

# Axial Compressor On/Off-line Washing

## Benefits

- ■ □ Increased production
- ■ ■ Higher efficiency
- □ □ Compliance with environmental regulations
- ■ □ Availability and Reliability
- □ □ Life extension

Gas turbine installations have inlet air filtration systems to reduce or eliminate contaminants that can damage the axial compressor or affect its performance.

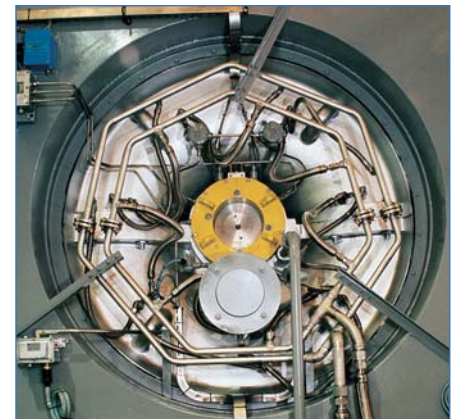
Regardless of filter efficiency, axial compressor fouling is unavoidable and depends on environmental conditions. Excessive fouling of compressor blades results in lower compressor efficiency and consequently a loss of gas turbine performance.

Axial compressor fouling can be caused by several types of contaminants.

Benefits of axial compressor washing include:

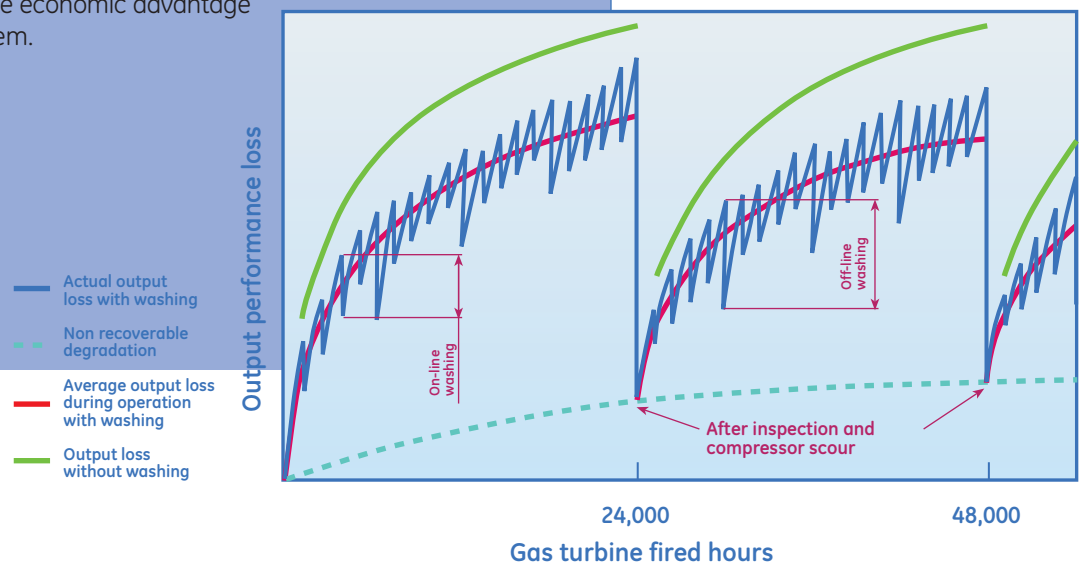
- Restoration of lost performance
- Reduced turbine operating costs
- Reduction of gas turbine fuel consumption

The following example shows the economic impact of running the gas turbine with the axial compressor fouled. Consider an MS5002C running at full speed full load for 8000 hours/year. If we assume a 2% average decrement of gas turbine efficiency, this will cause an extra fuel consumption of  $\sim 8.2 \times 10^{10}$  kJ/year. Taking into consideration a fuel gas having a LHV of 33500 kJ/Nm<sup>3</sup> and assuming a cost of 0.15 \$/Nm<sup>3</sup>, we find a cost of  $\sim$ \$370,000 per year due to loss of performance. This evaluation can be done for each turbine model scaling on the output power. The result confirms the economic advantage of installing a washing system.



Water washing piping

Figure 1: Expected gas performance loss vs. fired hours



## What it is

### Performance Recovery with Axial Compressor Washing

There are two methods used for axial compressor cleaning:

- ON-LINE WASHING with the machine running at full speed and loaded
- OFF-LINE WASHING with the machine on crank

Cleaning consists of injecting detergents into the axial compressor inlet following defined procedures.

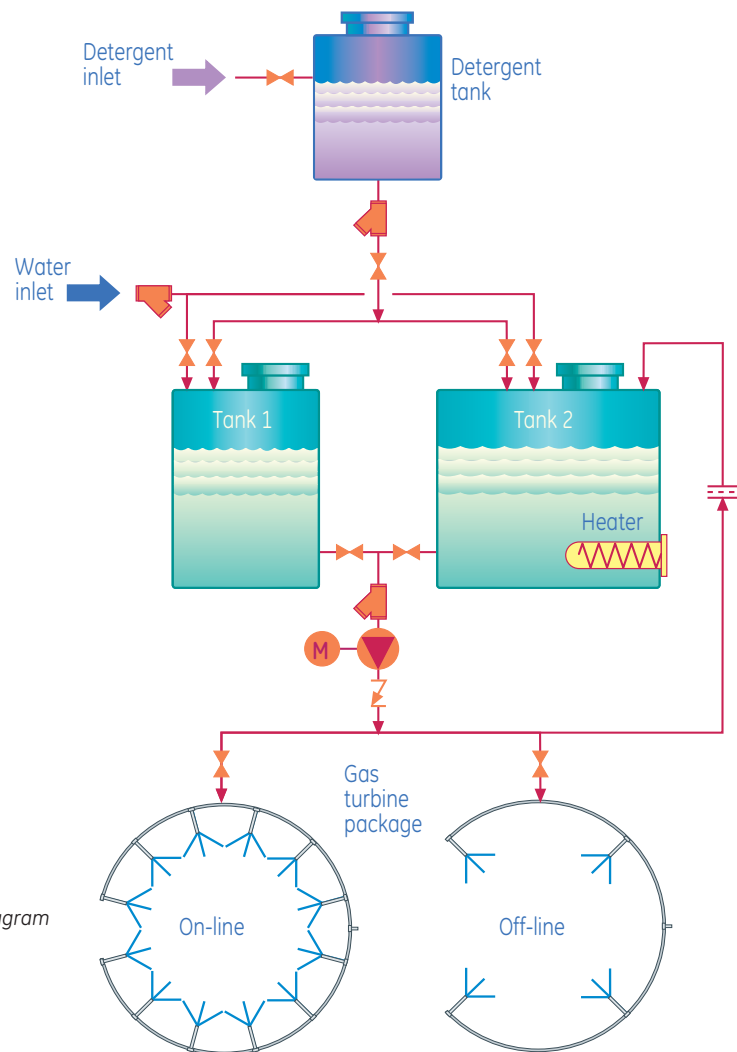
Figure 1 shows a graph representing a decline in output against running hours. As can be noted, each set of on-line washes alternates with an off-line wash. Correct application of this

procedure allows the turbine performance loss to be kept close to that due to aging of the machine, identified as non-recoverable degradation. The graph also shows that off-line cleaning is definitely more effective than on-line cleaning, thus explaining why the off-line system is an indispensable tool for the proper operation of gas turbines. Consequently, on-line washing is used in conjunction with off-line washing in order to extend time between shutdowns as much as possible. GE Specification ITN07831 gives a detailed description of the washing

operating procedure to be followed. This specification is available upon request. The type of detergent to be selected from the range of liquid detergents available depends on the type of fouling to be removed. The choice is made on site after evaluating how the type of fouling responds to the agents. Furthermore cleaning frequency and the quantities to be used in washes must be established during operation. These should be determined by analyzing axial compressor performance and monitoring efficiencies before and after cleaning.

## How it works

The diagram on the right illustrates the components of the kit. The kit consists of a skid, with three instrumented tanks. The upper tank contains the detergent. The other two tanks contain the water and/or the water/detergent mixture depending on the type of washing. The washing sequences are controlled by a local panel. A pump delivers the liquid to the proper manifold. Both the on-line and the off-line circuits have their own manifold. Several nozzles are connected to each ring. The exact number depends upon the turbine model. The nozzles of the off-line system are mounted on the inlet casing. The nozzles of the on-line system are mounted on the inlet plenum or on the inlet casing. The on-line system has a greater number of nozzles in order to provide a better dispersion of the detergent and to direct it uniformly into the axial compressor inlet.



On/off - line washing system diagram



GE imagination at work