

AT THE LEADING EDGE



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Two factors which can affect seriously the performance of a gas turbine and component life are the quality of the fuel and the cleanliness of the air entering it.

For gas turbines burning liquid fuel, the presence of vanadium or alkali metal ash in the hot gas path can lead to high temperature corrosion and hot section fouling resulting in loss of output unless the fuel is pre-treated with suitable inhibitors.

For gas turbines operating on naphtha, gas condensates, and kerosene, lubricity enhancing additives are necessary to reduce poor inherent fuel lubricity and alleviate excessive operational and maintenance issues.

Traffic fumes, fine aerosols, industrial dust, and pollen are among the air borne pollutants which can pass through even the best filter systems, leaving a sticky deposit on the compressor blades which can give rise to significant loss of power in only a few days.

A well treated, and carefully monitored liquid fuel, and a clean compressor are the keys to sustaining high output and long life: the investment can pay for itself in a relatively short time.

With large natural-gas fired combined cycles now the system of choice for power system development in the world, high availability and reliability are key factors for operators in the deregulated market. Regular on-line washing can significantly reduce the rate of power loss for an operating unit. With today's high fuel prices even a small gain in output can give a significant increase in income and overall profitability of the plant.

In this situation if a 250 MW base-loaded gas turbine can lose 4% of its output in a few weeks because of compressor fouling in a polluted environment, regular on-line washing can slow the rate of power loss and considerably extend the time between outages to perform off-line washes on a cooled gas turbine.

Today, the large scale use of gas turbines in combined cycles and industrial CHP schemes has meant that on-line and off-line washing systems are now standard equipment on many gas turbine installations.

One company can supply the chemicals, both for effective liquid fuel treatment and efficient compressor cleaning. Turbotect Ltd founded in 1978, in Baden, Switzerland, specialises in production of gas turbine fuel additives, demulsifiers, and lubricity enhancing chemicals; also detergents for compressor cleaning, and the systems to deliver them. The company also provides consulting services in gas turbine metallurgy and material selection.

But Turbotect's interest goes much deeper than supplying the essential chemicals. Turbotect offers a system called Professional System Approach (PSA) which allows the operator to maintain gas turbine performance by removing effectively any deposits on the compressor blades and vanes and thus enable the machine to operate at its guaranteed performance.

A two year investigation of a gas turbine equipped with an on-line and an off-line washing system has shown how regular on-line washing can recover lost output, and achieve significant extra income for the operator.



*Hyundai Power Company, Korea
Daesan, Siemens SGT6 3000E*



*Iberdrola International and CFE, Mexico
Monterrey, Alstom Power GT24*



*Ministry of Electricity and Water, Bahrain
Rifaa, Siemens Model V93.1 and Alstom GT13D*

THE SYSTEM



*CS Energy Limited, Queensland, Australia
Swanbank E, Alstom Power GT 26*



*Electrabel Nederland BV, Netherlands
Eemscentrale, General Electric Frame 9FA*



*Yamama Cement Co., Saudi Arabia
Riyadh, Siemens SGT 700*

The PSA compressor cleaning system has two main components: the delivery system and the preparation skid. The delivery system is permanently mounted in the air intake structure. It can be installed either by the OEM during construction, or retrofitted during an outage of an operating plant, and is unique to the type of gas turbine and the inlet configuration.

The preparation skid comprises water and chemical storage tanks, chemical mixing system, and the injection pump which is used both for on-line and off-line washing. The whole on-line washing process can also be remotely operated from the plant's control room.

The preparation system is a stationary fixed skid unit, as for example, with each single-shaft combined cycle block, or with connections to several gas turbines on the same site. Both solvent-based and water-soluble detergents can be used, and are equally suitable for use in regular on-line washes or off-line crank washes. A mobile skid can be supplied on demand

For on-line compressor washing demineralised water must be used, to prepare the wash fluid and so avoid the risk of corrosion in the hot parts due to dissolved salts. The liquid must be applied in a fine spray which will ensure the uniform wetting of the whole area of the compressor. The droplets must be small enough that they do not give rise to blade erosion, and light enough that they do not drop out of the air stream before they reach the compressor surfaces.

To achieve this, the Turbotect Mk 1 injection nozzles, with an adjustable atomising spray on a spherical body, are installed in the surface of the intake structure. The body can be rotated to set the spray angle, but penetration of the nozzle into the air stream is minimal. The nozzles are fabricated in stainless steel and are arranged so as to distribute a fine atomised spray into the air stream which is carried uniformly to compressor vane and blade surfaces.

As gas turbines have become bigger with larger dimensions and higher mass flow rates, a new air-assisted nozzle has been developed which has an air jet incorporated in it to accelerate the droplets out into the middle of the air stream. Known as the Turbotect Mk 3 nozzle, the first commercial installations have shown that fewer are required to achieve greater wetting of the blade surfaces with the same or lesser quantity of water as for the earlier Mk 1 system.

As a general rule, the Mk 1 nozzle can be used with gas turbines up to 120 MW capacity. The air-assisted Mk 3 nozzle is best used with gas turbines of greater than 120 MW capacity and is essential for on-line washing with the 270 MW class units which are the workhorses of combined cycle programs around the world.

Usually nozzle sets for off-line and on-line cleaning are installed. An optimised washing program is determined by the site conditions. Careful attention must be paid to the frequency and intensity of the washing and rinsing cycles.

At planned outages with the cold gas turbine, a crank wash can be performed with the off-line system. Turbotect also offers illuminated sight glasses to be installed on the inlet so that the operator can see the first stage guide vanes.

THE PRODUCTS

Fuel treatment

Turbotect fuel additives are formulated to reduce high temperature corrosion of turbine blades by vanadium compounds and sodium sulfates formed when firing crude and heavy fuel oils.

TURBOTECT™ 131, among a range of more than 15 different additive formulations, introduces magnesium into the fuel which reacts with vanadium to form various high melting point magnesium vanadates, interrupting the corrosion process associated with low melting vanadates.

Smoke and particulate emissions

Turbotect offers combustion improving additives to reduce particulate emissions from gas turbines.

TURBOTECT™ 703 is a combined fuel additive to reduce particulates and inhibit high temperature corrosion when burning, for example, low sulfur, waxy residual fuel oils containing vanadium.

Demulsifiers

Turbotect offers special desalting aids to improve the oil/water separation in centrifugal or electro-static treatment of heavy fuels, such as crude oils and high density gas turbine heavy fuels.

Lubricity enhancement

Turbotect offers a lubricity improving fuel additive for gas turbine applications burning low lubricity fuels including naphtha, gas condensates and kerosene.

TURBOTECT™ ER-517N to control corrosion in aggressive naphtha and gas condensates, and **TURBOTECT™ ER-517** are both designed specifically to reduce potential wear problems due to poor lubricity in critical engine components such as fuel pumps and flow dividers and alleviate operation and maintenance issues. Both additives create a thin lubricating film by adsorption on metal surfaces.

Water separation from fuel

Emulsified water can be found in distillate fuel tanks which can be caused by contamination by sea water during transport, or as the result of seasonal temperature variations in storage. **TURBOTECT™ EP-390** can improve the separation rate and reduce the settling time.

If water accumulates in fuel oil, internal corrosion of the tank can occur and the build up of biological slime which can cause blockages in downstream filters and pumps. **TURBOTECT™ EXP 111** assists water separation and kills most problematic micro-organisms at an early stage to prevent the build up of biological slime.

Compressor cleaning systems

TURBOTECT™ PSA compressor cleaning system is a series of low profile nozzles for on-line and off-line washing, fabricated in stainless steel in versions for large and small gas turbines, together with a fluid preparation skid. It operates at low flow rates and low pressure. Turbotect also provides consulting services in this specialized subject.

Compressor washing

Turbotect offers both solvent-based and water-soluble detergents which can be used with any on-line or off-line compressor cleaning system.

TURBOTECT™ 927 is a traditional solvent-based detergent for off-line and on-line compressor washing which is particularly effective in removing organic dirt, oily deposits, and the like, as well as water soluble dirt. In on-line washing the product is consumed, but when used for off-line cleaning the oil fraction must be separated from the wash water and disposed of as oil waste.

TURBOTECT™ 950 is a water-based compressor cleaner for on-line and off-line use. It is a blend of inorganic surfactants and emulsifiers formulated to remove the most commonly found deposits on compressor blades. It is totally consumed during on-line washing.

TURBOTECT™ 2020 is a more powerful water-based compressor cleaner for on-line and off-line use, with similar cleaning efficiency to that of solvent type cleaners. It has been formulated to the type of fouling commonly found in today's gas turbines, particularly on urban and industrial sites which are caused by mixtures of various salts and industrial pollutants and vehicle exhausts.

Anti-icing protection

TURBOTECT™ ARF-301 is a ready mixed antifreeze and rinsing solution for on-line and off-line cleaning at low outside temperatures. It is offered for use with installations which are exposed to compressor icing during on-line washing at below +10°C, and off-line washing at lower temperatures. ARF-301 can be used with Turbotect cleaners 927,950 and 2020 on sites where high humidity and low winter temperatures give rise to intake icing.

Consulting services

Turbotect provides a wide range of consulting services and on-site training in the metallurgical aspects of gas turbine technology, including destructive and non-destructive testing and component failure analysis. The services are designed to enable power plant operators to minimize operation and maintenance costs by considering the various aspects of component life cycle engineering and materials selection.



Preparation skid for on-line and off-line washing for a 280 MW gas turbine.



Mk 1 nozzle with adjustable body to set the direction of the atomizing spray.



The Mk 3 air-assisted nozzle in action on a GE Frame 9E operating at base load.



Turbotect Ltd.

PO Box 1411
CH-5401 Baden, Switzerland
Phone: +41 56 200 5020
Fax: +41 56 200 5022
E-mail: turbotect@turbotect.com

Turbotect (USA), Inc.

18811 N. Roselake Drive
Tomball, Texas 77377
Phone: 1-281-255-6092
Fax: 1-281-516-0427
E-mail: andrew.bromley@turbotect.com

www.turbotect.com

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