Effect of the Off-line Wash system for Gas Turbines Ruston TB5000 in high polluted conditions

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CASE STUDY

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ABSTRACT.

This work shows the effect of an Off-line wash system with water based on the case of 3 gas turbines Ruston TB5000 located in high polluted conditions like ashes in the ambient, high humidity and temperature.

This research was ran making periodical measurements of the principal turbo-pump’s variables values during 1 year of operation with nonstop charge conditions around 125 mbpd (millions of barrels per day) of gas L.P.

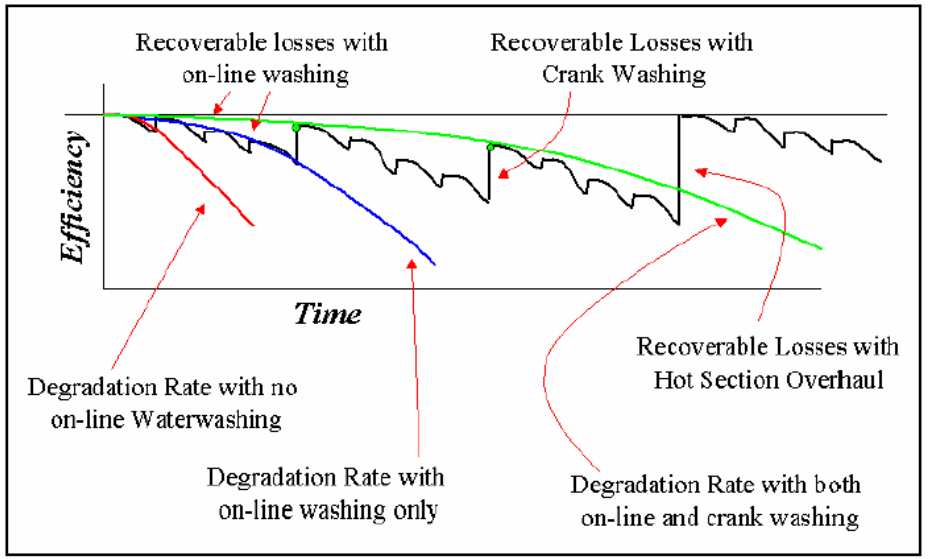
ABSTRACT.

All this data were inserted in a statistical program and then analyzed to create Temp./Discharge P. ratio curves and comparing with other cases, one washed with different system in the same polluted ambient and other without washed.

ABSTRACT.

Due to their high polluted ambient the demand from the filter system is hard, and in some cases limited a very efficient wash system is required.

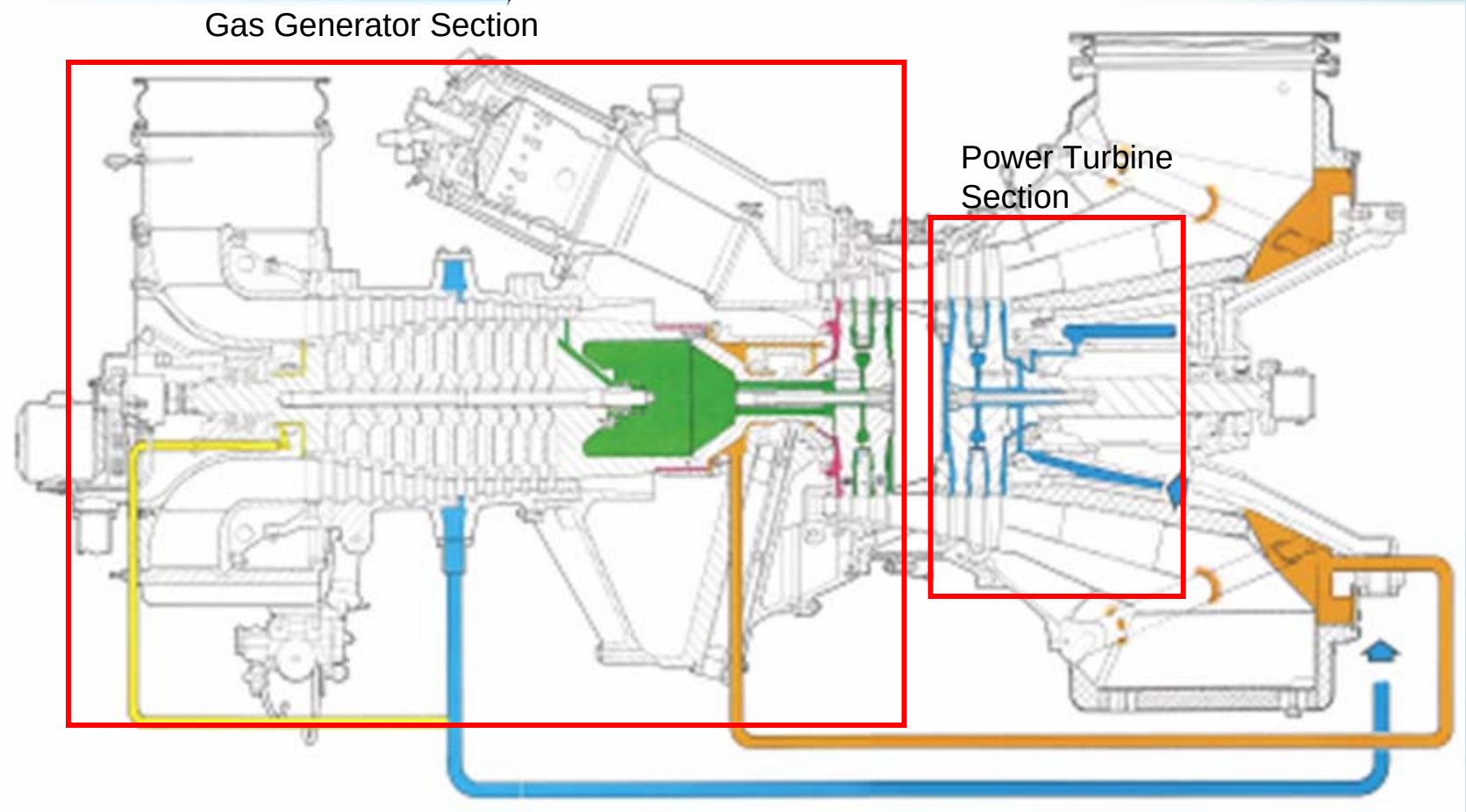
INTRODUCTION.



This case of study shows the effects for these turbines with a water based wash system in the off-line mode which some predictions were estimated by Basendwah A. [1] proposing this maintenance method as a very good way to reduce the consumption of fuel and to extend the period between overhauls. The turbomachinery department of CIATEQ [2] in Mexico and Conntect Inc. [3] from USA, developed a new wash system using water based and bio-degradable detergent as an alternative to the OEM's system.

[1] Basendwah A.
Department of Power Engineering
and Propulsion
School of Engineering
Cranfield University, England
[2] CIATEQ is a mexican government company which is intended to support mexican industry
[3] CONNTECT is a private USA Company which is related with the compressor washing

INITIAL CONDITIONS

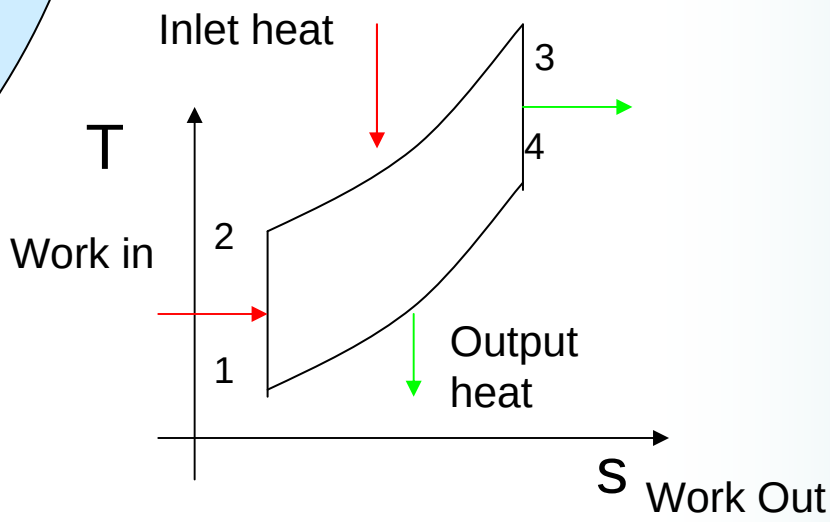


Transversal section schematic for the Ruston TB5000. EGT Lincoln, Uk.

INITIAL CONDITIONS

Considerations:

Using the Brayton Cycle and the performance principle:



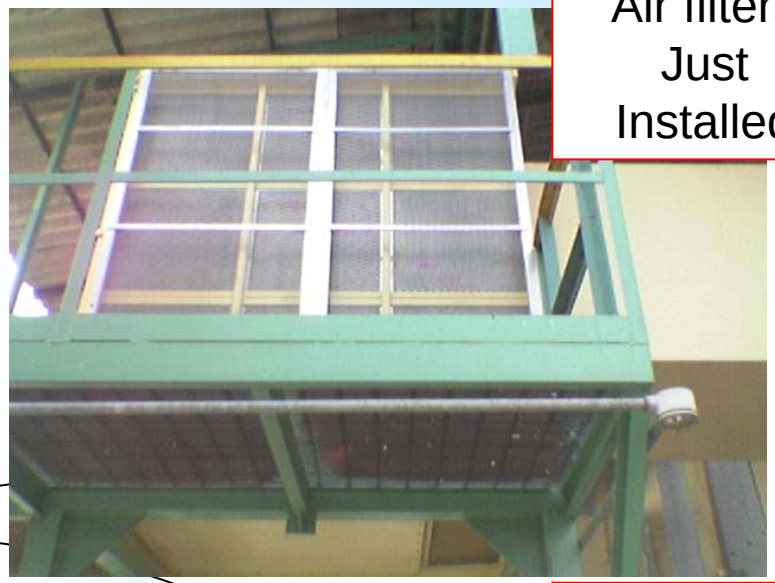
$$\eta = \frac{W_{out} - W_{in}}{H_{in}}$$

Where
η = Performance
W_{out} = Net Work Out
W_{in} = Work required by the compressor.
H_{in} = Inlet heat from the fuel combustion.

$$\eta_a = \frac{\text{Station' s Discharge Pressure}}{\text{Operation Temperatur e}}$$

$$\eta_1 = \frac{\text{Station' s Discharge Pressure}}{\text{Percentage of the Gas Generator shaft Speed}}$$

INITIAL CONDITIONS



Air filters Just Installed

Air filters after 1 month working

Environment Conditions:

Ambient Temperature: 20 to 40°C at noon

Humidity: 90% in summer

TWO STATIONS IN DIFFERENT ALTITUDE

TWO TURBINES IN DIFFERENT STATIONS

INITIAL CONDITIONS

Operation Conditions
Turbine 1
LPG Pump Station:

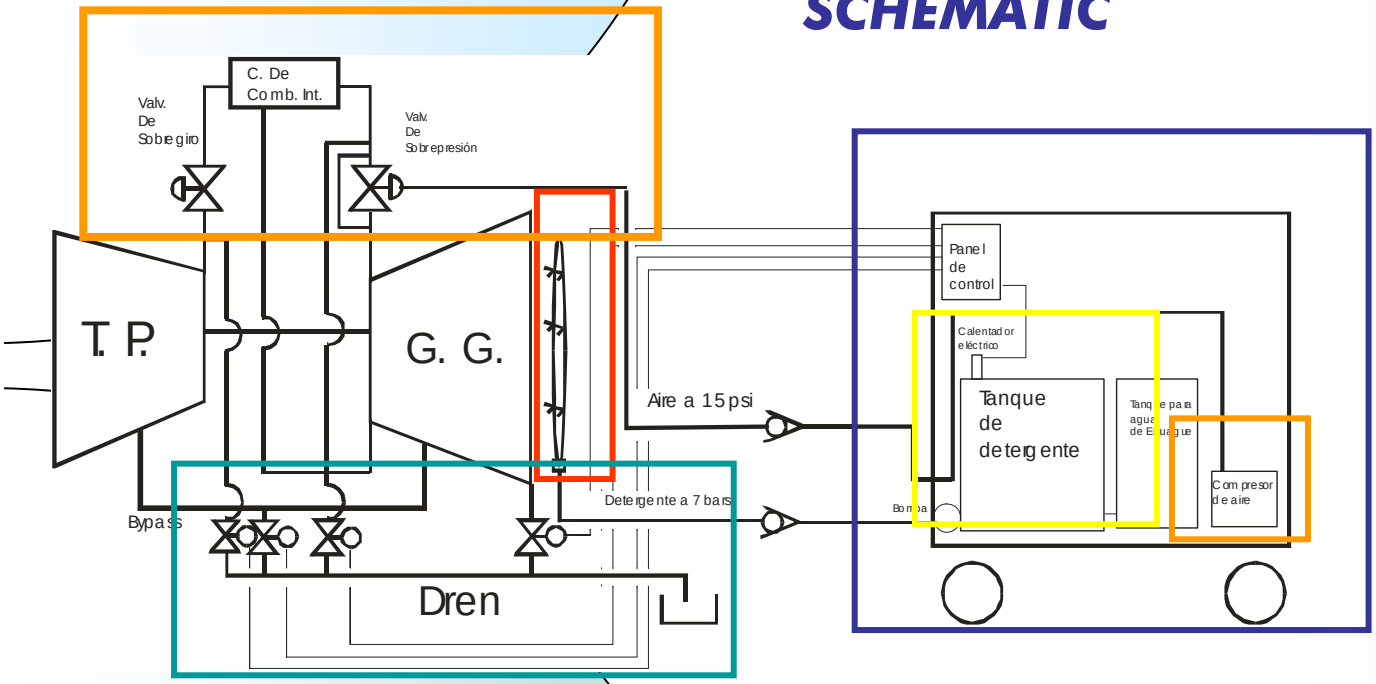
Date: 28/12/06	**Qty**	**Units**
Operation Hours:	110119	h
Operation Temperature:	417	ºC
Pressure Compressor Discharge (PCD):	52.3	Psi
% of Gas Generador speed:	89	%
Station's Discharge Pressure:	48.6	kg/cm^2
Station's Discharge Flow:	11648	BPH

Turbine 2
LPG Pump Station:

Date: 28/01/07	**Qty**	**Units**
Operation Hours:	109196	h
Operation Temperature:	429	ºC
Pressure Compressor Discharge:	52.7	Psi
% of Gas Generator Speed:	92	%
Station's Discharge Pressure:	50	kg/cm^2
Station's Discharge Flow:	11648	BPH

WASH METHODOLOGY.

WASH SYSTEM SCHEMATIC



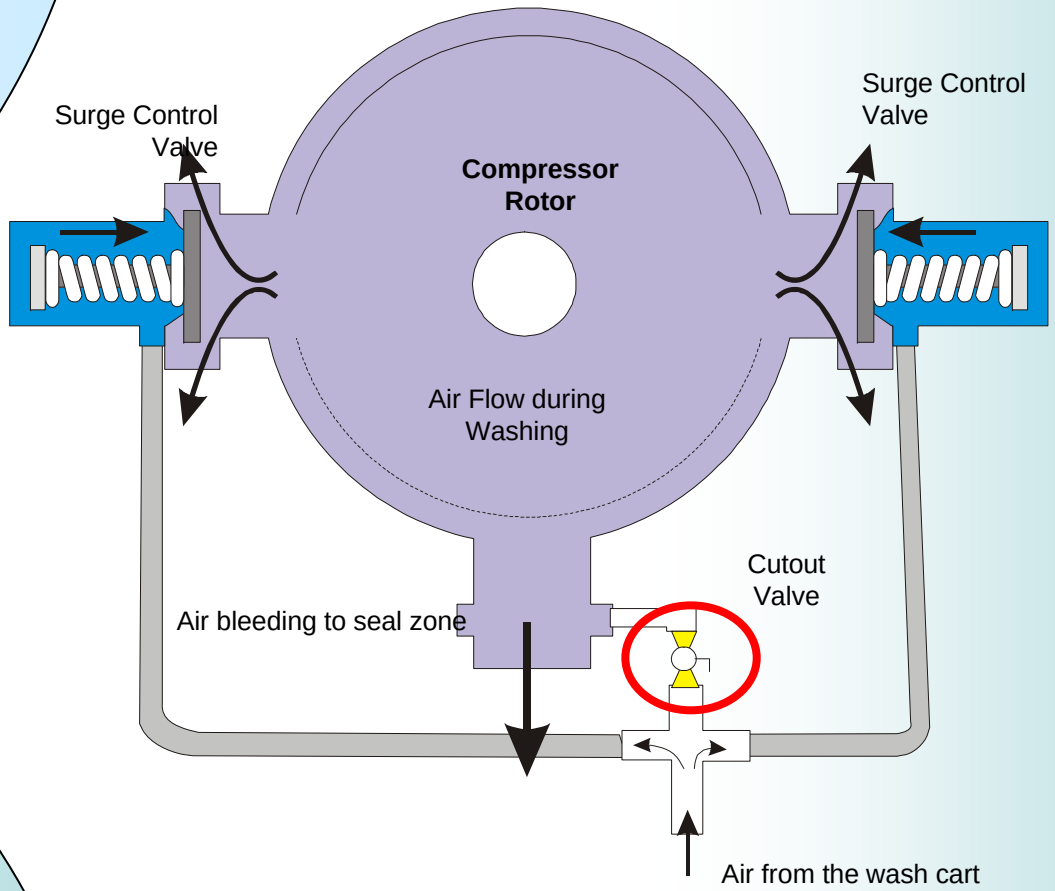
Wash Cart Nozzles System

Drain System

Surge Valve's Hatching System

Detergent and water tanks

WASH METHODOLOGY.



Surge Valve's Hatching System

This System works entering 20 psi, or less, pressure air to the surge valves in order to latch them and avoid the leakage during the wash sessions. The operator need just close one ball valve.

WASH METHODOLOGY.

1. Wash Session. Crank the compressor rotor and inject detergent mixture (4 parts of demineralized water per 1 part of detergent) for 1 min because its starting motors may be damaged for a longer period.
2. Suck time. Let the detergent for 20 min for react with the dirt and fouling deposited on the blades and internals surfaces.
3. Rinse Session. Crank the compressor again for 1.5 min for rinse the first wash session,
4. Repeat. If the drain liquid is dark it required to inject more detergent mixture, and repeat the three first steps until the drain becomes clearer.

RESULTS.

Turbine 1
LPG Pump Station:

Date: 30/01/07	**Qty**	**Units**
Operation Hours:	110119	h
Operation Temperature:	392.6	ºC
Pressure Compressor Discharge (PCD):	47.5	PSI
% of Gas Generador speed:	86.6	%
Station's Discharge Pressure:	48.6	kg/cm^2
Station's Discharge Flow:	392.6	BPH

Turbine 2
LPG Pump Station:

Date: 28/01/07	**Qty**	**Units**
Operation Hours:	109196	h
Operation Temperature:	395	ºC
Pressure Compressor Discharge:	49	PSI
% of Gas Generator Speed:	90	%
Station's Discharge Pressure:	50	kg/cm^2
Station's Discharge Flow:	392.6	BPH

After the wash sessions these turbines were ran again and then go on with the comparison. This comparison was made once the turbine has reached the same flow and pressure in the discharge

RESULTS.

Turbine 1's Liquid drain

η_0 = 48.6 [kg/cm^2] / 392.5 [°C] = 0.1238 kg/cm^2°C

24.4°C less to reach the same discharge pressure

η_1 = 48.6 [kg/cm^2] / 90 % = .54 kg/cm^{2}x100 rpm

2.4% = 240 rpm less in the G.G. to reach the same discharge pressure

Turbine 2's Liquid drain

η_0 = 50 [kg/cm^2] / 395 [°C] = 0.1266 kg/cm^2°C

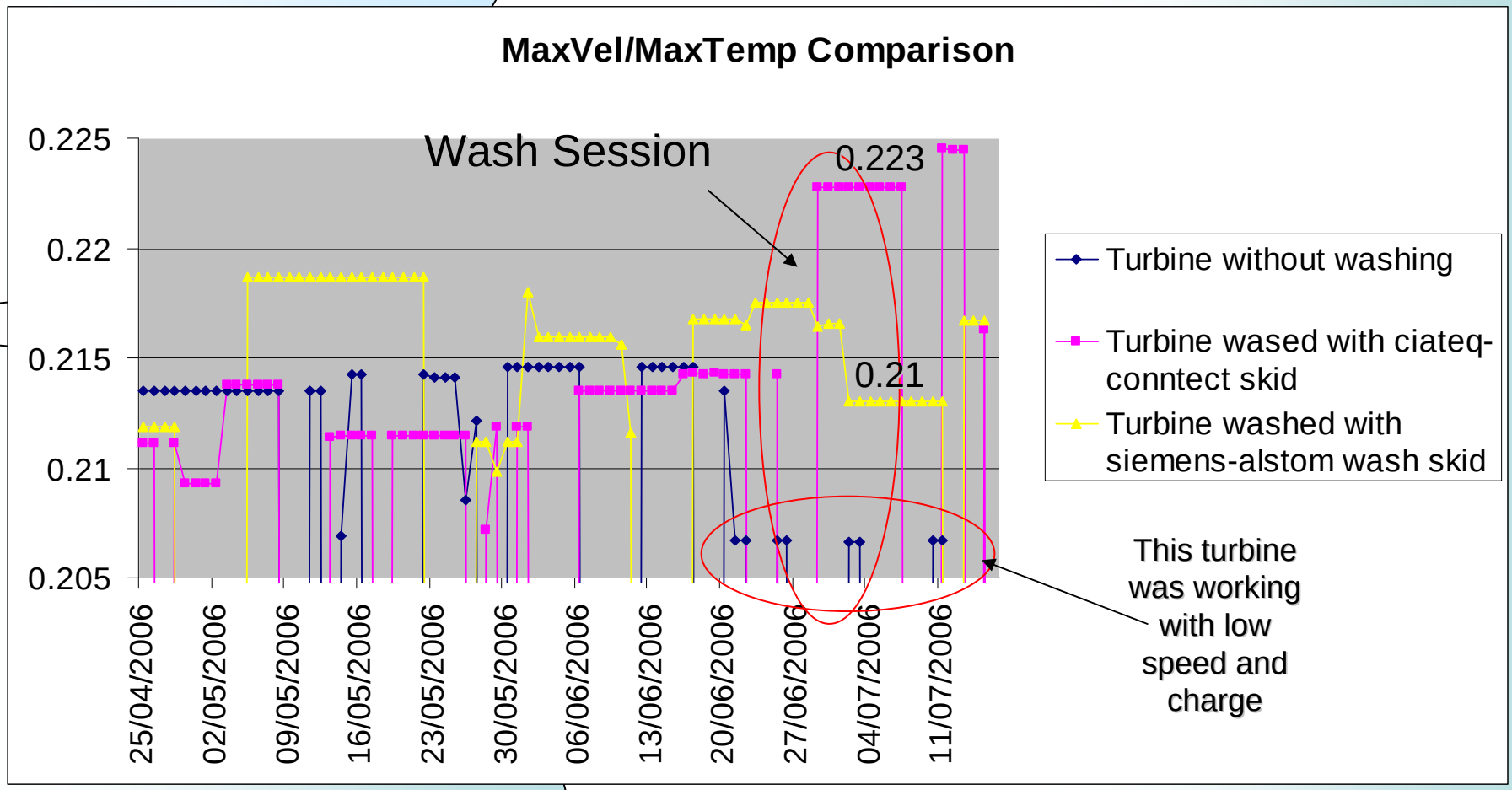
34°C less to reach the same discharge pressure

η_1 = 50 [kg/cm^2] / 86.6 % = .561 kg/cm^{2}x100 rpm

2% = 200 rpm less in the G.G. to reach the same discharge pressure

COMPARISON.

The operation tendency comparison with another turbine which has not been washed is plotted as seen in the image below:



COMPARISON.

Temperature decreasing with alstom-siemens wash system:
From 460°C to 440°C = 20°C less

G.G. SPEED AT 90%

Temperature decreasing with ciateq-conntect wash system:
From 429°C to 395°C = 34°C less

G.G. SPEED FROM 92% TO 90%

THANK YOU