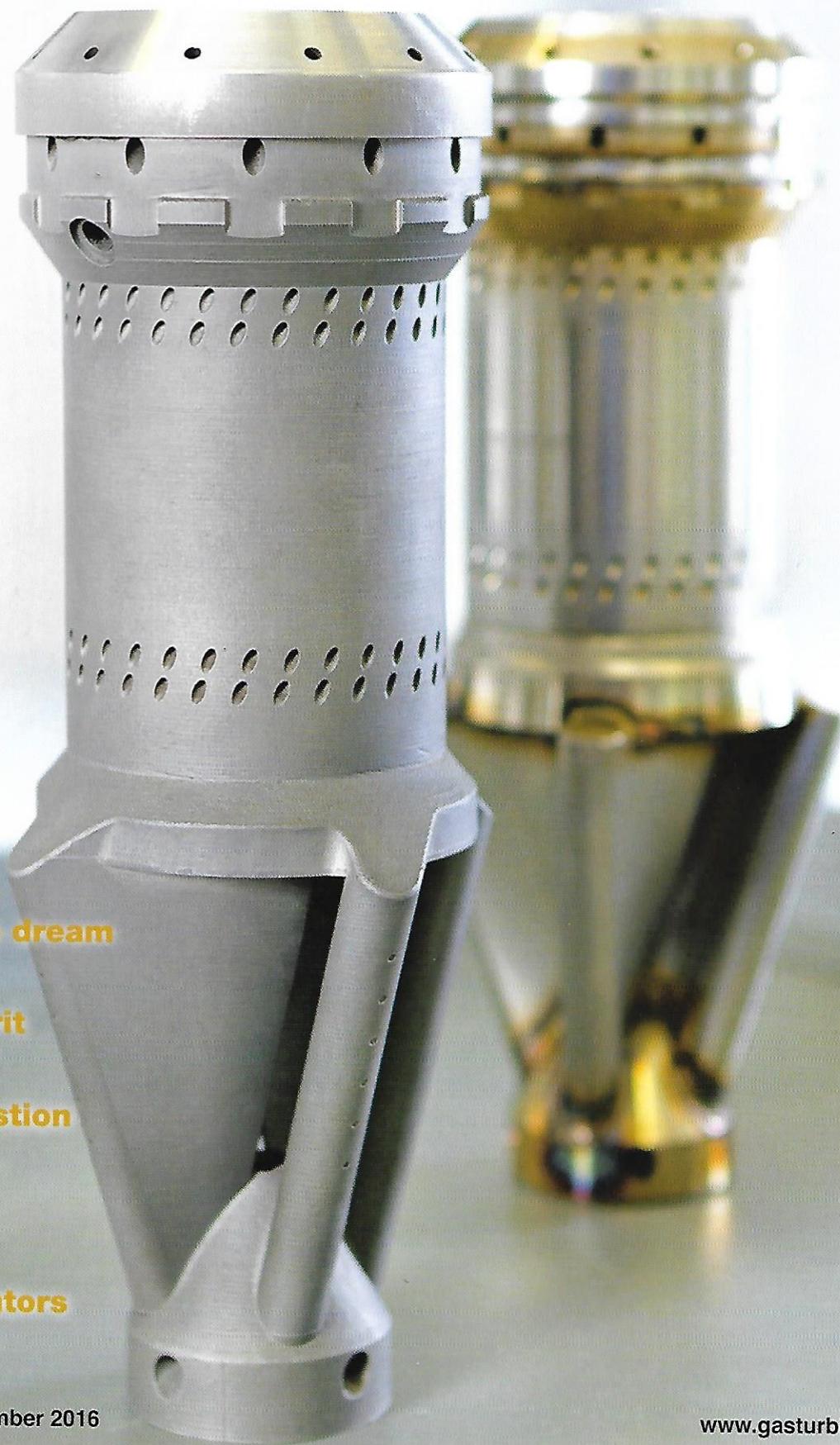


Gas Turbine World



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Major market trends favor 4-pole generators

Demands for larger gas turbine generator sets are focusing attention on 4-pole generators, which are now available up to a maximum output of 85 MVA. Advantages over 2 pole units include lower investment and running costs, reduced maintenance requirements and a smaller footprint. The generators can be used with the new CAWA (Cooling from Air-to-Water-to-Air) integrated water cooler for a very compact solution.

Turbine OEMs, packagers and end users are increasingly demanding higher generator power outputs. Generating more power with fewer, larger turbines helps to keep capital expenditure (CAPEX) down. At the same time it ensures that the package has the smallest footprint to make the most efficient use of the minimal space available. This trend favors larger 4-pole generators, with power outputs reaching the 80 MVA class.

Another trend that requires generators with higher power output is the desire to get more power from the same size turbine – either by cooling the turbine’s inlet air or by replacing it with an upgraded engine design.

There is also the issue of short-circuit peak current increasing in importance with higher total power output. This requires higher reactance to limit the current, which again results in the need for higher generator output.

Advanced 4-pole technology

“What happens is that some of these trends lead to de-rating – the generator is dimensioned for a higher power than is actually required,” says Anders Stiger, ABB’s Product Market Manager, Generators for Steam and Gas Turbines.

“When de-rating is needed – for high power applications in hot environments with air-to-air cooling, for example – customers previously had to use a 2-pole generator because it was the only solution available. Now we can offer advanced 4-pole technology which not only increases the actual maximum power levels, but also the power in hot

ambient conditions.”

“We now supply 4-pole generators for mid-size gas and steam turbines up to a maximum output of 85 MVA. As a result, 2-pole technology is no longer the only choice at these power levels. And the trends described – the demand for fewer but larger turbine gensets, boosting power by cooling the turbine inlet air, and the need for higher reactance – are further reasons to opt for the new 4-pole units,” says Anders Stiger.

Designing for high efficiency

ABB says the new 4-pole generators also enable higher speeds. “Steam and gas turbine manufacturers are looking



ABB supplies 4-pole generators for mid-size gas and steam turbines up to frame size 1400, enabling a maximum output of 85 MVA. Both 50 and 60 Hz versions are available.

to increase speeds in order to boost efficiency by operating their turbines in a more favorable range,” said Stiger.

By using a gearbox, OEMs can freely select the turbine speed and optimize the design for the lowest cost and highest efficiency. The result is a quiet turbine package with lower running costs. At the same time the need for cooling water and lubrication media is reduced by as much as 30%.

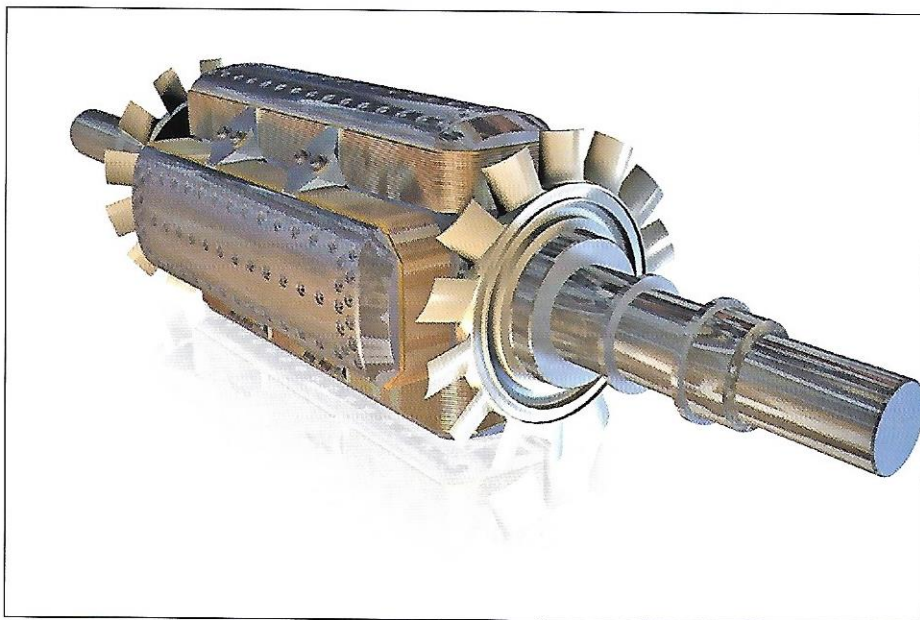
Lower costs and downtime

Stiger noted: “I would say the biggest benefit of larger 4-pole generators for customers is the lower CAPEX requirement – investment costs are typically 20-30% lower. Compact size is also a major advantage. These units are 20-30% shorter than the equivalent 2-pole generators, and they are around 20% lighter.”

Compared to 2-pole units, 4-pole generators offer simplified maintenance. Their long maintenance intervals mean that they can fit in to the turbine service plan, so no extra stoppages are needed for separate generator servicing. They are also more rigid than their 2-pole counterparts. As a result they offer better reliability to cope with the stresses posed by frequent start-stop operation, which is increasingly common. By contrast, these types of operating mode can be a major problem for 2-pole units, which need to run over the critical speed area every time they ramp up and down.

Excellent speed stability

The technology to enable 4-pole generators to be manufactured up to 85 MVA



The solid, salient 4-pole rotor design operates below the first critical speed, which helps to improve the generator's vibration characteristics.

has been developed by ABB. The solid, salient 4-pole rotor design operates below the first critical speed, as opposed to a cylindrical 2-pole rotor that has to pass it. As a result there are no forbidden speed areas in the operating range, which helps to improve the generator's vibration characteristics.

Solid, salient 4-pole rotors also provide high inertia, ensuring excellent speed stability for the turbine drive train system. There is no need for damper windings, which contributes to high reliability and a long lifetime. Maximized rotor coil surfaces, together with symmetrical air flow that avoids hot spots, result in highly efficient and evenly distributed cooling.

New compact CAWA cooler

ABB has also developed the CAWA cooler, a compact integrated water cooling package that is ideal for offshore applications. Up to now, cooling for totally enclosed generators has been based on either air-to-air (CACA) or water-to-air (CACW) type heat exchangers. Higher efficiency is achieved with water coolers, CACW, but they require availability of a separate cold water system. The conventional solution for facilities where no water supply was available has been a CACA cooler. This is less efficient and more expensive than CACW,

and the cooling system is much larger – up to three times the size of the generator itself. CACA coolers also mean long lead times.

The new CAWA cooler offers over 60% weight reduction compared to CACA. CAWA means Cooling from Air-to-Water-to-Air, i.e. from the primary internal air circuit to the secondary closed water circuit and then to ambient air (IC 8A1W7 as described in IEC 60034-6). The CAWA cooler is an independent, closed-circuit cooling system mounted on top of the generator. It is built using standard components and delivered with a water mixture installed, providing a 'plug and play' solution similar to CACA coolers.

Figure 3 shows the CAWA subsystems. The grey unit at the top is the air blast cooler (CACW). This water heat exchanger has six fans to cool down the water coming from the machine cooler – the generator secondary cooling circuit's water cooler. The fans can be operated by a temperature controller (not included) that monitors the generator's internal air temperature. This saves energy by running only as many fans as needed. One of the fans is reserved for 20% redundancy.

The grey unit on the side is the machine cooler (CACW). This water heat exchanger cools down the internal air in

the generator's primary cooling circuit. The generator uses its own shaft-mounted fans to circulate the hot internal air through this water cooler.

The piping system (on the left in grey) includes two pumps for 100% redundancy and circulates the cooling medium (water/30% ethylene glycol mixture) between the two-cooler unit.

The CAWA cooler is a cost saving design with shorter manufacturing lead times that enables a higher maximum output power from the same generator frame size. OEMs can supply higher powers using their standard turbine skirts because the same generator size can deliver wider power levels. This improves both the performance and economy of the turbine generator set.

Stiger commented: "Platform operators with CACA cooled generators can also use CAWA to increase power. By replacing their CACA units with CAWA they can avoid the need to invest in new generators. The compact CAWA cooler can easily cope with high wind loads offshore. It runs on low power, unlike the main water pump which an emergency generator cannot operate during a black start. CAWA coolers offer built-in redundancy for both blower and pump capacity, which helps to ensure high availability." ■

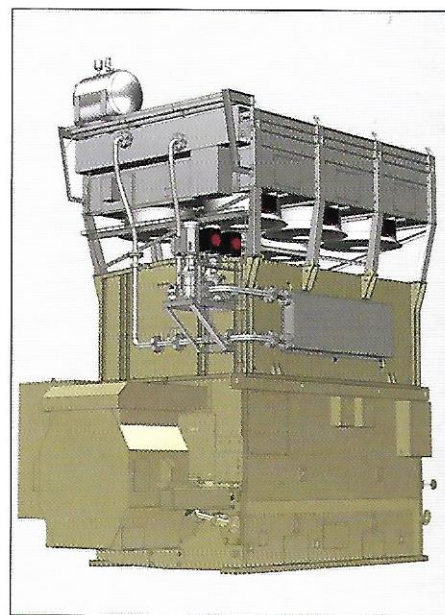


Figure 3. The CAWA cooler is a 'plug and play' closed-circuit cooling system installed on top of the generator. The drawing shows the CAWA subsystems.