



ProcessPlugins Gas Turbine Performance



Partner Organizations:



Process
Innovations
Inc.



PROCESS PLUGINS™ COMBUSTION GAS TURBINE PERFORMANCE & CONDITION MONITOR

The Gas Turbine Condition Monitor provides real-time compressor efficiencies, expected generator capacity, and expected efficiency based upon various ambient conditions. This information can be useful in determining loss of turbine efficiency or other problems. Curves are customizable and can be easily adjusted anytime afterward. Expected values calculations require the availability of appropriate curves (from the manufacturer or actual historical data). This tool makes it easy to identify problems with turbine performance early.

Element Relative Display

Search: Search Mask

Elements of Interest: Group by: Template

Name	Description
Gas Turbine	Kazadale CGT 61
Gas Turbine	Kazadale CGT 62
Gas Turbine	Kazadale CGT 63
Gas Turbine	Kazadale CGT 64
Gas Turbine	Kazadale CGT 65
Gas Turbine	Kazadale CGT 66
Gas Turbine	Kazadale CGT 67
Gas Turbine	Kazadale CGT 91
Gas Turbine	Kazadale CGT 92
Gas Turbine	Richville CGT 1000
Gas Turbine	Richville CGT 2000
Gas Turbine	San Gando CTG A
Gas Turbine	San Gando CTG B
Gas Turbine	San Gando CTG C
Gas Turbine	Ticu CGT 101

Train Sum | **HRSG** | **Generator** | **Exh Profile** | **Comp Wash** | **Pumps** | **Costs** | **Corp Overview**

RICHVILLE CGT 1000

AIR INLET	
Barometric Pressure	15.9 psi
Ambient Air Temperature	68.5 °F
Compressor Suction Temp	68.5 °F
Compressor Suction dP	0.00 inH2O

AIR COMPRESSOR	
Discharge Temperature	896.0 °F
Discharge Pressure	267.2 psi
Isentropic Efficiency	79.0 %
Polytropic Efficiency	85.4 %

EXHAUST	
Minimum Temperature	907.8 °F
Maximum Temperature	1,058.7 °F
Average Temperature	988.9 °F
Expected Temperature	1,036.5 °F

TURBINE PERFORMANCE	
Fuel Gas Flow	11,941 SCFM
Fuel LPG Flow	0 SCFM
Gross Generation	57.32 MW
Gross Gen Corrected to Ref	54.80 MW
Baseload Capacity (Iso-Corr)	57.53 MW

STACK EMISSIONS	
Oxygen	14.4 %
NOx	4.86 ppm
NOx (EPA Calc)	0.0163 lb/MMBtu
CO	0.38 ppm
CO (Calc)	0.0008 lb/MMBtu

HEAT RATE	
LHV Heat Rate Actual	11,911 Btu/kWh
LHV Heat Rate Corrected*	11,784 Btu/kWh
LHV Heat Rate Expected	9,193 Btu/kWh
HHV Heat Rate Actual	13,118 Btu/kWh
HHV Heat Rate Corrected*	12,978 Btu/kWh
HHV Heat Rate Expected	10,125 Btu/kWh
*CTG Base Loaded:	YES

HRSG	
HRSG Efficiency	72.5 %
HRSG Effectiveness	90.5 %

CGT MW & HHV Heat Rate

5/3/2011 9:30:56 AM | 2.00 hours | 5/3/2011 11:30:56 AM

Legend: ● 57.0486 MW, ○ 12578.7 Btu/kWh

Using the 'Element Relative Display' feature, one master Process Book display file may be used to consistently display the key performance indicators of each turbine by simply selecting the turbine in the Element Relative pane (left side of display). With the 'Element Relative Display' feature, one master display file may be used for an unlimited number of similar assets. Corporate level summary "drill down" screens make navigation easy via PI Process Book, or Internet Explorer using PI Web Parts.

Flexibility of the OSIsoft AF structure allows for value substitution whenever certain instrumentation may be unavailable. This substitution can take a number of forms including real-time calculation of the expected value based upon surrounding instrumentation, manual input via AF, manual input to a PI tag based on operator rounds, or any combination of manual and calculated inputs.

Live Data Inputs Suggested for Best Results:

- Fuel flow to turbine
- Fuel temperature to turbine
- Fuel pressure to turbine
- Fuel heating value or constituents necessary (chromatograph) to calculate heating value
- Exhaust gas temperature
- Air compressor inlet temperature
- Barometric pressure
- Air compressor filter outlet pressure or filter differential pressure
- Air compressor outlet temperature
- Air compressor outlet pressure
- All available bearing temperatures
- All available bearing vibration
- All available emissions data

Optional Live Data Inputs (Recommended if corresponding performance curves are available):

- Relative humidity (or wet bulb temperature)

Recommended Technical Information:

- All manufacturer design rating specifications
- All manufacturer performance curves

The following parameters are calculated, ISO-corrected, and key performance indicators (KPIs) are visually displayed in a real time comparison to manufacturer design curves or data, or to historical data trends:

- Air compressor isentropic (adiabatic) efficiency
- Air compressor polytropic efficiency
- Power from Fuel
- Turbine Work
- Gas Turbine Heat Rate

The Process Plugins™ solution has the capability of monitoring an unlimited number of turbines, which could be added by the end user at any time in the future.

MORE ABOUT PROCESS PLUGINS™

OSIsoft's PI System continues to be the industry standard in data historians, which has been the core of its 21st century real-time infrastructure platform. And now this platform comes fully loaded with every feature necessary to support all of your needs for monitoring, modeling, diagnostics, or forecasting without the need for any 3rd party software. That's where the Process Plugins™ package comes in.

Process Plugins™ is not 3rd party software. The Process Plugins™ package customizes your OSIsoft platform for your plant. This is the only existing solution if you want:

1. No unnecessarily redundant PI tags
2. No 3rd party software
3. One Microsoft certified package with seamless integration of calculations and models
4. Web browser interface capability
5. Ability to drill down into calculations to see (or edit) exactly what they're doing

PI System Explorer

File Edit View Go Tools Help

Database Query Date Back Check In New Element New Attribute Search

Elements

- Environment
- Forecast
- Fuel
 - Train 1000
 - FWPumpA
 - FWPumpB
 - Gas Turbine
 - Compressor
 - Exhaust
 - FuelMixture
 - HeatRate**
 - Output
 - PPI_WriteToPI1
 - PPI_WriteToPI2
 - Generator
 - HRSG
 - FlueGasEnthalpyIn
 - FlueGasEnthalpyOut
 - FlueGasEnthalpyRef
 - PPI_WriteToPI1
 - PPI_WriteToPI2
 - PPIStmEng_HPTsuperHe
 - PPIStmEng_HTLfeed
 - PPIStmEng_TsatPdum
 - Stack
 - EPA

HeatRate

General Child Elements Attributes Ports Version

Filter

Name	Value
CorrectionFactor	0.9949144 factor
FuelFlow	37616.16 lb/h
FuelHeatDemandFromNOxStm	40.56076 MMBtu/h
FuelHeatInputHHV	640.3727 MMBtu/h
FuelHeatInputLHV	581.0416 MMBtu/h
HeatRateHHV	12110.4 Btu/kWh
HeatRateHHVBaseline	10045.13 Btu/kWh
HeatRateHHVCorrected	12048.81 Btu/kWh
HeatRateHHVCorrZeroNOxStm	13550.55 Btu/kWh
HeatRateHHVExpected	10082.98 Btu/kWh
HeatRateLHV	10988.36 Btu/kWh
HeatRateLHVBaseline	9114.438 Btu/kWh
HeatRateLHVCorrected	10932.47 Btu/kWh
HeatRateLHVCorrZeroNOxStm	12220.75 Btu/kWh
HeatRateLHVExpected	9148.783 Btu/kWh
TurbineWork	52877.93 kW

Group by: Category

Name: HeatRateHHV

Description:

Configuration Item:

Categories:

UOM: Btu/kWh

Value Type: Single

Value: 12110.4 Btu/kWh

Data Reference: Formula

Settings...

A=FuelHeatInputHHV;UOM=Btu/h;B=TurbineWork;UOM=kW;[if B > 0 then A/B else 0];UOM=Btu/kWh

HeatRate Modified:4/22/2011 6:01:30 AM. Version: 1/1/1970 12:00:00 AM, Revision 1

The Process Plugins™ package resides primarily within OSIsoft's PI Asset Framework (PI-AF). Your plant customization exists in the form of *elements* which handle most of your basic performance calculations. Using PI System Explorer, system administrators can view, modify, or enhance elements as desired.

Element Formulas

The screenshot shows a 'Formula Configuration' dialog box for the element 'HeatRateHHV'. The dialog is divided into two main sections: 'Parameters' and 'Equations'. The 'Parameters' section contains two lines of text: 'A=FuelHeatInputHHV;UOM=Btu/h' and 'B=TurbineWork;UOM=kW'. The 'Equations' section contains a single line of text: 'if B > 0 then A/B else 0'. Below these sections is a checkbox labeled 'Default Values Allowed' which is currently unchecked. At the bottom of the dialog, there is a 'Result' section with a 'Unit of Measure' dropdown menu set to 'Btu/kWh', and two empty text boxes for 'Minimum' and 'Maximum'. An 'Evaluate' button is located to the left of a text box displaying the result '13024.4068689356 Btu/kWh'. At the very bottom are 'OK' and 'Cancel' buttons.

Formula Configuration:(HeatRateHHV)

Parameters

A=FuelHeatInputHHV;UOM=Btu/h
B=TurbineWork;UOM=kW

Equations

if B > 0 then A/B else 0

Default Values Allowed

Result

Unit of Measure: Btu/kWh Minimum: Maximum:

Evaluate 13024.4068689356 Btu/kWh

OK Cancel

Fundamental performance calculations exist as formulas within elements.

Element Templates

The screenshot displays the 'PPI - PI System Explorer' application window. The main interface is divided into several sections:

- Library:** A list of element templates on the left, with 'PPIstmSI_VTL' selected and highlighted in blue.
- General Tab:** The central pane shows the configuration for 'PPIstmSI_VTL'. It includes a search bar and a table of attributes:

Name	Description
InputT	Temperature
OutputV	Specific Volume

- Configuration Fields:** On the right, fields for 'Name' (InputT), 'Description' (Temperature), 'UOM' (°C), 'Value Type' (Single), and 'Data Reference' (Formula) are visible. A 'Settings...' button is also present.
- Formula Editor:** Below the settings, a text area contains the formula: `A=.\|Temperature;UOM=°C;[A]`
- Search Panel:** On the far right, a search panel lists categories: Formula, PI Point, PI Point Array, and Table Lookup.

The status bar at the bottom indicates: 'PPIstmSI_VTL Modified:2/14/2009 5:04:04 PM.'

The Process Plugins™ package comes with a complete set of “Drag & Drop” Element Templates for use in PI-AF. Some routines utilize the Process Plugins™ Windows service, which delivers results back to an element.

Lookup Tables

GasProperties							
General	Table	Define Table	Version				
GasProperties							
	Name	Molecule	MolWeight	HHVdry	LHVdry	SpecHeatRati	SpecHeatCp
	Acetylene	C2H2	26.03728	1488	0	1.232	1.69
	Air	AIR	28.963	0	0	1.4	1.01
	Ammonia	NH4	18.03846	0	0	1.31	2.19
	Argon	Ar	39.948	0	0	1.667	0.52
▶	n-Butane	C4H10	58.123	3392	3131	1.094	1.67
	i-butane	C4H10	58.123	3392	3131	1.094	1.67
	Carbon Dioxide	CO2	44.01	0	0	1.289	0.844
	Carbon Monoxide	CO	28.01	321	321	1.4	1.02
	Chlorine	Cl2	70.906	0	0	1.34	0.48
	Ethane	C2H6	30.07	1789	1636	1.187	1.75
	Ethylene	C2H4	28.05316	1614	1485	1.24	1.53
	Helium	He	4.002602	0	0	1.667	5.19
	Heptanes	C7H16	100.204	5502.5	5100	1.05	0
	Hexanes	C6H14	86.177	4755.9	4403.8	1.06	0
	Hydrogen	H2	2.016	325	273.8	1.405	14.32
	Hydrochloric Acid	HCl	36.46094	0	0	1.41	0.8
	Hydrogen Sulfide	H2S	34.08	647	596	1.32	1.017
	Hydroxyl	OH	17.00734	0	0	1.384	1.76
	Methane	CH4	16.043	1014	913	1.304	2.22
	Methyl Chloride	CH2Cl	49.47958	0	0	1.2	1.005
	Nitric Oxide	NO	30.0061	0	0	1.386	0.995
	Nitrogen	N2	28.013	0	0	1.4	1.04
	Nitrous Oxide	N2O	44.0128	0	0	1.27	0.88
	Oxygen	O2	31.999	0	0	1.395	0.919
	n-Pentane	C5H12	72.15	4200	3884	1.07	0
	i-pentane	C5H12	72.15	4200	3884	1.07	0
	Propane	C3H8	44.097	2573	2367	1.127	1.67
	Propylene	C3H6	42.07974	2383	2192	1.15	1.5
	Sulphur Dioxide	SO2	64.0638	0	0	1.29	0.64

The Process Plugins™ package comes with both industry standard and site specific tables which are used by elements for lookup functions as well as interpolation.

Data Storage

The screenshot displays the 'PPI - PI System Explorer' application window. The interface is divided into several panes:

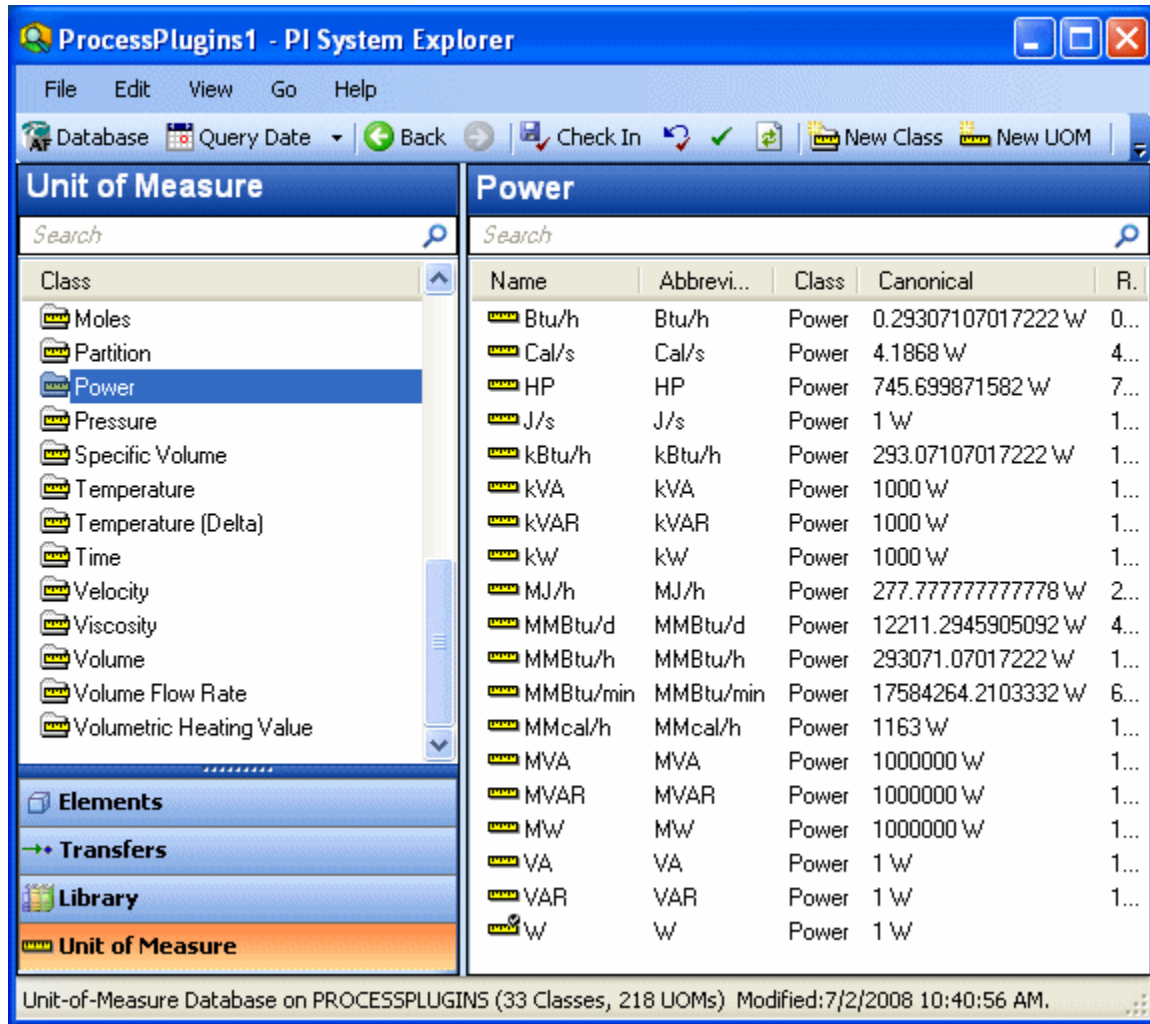
- Elements:** A tree view on the left showing a hierarchy of elements. Under 'Performance', 'PPI_WriteToPI' is selected.
- Attributes:** A central pane showing a table of attributes for the selected 'PPI_WriteToPI' element.

Name	Value
Formula	6508.577
PIPoint	6508.572
- Configuration:** A right-hand pane with tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Version'. The 'Attributes' tab is active, showing fields for 'Name' (PIPoint), 'Description', 'Configuration Item', 'Categories', 'UOM' (<None>), 'Value Type' (Single), 'Value' (6508.572), and 'Data Reference' (PI Point). A 'Settings...' button is visible below these fields.
- Search:** A vertical list on the far right showing search results for various 'PPIStmEng' tags, such as 'PPIStmEng_HPS', 'PPIStmEng_HPT', etc.

At the bottom left of the window, the text 'PIPoint' is displayed.

Key resultant data generated by Process Plugins™ modules are stored in the OSIsoft PI historian. Process Plugins™ modules do NOT store redundant or unnecessary data, but only a handful of PI tags for key results.

Units of Measure



Unit of Measure

Search

- Class
- Moles
- Partition
- Power**
- Pressure
- Specific Volume
- Temperature
- Temperature (Delta)
- Time
- Velocity
- Viscosity
- Volume
- Volume Flow Rate
- Volumetric Heating Value

Power

Search

Name	Abbrevi...	Class	Canonical	R.
Btu/h	Btu/h	Power	0.29307107017222 W	0...
Cal/s	Cal/s	Power	4.1868 W	4...
HP	HP	Power	745.699871582 W	7...
J/s	J/s	Power	1 W	1...
kBtu/h	kBtu/h	Power	293.07107017222 W	1...
kVA	kVA	Power	1000 W	1...
kVAR	kVAR	Power	1000 W	1...
kW	kW	Power	1000 W	1...
MJ/h	MJ/h	Power	277.777777777778 W	2...
MMBtu/d	MMBtu/d	Power	12211.2945905092 W	4...
MMBtu/h	MMBtu/h	Power	293071.07017222 W	1...
MMBtu/min	MMBtu/min	Power	17584264.2103332 W	6...
MMcal/h	MMcal/h	Power	1163 W	1...
MVA	MVA	Power	1000000 W	1...
MVAR	MVAR	Power	1000000 W	1...
MW	MW	Power	1000000 W	1...
VA	VA	Power	1 W	1...
VAR	VAR	Power	1 W	1...
W	W	Power	1 W	1...

Unit-of-Measure Database on PROCESSPLUGINS (33 Classes, 218 UOMs) Modified:7/2/2008 10:40:56 AM.

The Process Plugins™ package includes a complete set of engineering units utilized by the utility industry for use with the PI AF Unit of Measure (UOM) system. PI-AF automatically performs unit conversions on demand and delivers results in either the U.S. English or S.I. engineering unit systems.



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