

Gas Turbine Offline Wash Advisor

Process Plugins™

Methodology:

The Compressor Wash Advisor is a handy tool for determining the most economically advantageous time to perform an offline compressor wash. The advisor calculates this date/time using: *Maximum Net Profit Analysis*.

Maximum Net Profit Analysis:

A *wash cycle* is the total time beginning when the machine was started after the last offline wash to the time when the next offline wash is completed. Wash cycle period (P) is this time in hours. Wash cycle revenue (R) is the total income in dollars (\$) during the wash cycle. Washing cost (C) is the total cost in dollars (\$) for an offline wash. Washing cost does not include lost revenues due to being offline. The average profit over the entire wash cycle is: $(R-C)/P$ in \$/hr. This value is calculated for $P=1\text{hr}$, $P=2\text{hr}$, etc., throughout the entire period of time being analyzed. The period resulting in the maximum average profit is the optimal wash cycle period, and correlates to the optimum time to shut down and commence the next offline wash.

OSIsoft PI Data Interface:

All data used by the wash advisor (inputs), and generated by the wash advisor (outputs) are stored in the OSIsoft PI historian. The calculations are performed within the OSIsoft PI Advanced Computing Engine (ACE), and are triggered by a change in any of the inputs that have been registered to trigger the calculations (see Input Data). The user interface to the wash advisor is the OSIsoft Process Book display (see figure 1).

GAS TURBINE COMPRESSOR OFF-LINE WASH ADVISOR

ADVISOR INPUTS

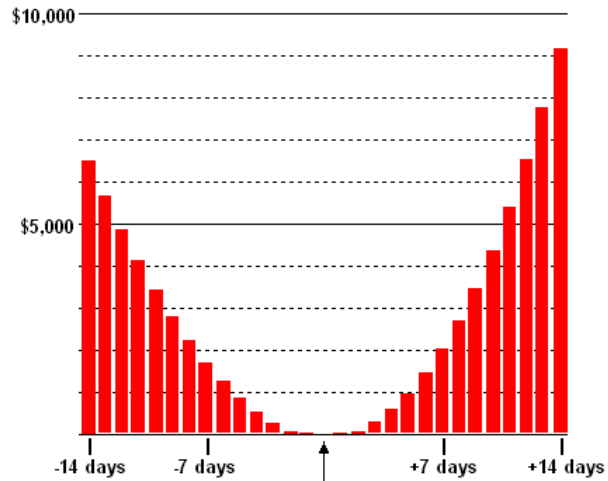
GAS TURBINE BASE LOAD CHARACTERISTICS

Clean Power Output: 200,000 kW
 Clean LHV Heat Rate: 9,360 Btu/kWh
 Avg kW Degradation Rate: 20.0 kW/day
 Avg HR Degradation Rate: 1.00 Btu/kWh/day

OPERATIONAL DATA

Avg % of Base Load: 90.00 %
 Generation Sale Price: 0.20 \$/kWh
 Fuel Cost: 2.00 \$/MMBtu
 *Off-Line Wash Costs: 5,000.00 \$
 Off-Line Wash Duration: 8.00 h
 Last Post-Wash Startup: 6/6/2008 1:29:06 AM

[EDIT INPUT DATA](#)



ADVISOR RESULTS

OPTIMAL TIME TO SHUT DOWN FOR WASH: 8/27/2008 5:00:00 AM

SUPPORTING DATA:

Optimal Duration Between Washes: 1972 h
 Resultant Maximized Overall Avg Net Profit: 32,362.66 \$/h
 This calculation was performed by PI-ACE on: 6/10/2008 2:13:16 PM

*Off-Line Wash Costs includes cost of detergent and disposal, but does not include lost revenue.

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Figure 1 – OSIsoft Process Book display

Process Plugins© Wash Advisor

Clean Power Output: 200000 kW
 Clean LHV Heat Rate: 9360 Btu/kWh
 Avg kW Degradation Rate: 20 kW/day
 Avg HR Degradation Rate: 1 Btu/kWh/day
 Avg % of Base Load: 90 %
 Generation Sale Price: 0.2 \$/kWh
 Fuel Cost: 2 \$/MMBtu
 Off-Line Wash Costs: 5000 \$
 Off-Line Wash Duration: 8 hours
 Last Post-Wash Startup Date & Time:
 12/25/2007 12:29:06 AM
 Write Data to PI

Figure 2 – OSIsoft Process Book Input Data Editor

Input Data:

Any of the wash advisor's input data can be easily edited using the Process Book display's Input Data Editor (see figure 2). When the user clicks on the button labeled "Edit Input Data", the window in figure 2 will be activated with all values defaulted to the current values in the OSIsoft PI historian. This default feature is very convenient when the user wishes to change only a few of the input values.

***Clean Power Output** is the maximum kilowatt output that the gas turbine generator is expected to be capable of delivering immediately after an offline wash.

***Clean LHV Heat Rate** is the minimum (best) heat rate that the gas turbine generator is expected to achieve immediately after an offline wash.

Avg kW Degradation Rate is the average rate at which the gas turbine generator's maximum kilowatt output capability degrades when base-loaded. This input is not registered to trigger the ACE calculation since this could be configured as a performance equation, and thus have a volatile value. Although the rate of change is negative, a positive number should be used.

Avg HR Degradation Rate is the average rate at which the gas turbine generator's heat rate degrades (increases) per day when base-loaded. This input is not registered to trigger the ACE calculation since this could be configured as a performance equation, and thus have a volatile value.

Avg % of Base Load is the overall weighted average load as a percentage of base-load. This input is not registered to trigger the ACE calculation since this could be configured as a performance equation, and thus have a volatile value. Example: If the machine ran at base load for 10 hours, 3/4 base load for 8 hours, and was shut down for 5 hours, then:
$$100 * (1*10 + 0.75*8 + 0*5) / (10+8+5) = 64\%$$

***Generation Sale Price** is the net price received for generated power.

***Fuel Cost** is the net cost paid for fuel.

***Offline Wash Costs** are all costs of performing the wash. This should include detergent, disposal costs, and any other costs incurred by the wash. This should not include any costs that exist without washing (i.e. salaries), but should include any increase caused by the wash (i.e. overtime). This should not include lost revenues due to being offline since this loss is already inherent in the calculation.

***Offline Wash Duration** is the total number of hours expected to be shut down in order to perform the offline wash.

***Last Post-Wash Startup Date & Time** is the date and time that the machine was last started after an offline wash.

* Indicates an input that is normally registered to trigger the wash advisor calculation in ACE upon a change in value. These are usually values which are normally constant set-points and not live volatile values.

Running the Wash Advisor:

To run the wash advisor, simply click the button labeled “Edit Input Data” from the Process Book display (see figure 1), change one or more of the input data values on the Input Data Editor (see figure 2), and click the button labeled “Write Data to PI”. This will cause the Input Data Editor window to close, and the input values on the Process Book display will change accordingly within a few seconds. Within a minute, the user will notice a change in the results of the wash advisor.

Advisor Results:

The advisor calculates the overall average net profit achieved from operations if the offline wash occurred 1 hour after the last post-wash startup; then 2 hours, then 3, 4, etc. The calculation repeats until it finds the maximum net profit, and then continues until it has enough data to complete the bar chart which extends 14 days beyond the ideal wash time.

Optimal Time to Shut Down for Wash is the time, rounded to the nearest hour, at which shutting down to perform an offline wash would be most financially advantageous. Note that it is possible that the wash advisor might return a date and time in the past. In this event, an offline wash is recommended as soon as practicable.

Optimal Duration Between Washes is the advisor’s corresponding total number of hours that the machine should go without an offline wash.

Resultant Maximized Overall Avg Net Profit is the maximum profit found by the wash advisor, from which the corresponding duration (above) was determined.

This calculation was performed by PI-ACE on the date and time at which the code ran and developed the displayed results.

Untimely Wash Cost is displayed by the bar chart (see figure 1), and indicates the total cost of performing the offline wash on dates other than optimal.