Design Optimization International Conference,
March 31- April 2 2004, Athens, Greece,

INSTRUCTIONS TO PREPARE THE FINAL PAPER FOR THE ERCOFTAC DESIGN OPTIMIZATION 2004 INTERNATIONAL CONFERENCE

First A. Author*, **Second B. Author**†,
Third C. Author†

*National Technical University of Athens,
Lab. of Thermal Turbomachines,
P.O. Box 64069, Athens 157 10, GREECE,
e-mail:design04@mail.ntua.gr,

Key words: Design, Optimization, Evolutionary Algorithms, Adjoint Formulation, Aeronautics, Turbomachinery, Hydraulic Machines, Combustion, Fluid Mechanics, Heat Transfer, Power Generation.

Abstract. *This document provides instructions for the preparation of the final paper for the ERCOFTAC DESIGN OPTIMIZATION 2004 INTERNATIONAL CONFERENCE (Athens, March, 31–April, 2 2004). The paper can be written in Tex, Latex or MS–Word; if MS-Word is to be used, the authors are kindly requested to use a similar template. Before submission, the full paper should be translated to Portable Document Format (PDF).* **Please do not excess the maximum size of twelve (12) pages! Please read carefully instructions included in the section entitled JOURNAL PUBLICATION.**

1 INTRODUCTION - DESCRIPTION OF THE PROBLEM

Electric power generation using both gas and steam turbines, operating in combined cycle, is nowadays in widespread use. The main reason is that combined–cycle gas turbine power plants have short erection time, low investment cost and higher efficiency compared to conventional steam power plants. This paper presents a design method for optimal combined–cycle power plants with supplementary firing, such as the one shown in fig. 1. Supplementary firing is employed at the gas turbine exit (position 0) in order to increase the temperature of exhaust gases entering the heat–recovery steam–generator, in the expense of additional fuel consumption. As already mentioned, the goal is to design power plants with maximum efficiency, maximum power output and minimum investment cost.

The design variables are listed below:

- high–pressure steam pressure,
- low–pressure steam pressure,
- superheated steam temperature at the exit of the high–pressure branch of the steam generator,
- feedwater temperature at the inlet to the high–pressure evaporator,

- feedwater temperature at the exit from the first high–pressure economizer,
- feedwater temperature at the inlet to the low–pressure evaporator, etc.

Twelve inequality constraints were imposed to ensure feasible heat exchanger design.

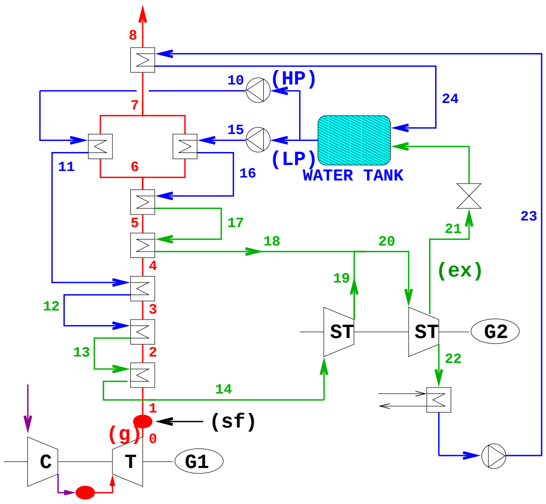

Figure 1: Combined Cycle Gas Turbine Power Plant with Supplementary Firing.

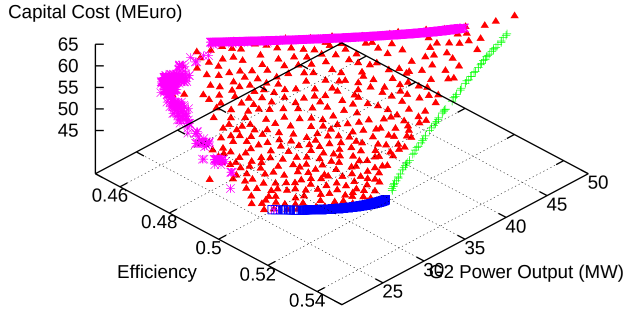

Figure 2: The computed Pareto front.

2 THERMODYNAMIC ANALYSIS

The power plant involves the Rankine steam cycle...

3 OPTIMIZATION AND ANALYSIS TOOLS

The optimization of the combined–cycle power plant is carried out using evolutionary algorithms, [1], [2]. The population size is 100 and binary coding is used. All inequality constraints are taken into account by penalizing the cost value of all the objectives. Practically, for any inequality constraint of the form $T_a \geq T_b$, the penalty factor $p_i = e^{\Delta T/T_b}$ $(\Delta T = T_a - T_b < 0)$ is first computed. The total penalty factor p_{tot} is the product of all p_i's and the penalized cost value is the $y_k = y_k/p_{tot}$.

4 RESULTS

Some indicative results are given below. So, in fig. 2, the Pareto fronts computed through four optimization runs are shown. This $3D$ plot includes one Pareto front (surface, formed by a cloud of points) from a three-objective optimization and three Pareto fronts ($3D$ curves) resulted from three two–objective optimizations. For the latter, the objectives were (a) max.efficiency–max.power, (b) max.efficiency–min.cost and (c) max.power–min.cost.

5 JOURNAL PUBLICATION

Authors may submit their full paper for further review and possible publication in the Elsevier Journal **"Computer Methods in Applied Mechanics and Engineering"** . This journal publishes papers concerned with applications of digital computers to problems of applied mechanics and engineering. Papers submitted to the Journal should be of advanced character, containing substantial contributions to these fields and detailing methods as well as results. Papers dealing with techniques of wide applicability, beyond the boundaries of the field in which they were established, are especially emphasized.

Authors who would like to submit their full paper to the aforementioned journal should:

- read carefully the instructions for the preparation of the manuscript which are available on the Journal webpape *http://www.elsevier.com/locate/issn/00457825*,
- prepare a variant (according to the Journal instructions) of their ERCOFTAC paper and
- send it to **design04@mail.ntua.gr** (conference secretariat) by email; PLEASE, DO NOT SEND YOUR MANUSCRIPT DIRECTLY TO THE JOURNAL (or, if you do so, please act independently, without relating your submission to the ERCOFTAC Conference!)

Submission of a full paper for possible publication in **Computer Methods in Applied Mechanics and Engineering** is possible under condition that it, or any translation of it, has not been copyrighted or published or even submitted for publication elsewhere. Upon acceptance of an article for the Journal, the author(s) will be asked to transfer copyright of the article to the Publisher. It is evident that papers submitted to the Journal will be re–reviewed by two independent reviewers, according to the Journal standards. However, the whole process will be carried out through the **ERCOFTAC Design Optimisation: Methods & Applications** Conference Scientific Committee and the time required for the review process will be kept minimum.

6 CONCLUSIONS

...it is evident that a very high efficiency is achieved...

REFERENCES

[1] Giannakoglou, K.C., Design of Optimal Aerodynamic Shapes using Stochastic Optimization Methods and Computational Intelligence, Progress in Aerospace Sciences, 38, pp. 43-76, 2002.

[2] Karakasis, M., Giotis, A.P., Giannakoglou, K.C., Efficient Genetic Optimization Using Inexact Information and Sensitivity Analysis. Application in Shape Optimization Problems, ECCOMAS CFD Conference 2001, Swansea, Wales, 2001.