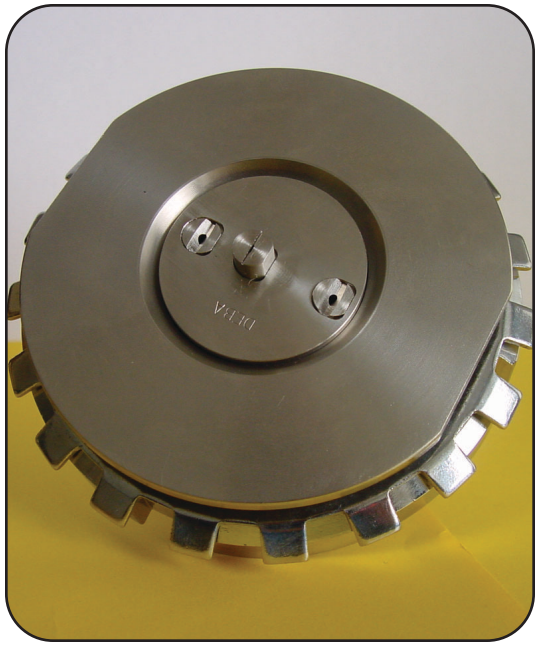
Wash Nozzles Designed for Larger Turbines



The new PSA Mark3 nozzle assembly from Turbotect is designed to handle a mixture of water and air and is intended for newer large gas turbines. The nozzle operates at a pressure of 4 bar and guarantees a droplet size in the 50 to 250 micron size.

By Roberto Chellini

Dust and soot carried by gas turbine inlet air not trapped by the air filter will stick to the compressor inlet guide vanes (IGV) with a consequent and progressive reduction of turbine output. To prevent this, it has become a common practice to clean the compressor IGV with an on- or off-line process to recover the lost power output translating into lost revenue.

Both systems show advantages and disadvantages. With an off-line procedure, cleaning is performed in a more efficient way and the power recovered is greater, but the machine has to be stopped for many hours with a consequent loss of production. The on-line washing is performed while producing energy. However, it does not recover all the power losses, but can be combined with off-line washing performed at longer intervals.

OEMs and independent companies have developed several low- and high-pressure washing systems and the Swiss company Turbotect, with 15 years of experience, can be considered a pioneer in this field. However, water spray nozzles of the first generation were developed for older gas turbines which, compared to the industrial gas turbines now on the market, featured much smaller sizes.

Bell mouth size, mass flow, and air velocity of newer, larger gas turbines, have increased to such an extent that the first generation of water spray nozzles showed their limits. In fact, the combination of the above stated characteristics makes it more difficult for the water spray to penetrate the boundary layer, allowing the air stream to deflect the water droplets in their mid-course trajectories before they have reached the required penetration to uniformly wet the vanes surface. An additional danger of poor performance is that excessive and often deflected water concentration will cause erosion in a defined blade area, while soot will accumulate in the dry area.

According to Turbotect, increasing the water flow does not improve the washing performance. Excessive water will be wasted to wet struts, walls and bell mouth surfaces with no benefit to the turbine output, but with a waste of cleaner and demineralized water.

Turbotect patented the PSA Mark1 nozzle developed at the start of the 1990s for gas turbines most in use at that time. This nozzle is still produced, and used for the range of small- and medium-size industrial gas turbines.

To solve the problems encountered on large gas turbines, Turbotect has now made available the patent pending PSA Mark3 nozzle capable of handling a mixture of water and air.

To increase the water spray penetration through the boundary layer and avoid premature deflection of the spray from the main stream of air at the compressor intake, the PSA Mark3 nozzle is of the air-assisted type. The flat profile water spray is, in fact, shielded and sandwiched between two high velocity, flat-profile air sprays.

These dual air sprays protect the water spray, and punch it through the boundary layer and into the main air stream. Water droplets are protected from premature deflection and a longer penetration trajectory is thus ensured.

The PSA Mark3 has been tested by Turbotect on a specially developed test rig and also in the wind tunnel of a Swiss university. Comparative tests of the PSA Mark3 nozzle placed horizontally at 1.2 m height showed that when operated in the conventional way, without air, the water spray wetted a surface at a distance between 0.8 and 2 m. When air-assisted, the same spray wetted a surface between 0.8 and 4.5 m.

The first field applications on large size gas turbines have confirmed all test results obtained in the development stage, according to the company.

Both the PSA Mark1 and PSA Mark3 are operated at low pressure, 4 bar, and guarantee a droplet size in the 50 to 250 micron range. Water consumption of

Water and air connections are made at the rear of the PSA Mark3 nozzle. With air assist, the nozzle water spray wetted an area between 0.8 and 4.5 m.

the new nozzle is almost double the previous model, but also the surface covered is extended so that the number of PSA Mark3 nozzles required is reduced to approximately half the PSA Mark1. In the end, the water consumption remains practically unchanged.

The fine water droplets and the uniform distribution make it possible to use a reduced amount of water and detergent when compared to other nozzles on the market, according to Turbotect. The total fluid required for an on-line cleaning cycle can be reduced by a factor of six.

Both nozzles are flush mounted on the gas turbine bell mouth in two separate ring manifolds spraying upstream and downstream. Both models feature the same nozzle holder so that the new nozzle can be easily mounted to replace the PSA Mark1 on large turbines. In this case, due to the reduction of nozzles required, some nozzle holders will be covered so as not to disturb the air flow.

The fluid used is generally demineralized water to which a cleaning solution is added. Turbotect also supplies its own cleaning solution and has recently introduced, for both on- and off-line cleaning procedures, its water based, biodegradable, Turbotect 2020 detergent. The Turbotect 2020 recommended dilution ratio is normally one part of detergent in four parts of water.

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