PRODES

Promotion of Renewable Energy for Water production through Desalination

Deliverable 3.2

Desalination with Renewable Energy:

Main contents of a higher education course

Elaborated in January 2009 by:

Plataforma Solar de Almería (CIEMAT)

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The aim of this document is to outline the main aspects that should be addressed in a higher education course on desalination powered by renewable energy. It establishes a comprehensive overview on desalination technologies, renewable energy generation, and their combination. The course covers the theory basis but also some practical aspects, with the purpose of training engineers and scientists.

The material presented here is intended to act as a guideline for the implementation of specific courses. The contents can be adapted to configure different training courses that reach the needs of diverse target audiences.

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ADVANCED COURSE ON DESALINATION POWERED BY RENEWABLE ENERGY

THEORY CONTENT (themes are presented with their relative contribution to the total)

1. Introduction. Basics and principles of salt water chemistry. Definition and fundamentals of desalination. Historical overview . [5%]

2. Conventional desalination processes and technologies. State of the art of desalination industry. Current technologies, their evolution and perspectives. [15%]

3. Renewable energies in relation to desalination. State of the art of renewable energy generation technologies and their application to desalination processes. [7.5%]

4. Technologies for desalination powered by renewable energy. Description of the basics of the technology and the development of the engineering of several desalination processes powered by solar energy.

4.1. Solar thermal energy and desalination.

4.1.1. Solar stills. Simple distillation systems based on the passive evaporation of saline water in greenhouse-type devices. [5%]

4.1.2. High capacity solar thermal distillation. Advanced systems of thermal distillation using active solar heating, as multi-effect distillation (MED) and multi-stage flash distillation (MSF). [5%]

4.1.3. Solar thermal membrane distillation. Thermally-driven systems based on hydrophobic micro-porous membranes to separate vapour from a salt water stream through the establishment of a vapour-liquid interface between both sides of the membrane. [7.5%]

4.1.4. Solar thermal humidification/dehumidification. Technologies that replicate the natural cycle of water, with evaporation of saline water and condensation at atmospheric pressure. [5%]

4.1.5. Solar ponds. Thermal desalination processes coupled with salinity-gradient solar ponds as a source of thermal energy. [5%]

4.2. Solar photovoltaic and desalination. Combination of electricity produced by solar photovoltaic energy and desalination using techniques of reverse osmosis and electrodialysis reversal. [10%]

4.3. Wind energy and desalination. Combination of electricity produced by wind energy and desalination using techniques of reverse osmosis and electrodialysis reversal. [10%]

4.4. Other renewable energy sources and desalination. Other processes which associate wave, tidal or geothermal energy generation with desalination. [5%]

5. Design and operation of desalination plants powered by renewable energy. Operation and management of industrial plants. Control and remote monitoring systems. Handling of detrimental effects as scaling, corrosion and fouling. Necessary pre-treatments and post-treatments to guarantee successful plant operation. Optimization of energy consumption and water cost. [10%]

6. Environmental issues on desalination powered by renewable energy. Environmental implications of desalination technologies and their association with renewable energies. [5%]

7. Economic and sustainability issues of desalination powered by renewable energy. Basic economics of the described technologies, costs of operation and maintenance, desalinated water tariff, etc. Sustainability also entails other aspects of society, as the policies of desalination and the involvement of the local community. [5%]

PRACTICAL CONTENT (themes are presented with their relative contribution to the total)

1. Practical assessment of solar energy resource. Basics of solar radiation measurement equipment and procedures. Available meteorological data suitable for solar radiation assessment. Characterization of solar radiation resources from in-situ measurements or meteorological data series. [15%]

2. Practical assessment of wind energy resource. Basics of wind energy resource measurement equipment and procedures. Available meteorological data suitable for wind energy assessment. Characterization of wind power resources from in-situ measurements or meteorological data series. [15%]

3. Mass and energy balances in thermal desalination processes, with basic concepts of design. Addressing the physics and chemistry basics of the desalination processes, and how they reflect on the design of the processes and technologies. [10%]

4. Design of low temperature (T < 80ºC) solar thermal fields to be coupled to a membrane distillation / humidification-dehumidification desalination system. Optical and thermal characterization of stationary solar collectors. Technical description of solar plant components and configuration. Solar plant dimensioning for prescribed thermal load and solar resources. [10%]

5. Design of intermediate (80ºC < T < 200ºC) solar thermal fields to be coupled to a multi-effect distillation (MED) plant. Optical and thermal characterization of tracking solar collectors. Technical description of solar plant components and configuration. Solar plant dimensioning for prescribed thermal load and solar resources. [10%]

6. Process design of a conventional membrane desalination process. Major components, process steps and configuration of membrane desalination plants. Optimization of power consumption and water cost. [10%]

7. Design of a solar photovoltaic field to be coupled to a reverse osmosis desalination plant. Photovoltaic panel characterization parameters. Technical description of solar photovoltaic plant components and configuration. Dimensioning for prescribed energy requirements. [10%]

8. Design of a wind energy field to be coupled to a reverse osmosis desalination plant. Wind energy turbine characterization parameters. Technical description of wind energy plant components and configuration. Dimensioning for prescribed energy requirements. [10%]

9. Overview of demonstration installations. Assessment and discussion of real plants, with thorough examination of experiences gained regarding performance, technical issues of operation, main problems encountered and cost analysis. [10%]