



European Desalination Society



Desalination with solar energy

A 4-day intensive course

May 3–6, 2010, Almería, Spain

Introduction

Desalination of sea and brackish water is a common technique to alleviate the increasing shortage of fresh water in many areas of the world today. Nonetheless, desalination processes require large quantities of energy, so their implementation is jeopardized by a significant environmental impact if fossil fuels are used. In addition, the cost of the different desalination techniques is very closely linked to the costs of energy. Therefore, in a context of continuously rising energy costs and with the impending exhaustion of the conventional energy resources, the development of desalination technologies associated with the use of renewable energies is a very attractive and promising prospect. This is especially true in the case of solar energy, as the regions with greater water shortages tend to be those with higher solar radiation.

Objectives

The general purpose of this 4-day intensive course is to provide experts, professionals and postgraduate students from all around the world with the latest knowledge of the different existing technologies involving the use of solar energy to drive desalination techniques. More specifically, the course will instruct scientists and technicians on the basic principles of desalination using solar energy, the state of the art of the most promising technologies and the experiences acquired so far. Theory lessons will be complemented with visits to the test facilities of Plataforma Solar de Almería operating on solar power production and desalination, which are the most advanced in the Mediterranean area.

Venue

The course will take place at the Hotel Tryp Indalo Almería, and one day will be spent on a technical visit to the operating facilities of Plataforma Solar de Almería (PSA).

This research centre, belonging to the public research institution CIEMAT, is one of the biggest and most complete existing facilities for the research, testing and development of solar technologies and their applications. It is located near the village of Tabernas, about 35 km from Almería city.



The Tryp Indalo Almería is a 4-stars hotel opened in 2004, beautiful yet modern, spacious and comfortable, providing ideal facilities and services for both business and leisure travellers, including the finest hi-tech meeting and congress venue in Almería. The hotel is located on the prestigious Mediterráneo Avenue, only 15 minutes from the beach, near the city centre of Almería.



Hotel Tryp Indalo Almería

Almería is a sun-baked province located in the far Southeast corner of the Iberian peninsula, with the most hours of sunshine and lowest rainfall in Europe. As a result of this climate, much of the province is comprised of semi-arid desert-like landscape and much of the area is a sparsely populated wilderness. Almería's skies, with an annual average of 3,000 hours of sunshine, are also the clearest in Europe. This hot climate and the natural protective barrier of Sierra de Gádor means that Almería is one of the most productive agricultural zones in Europe, with more than 10,000 Ha of land cultivated commercially for fruit, vegetables and flowers. Almería is the location of one of Andalucía's most outstanding wildlife areas and its largest coastal reserve, the Cabo de Gata-Níjar Natural Park. The provincial capital and port of Almería is overlooked by a vast, sprawling Moorish citadel, the Alcazaba. Also well worth exploring is Almería's old town, peppered with interesting monuments, including a cathedral with an impressive Gothic interior, a 300-year-old hospital and great tapas bars. In addition, a large number of very impressive beaches and modern tourist resorts attract the visitors to the province year round.



Syllabus

The course is organized in four modules

A) Introduction

1. Fundamentals of solar energy.
2. Fundamentals of water desalination.
3. Conventional desalination technologies.

B) State of the art of the technologies of solar desalination

4. Low capacity solar thermal distillation systems.
5. High capacity solar thermal distillation systems.
6. Solar powered membrane distillation.
7. Desalination with photovoltaic energy.
8. Research trends in desalination with renewable energy

C) Technical visit to PSA installations

9. Technical visit to solar power production installations.
10. Technical visit to solar multi-effect distillation plant.
11. Technical visit to other desalination facilities (membrane distillation, solar-driven ORC, CSP+D test-bed).

D) Solar desalination and the environment

12. Solar Ponds and brine management
13. Coupling of desalination with solar power generation
14. Economical and environmental aspects of desalination using solar energy



AQUASOL solar multi-effect distillation plant at PSA

Lecturers:

The course will be given by researchers and scientists from Plataforma Solar de Almería (CIEMAT-PSA):

- **Dr. Ing. Julián Blanco Gálvez** Course director. Head of Environmental Applications of Solar Energy unit of CIEMAT and Operating Agent of SolarPACES Task VI (Solar Energy and Water Processes and Applications). Large experience in the coordination and development of international R&D projects. Author of 7 books, 18 chapters and more than 60 SCI publications.
- **Dr. Diego-César Alarcón Padilla** Researcher with extensive experience in European R&D Projects related with the combination of solar thermal energy with desalination processes. He has published more than ten scientific papers in the field of solar energy and water treatment, co-author of two books in the field of solar desalination.
- **Dr. Guillermo Zaragoza** Researcher with extensive working experience in the application of renewable energy to desalination, including solar distillation and projects that combine it with greenhouse agriculture and architecture. He has participated in European R&D Projects and published over ten scientific papers in the field.
- **Elena Guillén** Staff of Environmental Applications of Solar Energy group at PSA specialized on membrane distillation systems using solar energy, with significant experience in the setup and testing of different commercial and research membrane distillation modules.



Plataforma Solar de Almería (PSA) in Tabernas, Almería (Spain)

Course Program:

DAY 1 Introduction to Solar Energy and Desalination

- 09:00 - 09:15 Opening and Introduction to the course
- 09:15 - 10:45 Fundamentals of Solar Energy I
Solar radiation
Low temperature solar collectors (Flat plate collectors;
CPC collectors; Evacuated tube collectors)
- 10:45 - 11:00 *Coffee break*
- 11:00 - 12:30 Fundamentals of Solar Energy II
Medium and high temperature solar thermal collectors
(Central receivers; Parabolic troughs; Fresnel collectors;
Parabolic dishes)
Photovoltaics
Energy storage in solar plants
- 12:30 - 13:30 Fundamentals of water desalination
Historic background
Definitions and fundamental parameters
Classification of desalination processes
Current world outlook
- 13:30 - 15:00 *Lunch*
- 15:00 - 17:00 Conventional desalination technologies
Thermal processes (Multi-stage flash evaporation; Multi-
effect distillation; Multi-effect distillation with thermo-
compression; Mechanical vapor compression)
Membrane processes (Reverse osmosis;
Electrodialysis)

DAY 2 Technologies of Solar Desalination

- 09:00 - 11:00 Low capacity solar thermal distillation systems
Solar stills
Technologies of Humidification-Dehumidification
- 11:00 - 11:15 *Coffee break*
- 11:15 - 13:15 High capacity solar thermal distillation systems
Multi-stage flash evaporation
Multi-effect distillation
Multi-effect distillation with thermo-compression
- 13:15 - 14:45 *Lunch*
- 14:45 - 15:45 Solar powered membrane distillation
- 15:45 - 16:45 Desalination with photovoltaic energy
- 16:45 - 17:45 Research trends in desalination with renewable energy

DAY 3 Practical Work at Plataforma Solar de Almería

09:00 – 10:00 *Trip to Plataforma Solar de Almería*

10:00 - 11:30 Technical visit to solar power production facilities at PSA (central receiver and parabolic trough)

11:30 - 12:30 Technical visit to MED plant at PSA

12:30 - 14:00 Technical visit to other PSA desalination facilities (solar membrane distillation plant, solar-driven ORC, CSP+D test-bed)

14:00 - 15:30 *Lunch*

15:30 - 16:30 *Return to hotel*



AQUASOL solar distillation plant at PSA

DAY 4 Solar Desalination and the Environment

09:00 - 11:00 Solar ponds and brine management

11:00 - 11:15 *Coffee break*

11:15 - 12:45 Coupling of desalination with solar power generation

12:45 - 14:15 Economical and environmental aspects of desalination using solar energy

14:15 - 16:00 *Lunch and adjourn*

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May 3–6, 2010, Almería, Spain

Lecturers: Julián Blanco Gálvez, Diego-César Alarcón Padilla,
Guillermo Zaragoza, Elena Guillén

REGISTRATION FORM

Surname _____ Name _____
Address _____
Country _____ Telephone _____
Fax _____ Email _____

Registration fee: For EDS members: **€2,150** For non-members: **€2,350**

The fee includes 5 nights accommodation, lunches, coffee, dinners, course Workbook and CD.

Payment can be made by:

Credit card

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send as an attachment to:

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or fax to: +1 928 543 3066