Power Augmentation Route Map and Summary

Gas Turbine Air Treatment Decision Guide

Power augmentation options

Wetted media

Fogging

Mechanical refrigeration

Absorption cooling

Wet compression

Indirect evaporative cooling

Humid air injection

Inlet Cooling options

Combustion Turbine Inlet Cooling (CTIC) for Power Augmentation: An Overview

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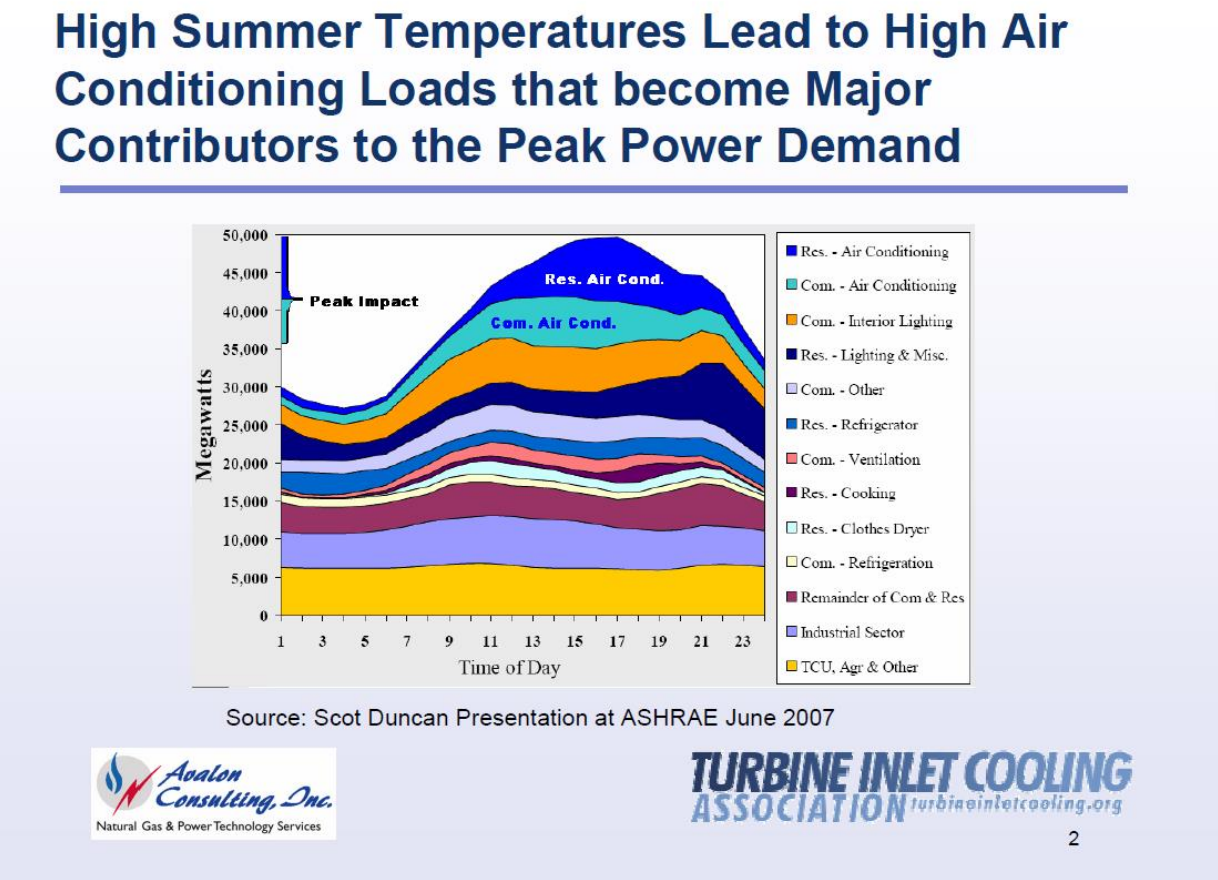
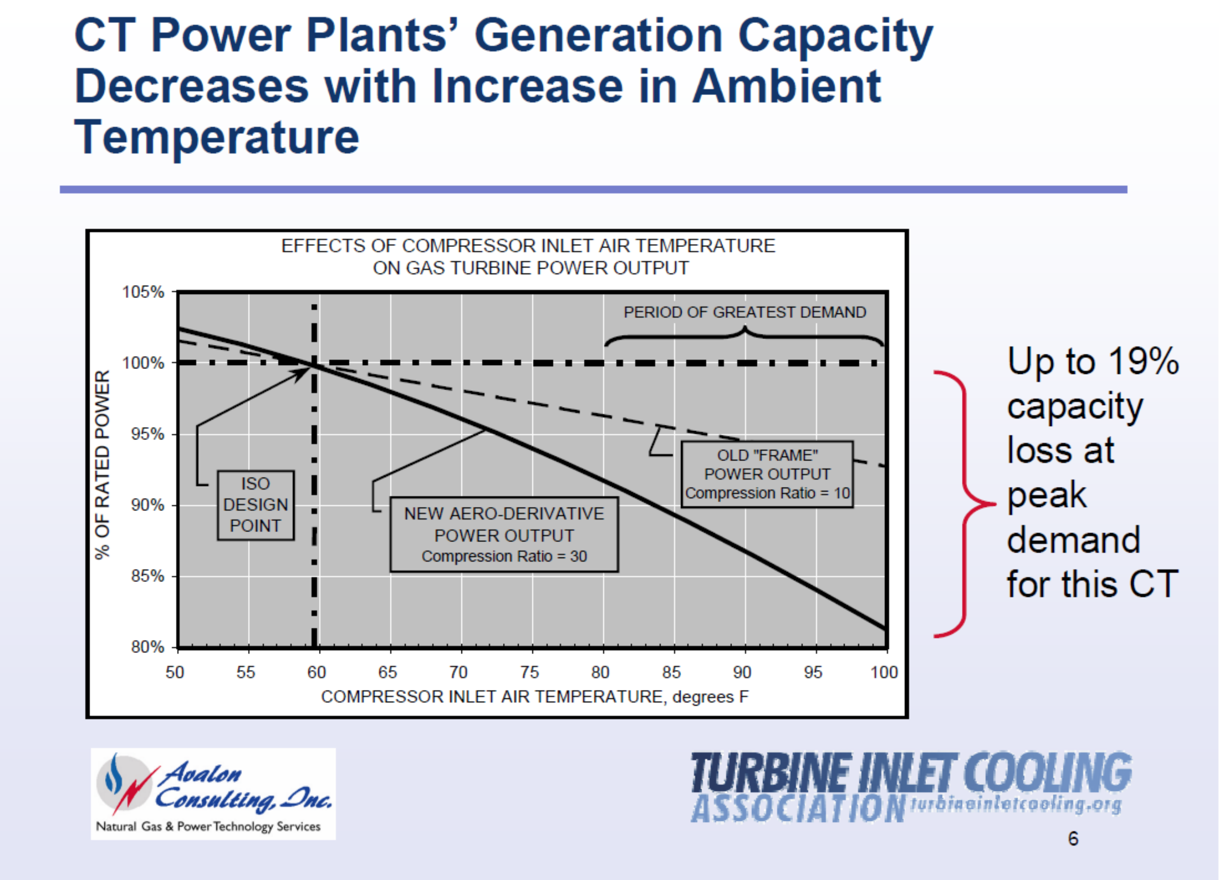
High ambient temperatures reduce load at most critical time

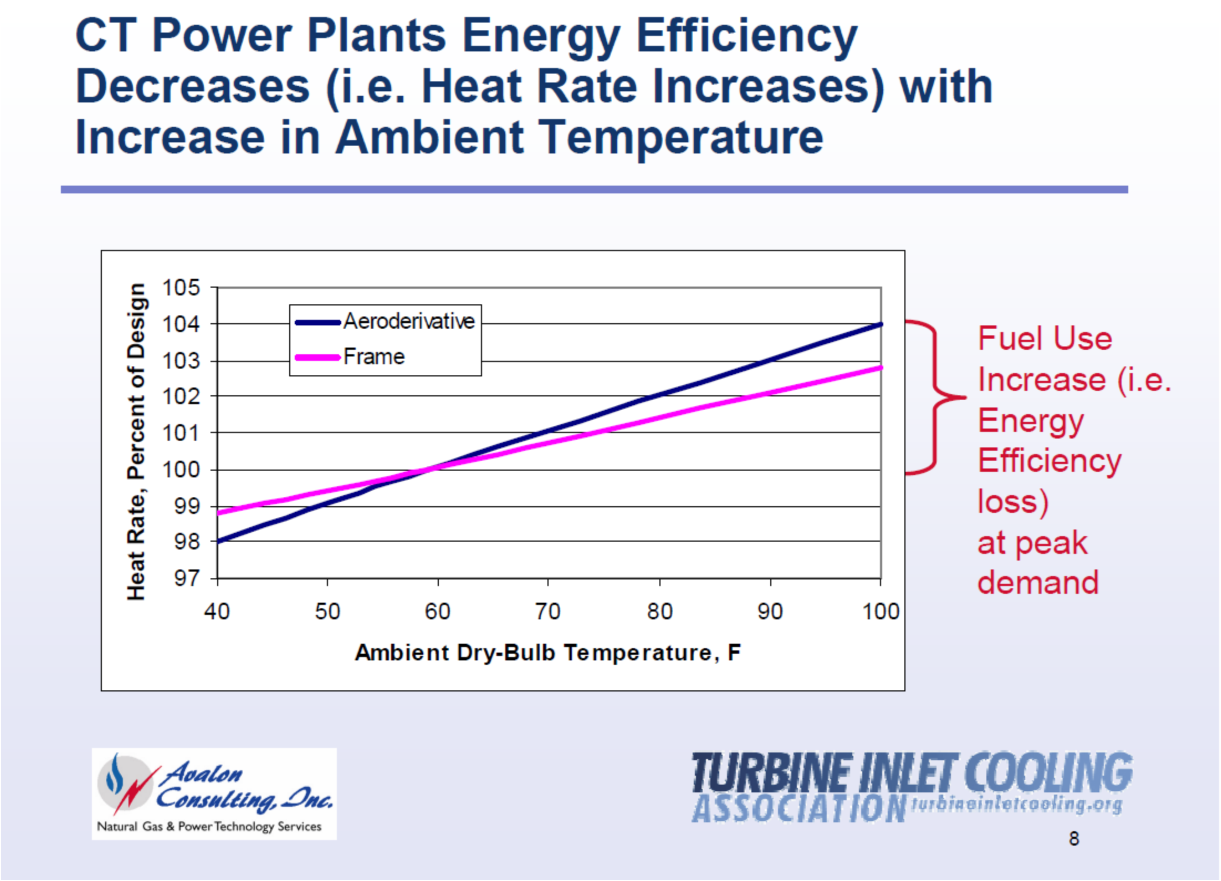


Capacity decreases with rising temperature

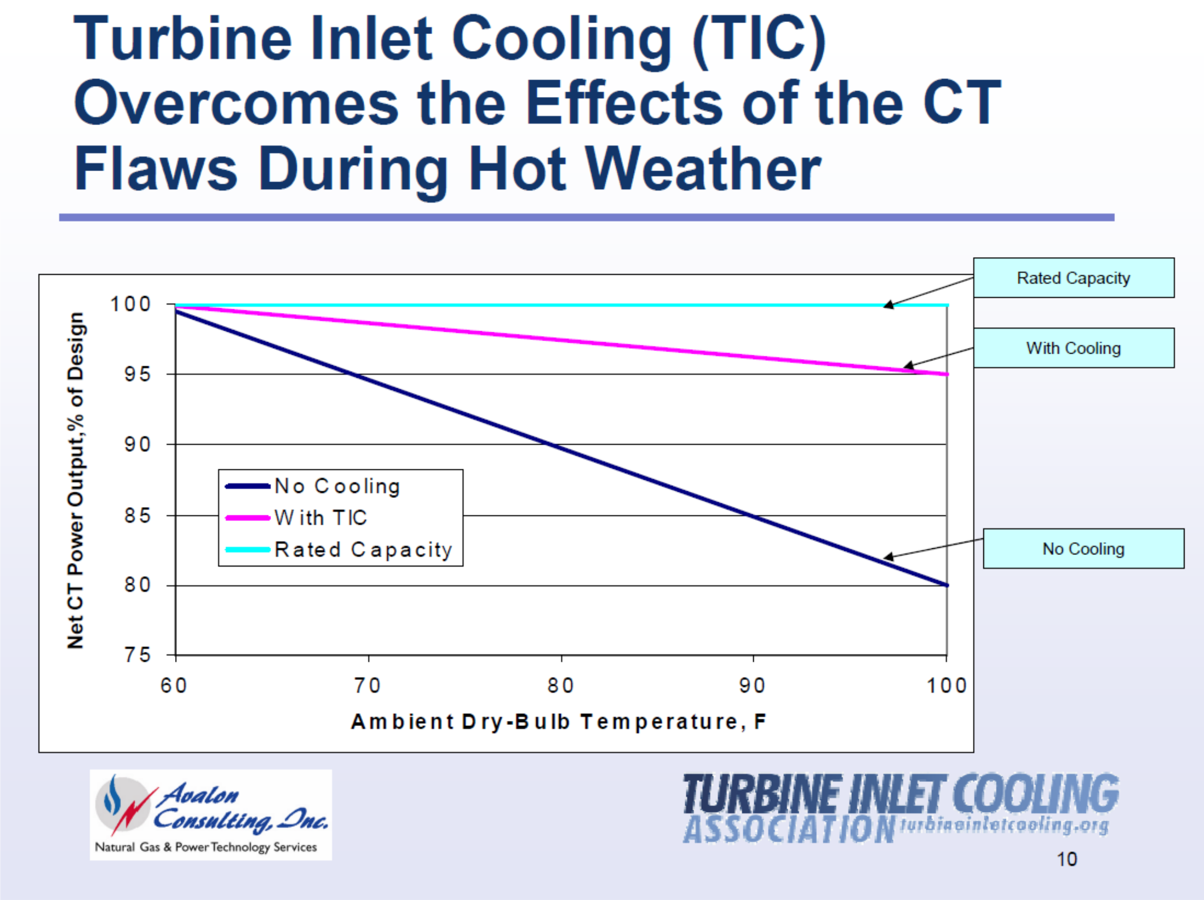


Up to 19% capacity loss at peak demand for this CT

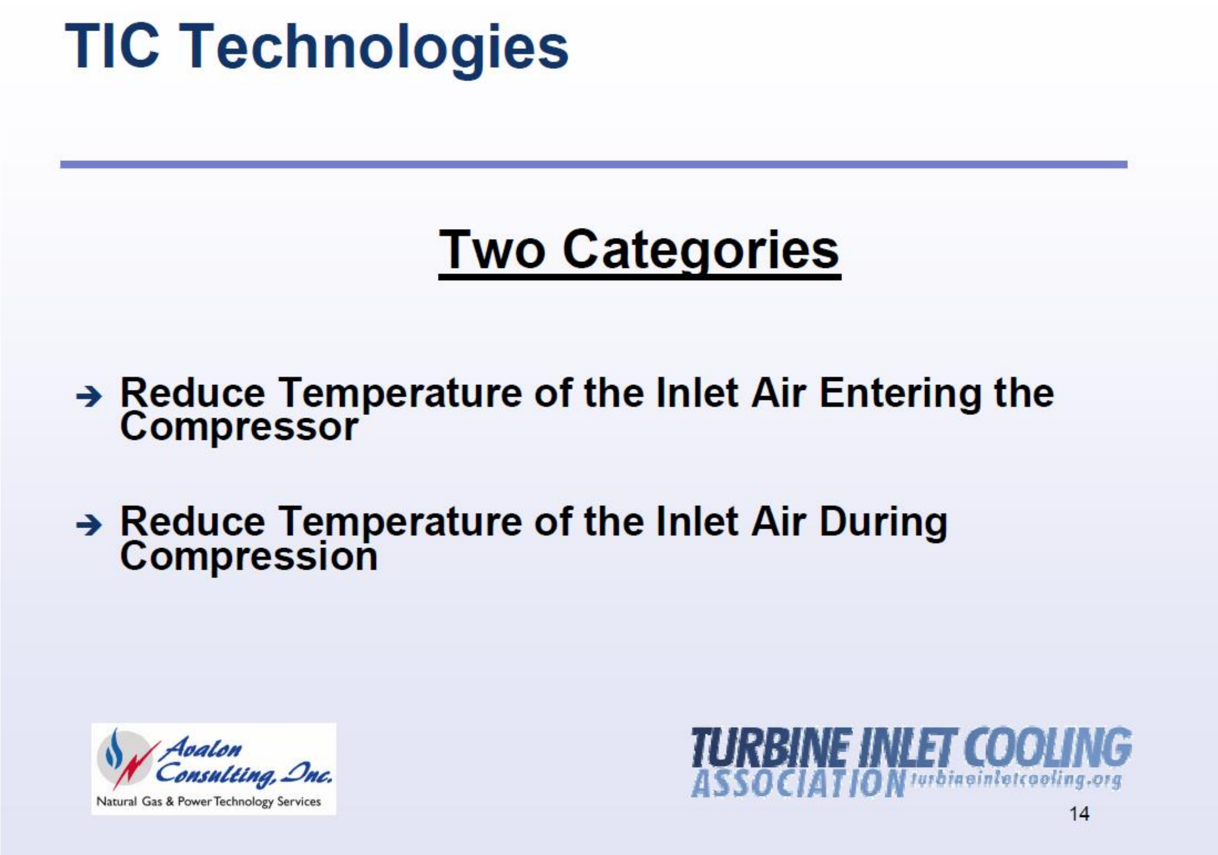
Impact of ambient air temperature on heat rate



Inlet cooling increases output



Temperature reduction -Inlet air or during compression



6 ways to reduce air inlet temperature

TIC Technologies

Reducing Inlet Air Temperature

- **Direct Evaporation**: Wetted Media, Fogging
- **Indirect Evaporation**
- **Chilled Fluid:** Indirect Heat Exchange, Direct Heat exchange
- **Chilled Fluid in TES:** Full-Shift and Partial-Shift
- **LNG Vaporization**
- **Hybrid:** Some combination of two or more cooling technologies

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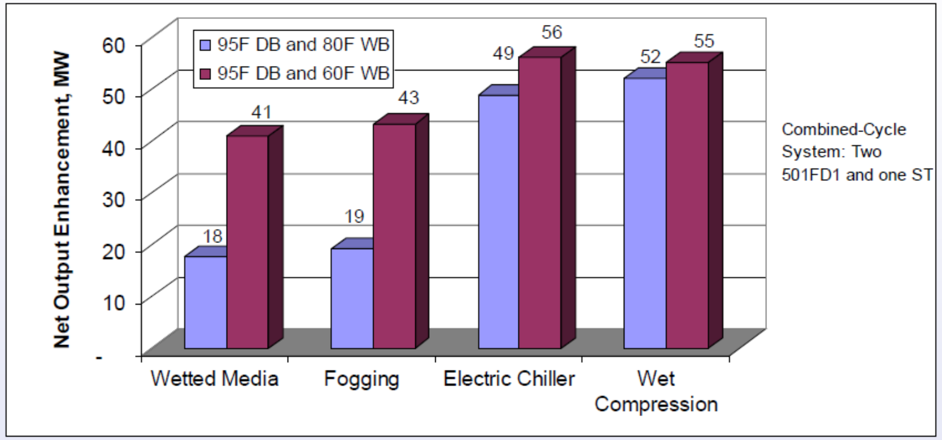
Examples of capcity enhancement with inlet cooling

Examples of the Effect of TIC Technology and Ambient Temperature on Capacity Enhancement



Sources:

Wet Compression: Caldwell Energy, Inc.

All Others : D.V. Punwani Presentation, Electric Power 2008

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Factors determining economics of iinlet cooling

Factors Affecting the Economics of TIC

- TIC Technology
- CT Characteristics
- Weather Data for the Geographic Location of the CT
- Market Value of the Additional Electric Energy Produced
- Fuel Cost

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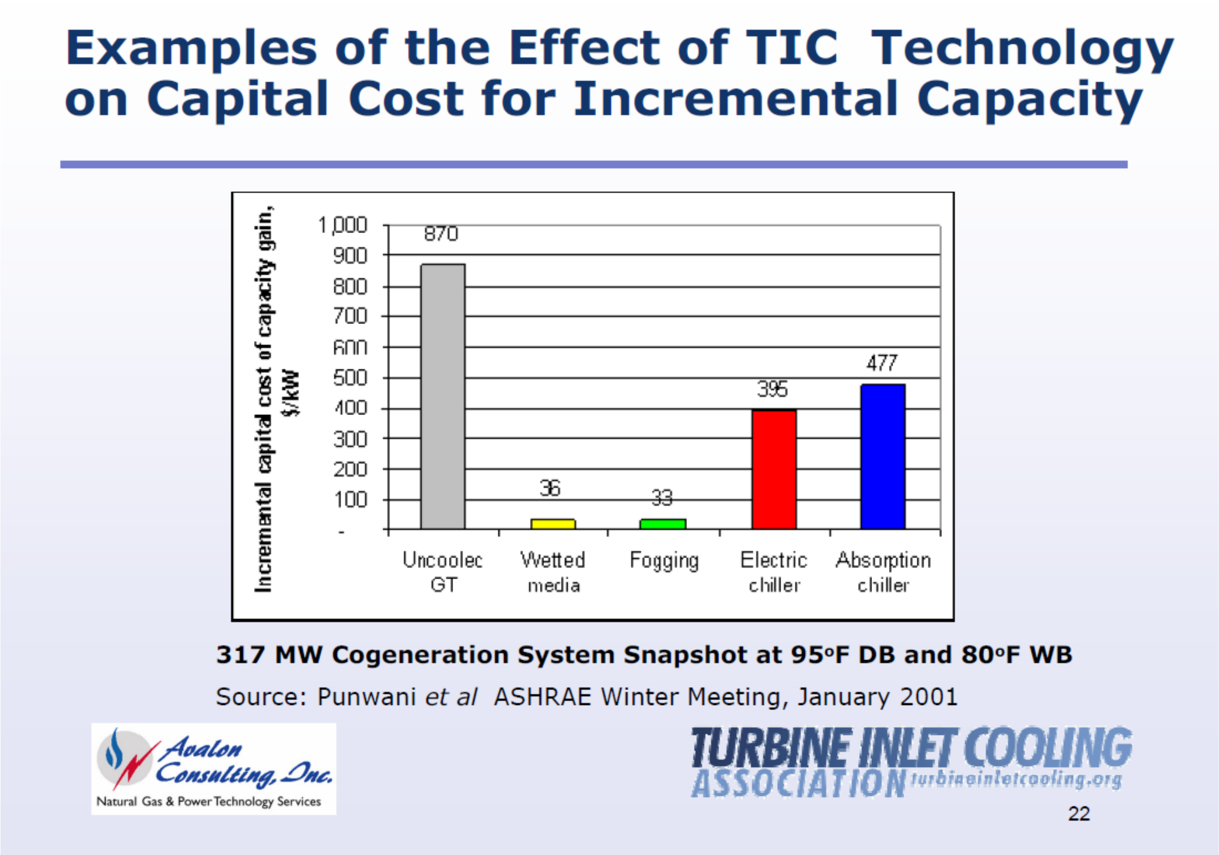
Incremental capital cost for inlet cooling



GTE's Water Injection and Power Augmentation System

Water injection system

- GTE created a single skid that incorporated both the Water Injection and Power Augmentation systems. The system is capable of interfacing with virtually any control system and gas turbine fuel system. One of the specification requirements was to have a system that did not require control air or hydraulics to operate. GTE employed a high-speed electronic valve to control NOx water flow rates and a water actuated stop valve to provide positive, failsafe shutoff. Power augmentation was accomplished via VFD driven positive displacement pumps for inlet water fogging. This modular, all-electronic approach created a universal fit system that easily interfaced with the two different turbine fuel and control systems.

results

- NOX levels achieved: GE Frame 5: 74-76ppm P&W FT4A: 68-70ppm
- • Power augmentation increase: 5-8% adjustable, based on demand and ambient conditions
- • Water Injection and Power Augmentation incorporated into one system
- • Commonality of design across GE and Pratt & Whitney engines

Steam injection at PGE Gorzow

- Summary. The impact of steam injection upon a gas turbine and a combined power plant performance has been investigated. This article describes and summarizes possibilities of modification for current gas turbine in PGE Gorzow power plant into the Cheng cycle. Our modification deals with a thermal cycle, in which steam produced in a heat recovery steam generator is injected into the gas turbine's combustion chamber. It has been proved that an increase of the mass flow rate of the expanded exhaust gases causes an increase in both the power and efficiency of gas turbine. Steam injection also helps to reduce NOx formation and is profitable from a thermodynamic, economic and ecological standpoint. The numerical analysis of thermal cycles, before and after the modification, has been carried out by means of an in-house COM-GAS code and Aspen Plus commercial package
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