

**LOTHECO**



**“Combined Cycle Power Plant with Integrated  
Low Temperature Heat”**

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# LOTHECO

## ENK5-CT-2000-00063



- EU project within 5th Framework Program
- Duration: 30 months (1<sup>st</sup> October 2000 - 30 April 2003)
- 6 partners: PPC, TU-BS, NTUA, TUM, ICSTM, FICHTNER
- Total project value: 340,087 Euro
  
- Objective: Investigation and development of an innovative Natural Gas Fired Combined Cycle, making use of low temperature waste heat to evaporate injected water droplets into the compressed combustion air of the gas turbine
  
- Focus on:
  - Cycle optimisation
  - Performance of feasibility studies for potential test cases application
  - Study and market survey on the components of the cycle
  - Experimental work on the gas turbine's combustor

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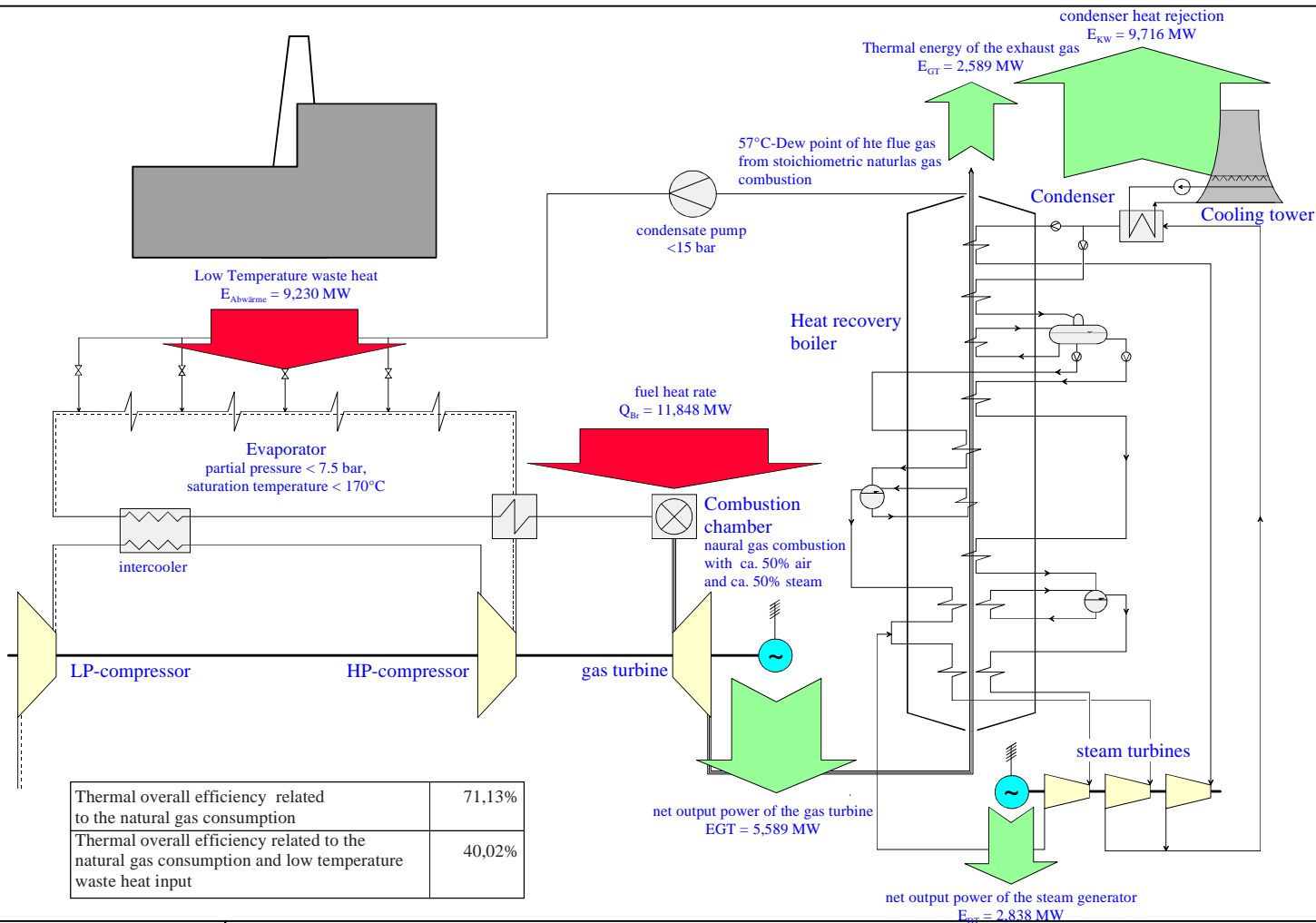
## ENK5-CT-2000-00063



- Application of LOTHECO cycle for the case of a paper mill in Greece (layout+calculation)
  - ↳ TU-BS
- Test rig modification, preparation for combustion chamber measurements
  - ↳ ICSTM
- Market survey for compressor and gas turbine
  - ↳ TUW
- Acquisition of data on potential sites for implementation of the new concept
  - ↳ PPC
- Basic configuration of water evaporator
  - ↳ NTUA
- Study of heat recovery boiler with water vapour condensation from the flue gas
  - ↳ NTUA

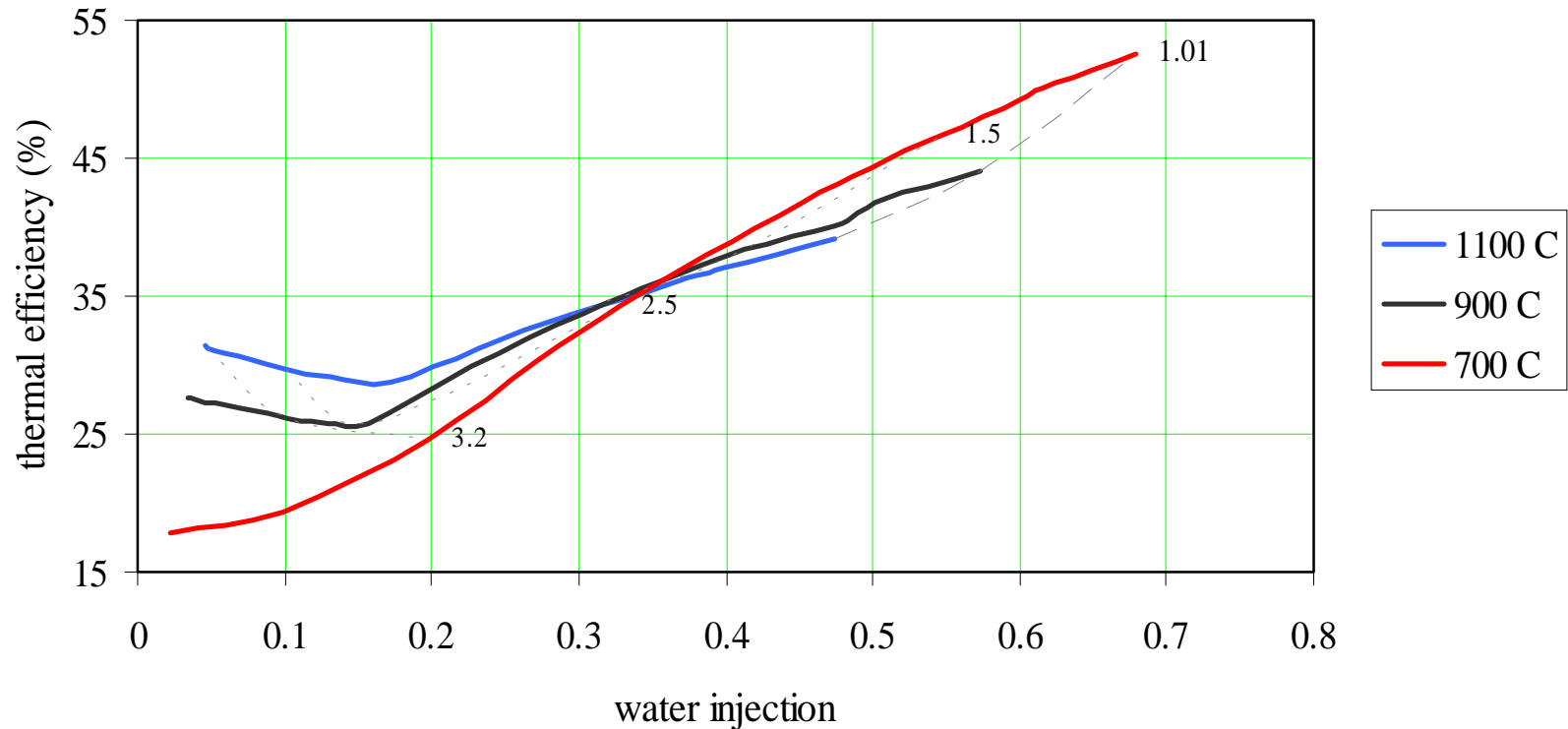
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thermal efficiency - water injection diagram





- Establishment of the possibility to conduct combustion measurements at smaller flow rates than originally intended
- Purchase of new steam generator
- Combustion measurements under way
- To be finished by month 15



- Market survey and proposals on configuration of gas turbine
  - ↳ Gas turbine with steam injection
  - ↳ Combination of industrial compressor and expander
- Market survey on steam turbines
  - ↳ Conventional steam turbine
  - ↳ Low-pressure steam turbine with sub- atmospheric inlet pressure



(1) Gas Turbine

- Turbine vs. comp. flow capacity (Steam to air ratio 1:1)

(2a) Compressor

- Industrial compressor ( $T_{out,max} \sim 300^{\circ}C$ )  $\Rightarrow$  Intercooler

(2b) Turbine

- Expander
- High H<sub>2</sub>O-content (60-80%)
  - Typical industrial exp. inlet temp. 500-600°C
  - $\Rightarrow$  Cooling required for higher temperatures

- Steam Turbine
- Turbine inlet temperature exceeds limit ( $T_{in} \sim 700^{\circ}C > T_{Limit} \sim 500-600^{\circ}C$ )





(3a) Conventional Steam Turbine

- Specification subsequent to final decision on low-pressure steam turbine

(3b) Low-Pressure Steam Turbine

- Turbine inlet pressure below *1bar*
- Small pressure ratio  $\Pi \sim 5$   
⇒ Uncommon axial and radial dimensions of rotating and stationary components



- 21 inquiries to date
- 12 replies received
  - ↳ 3 definite offers
  - ↳ 2 offers being refined
  - ↳ 7 inquiries not resulting in offers
- 9 responses pending



- Responses from companies are slow, probably because of the reduced engineering staff available for studies
- The LOTHECO team needs to be flexible and prepared to analyse cycle alternatives rather quickly if a fast response is expected from the manufacturers in return
- Guidelines on the number of plants that might be realised within a given period of time are needed.



- Preliminary design of evaporator
  - ↳ Study of various configurations for water injection in pressurised air
  - ↳ Selection of an optimum tube length for evaporation
  - ↳ Study of steam-air heat exchangers
  
- Preliminary design of HRSG
  - ↳ Selection of basic dimensions, material, number and geometry of tubes for each heat transfer surface

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- Application of LOTHECO cycle for three envisaged test cases (layout+calculation)
  - ↳ TU-BS
- Results from combustion chamber measurements
  - ↳ ICSTM
- Continuation of market survey on compressor and turbine
  - ↳ TU-BS
- Identification of main characteristics of the condensate polishing plant
  - ↳ NTUA
- Market survey for the evaporator
  - ↳ NTUA
- Identification of one ISCCS project, calculation and evaluation
  - ↳ Fichtner
- Identification of potential sites for implementation of the new concept
  - ↳ PPC, Fichtner, TU-BS, NTUA