This is an important factor when energy costs account for more than 80% of a compressor's total cost of ownership. These features in the new compressor technology combine to provide energy savings of up to 25%. It is estimated that a customer replacing an existing compressor with a new, 300 kW Quantima unit and making energy savings of only 20% would save over 5,500,000 South African rand over a 10-year operating cycle.

These features also make the new unit an attractive proposition for operators keen to improve their environmental credentials, with the potential to cut CO<sub>2</sub> emissions by up to 2,000 tonnes\* by consuming less electricity.

\*For a 300 kW Quantima unit over a ten-year period, compared to traditional screw technologies

The optional energy recovery kit adds an additional saving, by recycling up to 75% of the wasted heat from the compression process, which can be used to power other factory process such as the hot water supply.

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Ease of use is also critical to efficient operation, minimising operator training and error rates. The intelligent Q-master controller features a touch screen panel, offering intuitive, menu-guided operation that requires minimal user training. Operators can see, at a glance how the compressor is performing, with key parameters logged and trended to provide easy access to information.

Plant managers can also receive regular, detailed reports of the compressor's overall system performance, helping to improve plant efficiencies further.

It is also important to remember that maintenance and service can equate to around 8% of a compressor's lifecycle costs and unplanned repairs cause costs to escalate.

This has led manufacturers to implement a number of options for maintenance, for example conventional preventative maintenance, which focuses on agreed service schedules but which still requires the unit to be taken out of service at routine intervals and the parts and components maintained or changed on site.

This is now being superseded by predictive maintenance, which helps to prevent unscheduled downtime, by tracking the compressor's operating parameters and performance to predict when parts or components will need servicing or replacing.

For example, each new Quantima compressor incorporates remote monitoring technology as standard, which enables CompAir to monitor all operating parameters on every compressor remotely.

This means that the manufacturer can fix the part before it fails, by identifying problematic components long before routine replacement would normally take place. If the remote monitoring centre does identify a potential failure, the customer will be contacted in advance to schedule a suitable service time.

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The local engineer will then arrive at the customer's site, with prior knowledge of the issue and all the necessary parts to carry out the service or repair quickly and professionally.

This leads to a completely inclusive service package, providing maintenance and repair of any component for a single, annual fixed cost, allowing operators to budget accurately and avoid unplanned service expenses completely.

In summary, it is clear that the latest wave of investment in new compressor technologies, especially the use of centrifugal compression drives, enabling the number of moving parts to be reduced significantly, is a significant step forward for power generation plants. This technology enables operators to achieve the optimum balance of total reliability and lowest cost of ownership, when selecting compressors for new or existing plants.

**Should you require any further details on the Quantima compressor please contact:**

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