10th CONFERENCE
ON SUSTAINABLE
DEVELOPMENT OF
ENERGY, WATER
AND ENVIRONMENT
SYSTEMS

10th sdewes Conference Dubrovnik 2015

BOOK OF ABSTRACTS

Edited by:
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www.dubrovnik2015.sdewes.org

September 27 - October 2, 2015
Dubrovnik, Croatia

SDEWES2014.0697 CHP Retrofit for a Large Med-Tvc Desalination Plant: High Efficiency Assessment for Different Design Options Under the Current Legislative EU Framework

A. Cipollina[1], G. Micale*[1], A. Piacentino[2], A. Tamburini[1]

[1]Università degli Studi di Palermo, Italy; [2]University of Palermo, Italy(*giorgiod.maria.micale@unipa.it)

Abstract

A main obstacle to the economic viability of thermal desalination (TD) processes for seawater desalination is represented by the high energy consumption per m^3 desalinated water. However, as the most common TD technologies (like Multiple Effect Distillation, MED, and Multi-Stage Flash, MSF) may be fed via low temperature motive steam, dual-purpose configurations, simultaneously producing electricity and fresh water, are often considered as a more attractive option.

In this paper an existing MED plant with Thermal Vapor Compression (TVC) is examined, consisting of 4 MED units, each with a capacity of 9000 m^3/day of fresh water, and located in Sicily (Italy). Due to the high water production cost, the potentials of a retrofit action are analyzed, involving the replacement of the currently installed natural gas boiler with a power plant with condensation and steam extraction.

According to the current legislative framework, the heat consumed to drive a thermal desalination plant is "useful heat"; then, margins exist to design the retrofit plant so as to have it assessed as "high efficiency cogeneration". According to the Annex II of the Directive 2004/8/EC, the examined plant has a 80% minimum threshold for the total energy efficiency to have the whole amount of electricity produced assessed as "from efficient CHP"; also, in order to calculate the Primary Energy Saving index, the system requires a preliminary evaluation of the power loss factor β, which depends on a number of factors.

In this paper, a parametric analysis is performed by joining:

- The results of a detailed model of the MED-TVC plant developed in gPROMS®;

- A routine, developed in Engineering Equation Solver, that models the power plant.

The main design parameters or variables considered in the present study are:

- The number of MED units to be served by motive steam extracted from the power plant. In fact, due to the modular design of the MED-TVC section, the power plant may be scaled so as to drive only some of the 4 units (also depending on their annual operation time, that is adjusted to face the variable water demand from the served community);

- The steam extraction pressure, that is obviously related with both the power production rate and the "entrainment ratio" of the steam jet ejector;

- The particular fossil fuel used.

- The obtained results indicate that an appropriate selection of the aforementioned design parameters is required to have a significant fraction of the produced electricity assessed as "from efficient cogeneration". The operating point of the plant under the different design options is also plotted on a "Electric efficiency/Thermal efficiency" diagram to provide a graphical interpretation of the constraints imposed by the current legislative framework.