

The Handling and Control of the Desalination Plant Salt Water Using Sustainable Solar Energy

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Abstract: The paper proposes a style of approach and control of plant water desalination using sustainable solar energy in order to protect and preserve the national economy through the study and tests performed on the station water desalination using sustainable solar energy to one of existing facilities and include the station (pumps nutrients - high pressure pumps - pumps pumping - pumps for water circulation - evaporators - mechanical refineries - measuring and control devices - solar cell - batteries - organizer heating - the converter) and the control panel. The paper proposes the operating instructions of mechanical and electrical warnings and operating and maintenance program. The paper also includes factors to choose the appropriate method for water desalination and implementation of mechanical and electrical works. To make sure that the system works efficiently station is a commitment to a program of maintenance and calibration system for the station. The steps include maintenance and calibration station for water desalination using sustainable solar energy follows:

- Perform maintenance and repair of equipment and machinery

So as to ensure the quality of the state of the hardware, machinery and equipment, maintenance and repair of all equipment, machinery and equipment to ensure the continuity of its work without an abrupt halt, including the list of devices that are subject to regular maintenance and preventive maintenance program and record it all in the record maintenance.

- Calibration and adjustment of measuring /testing devices

This is to make sure that all the instrumentation and testing station can be used to rely on the measurements and the implications that it planned calibration and tuned and excellence, including the list of devices which are subject to a comprehensive calibration and calibration certificates.

Solar energy is not only sustainable, it is renewable and this means that we will never run out of it. It is about as natural a source of power as it is possible to generate electricity. The creation of solar energy requires little maintenance. Once the solar panels have been installed and are working at maximum efficiency there is only a small amount of maintenance required each year to ensure they are in working order.

And ended with the paper to the findings and recommendations of the need for testing and maintenance and calibration devices for the desalination plant in salt water and solar energy.

Key words: Salt water desalination plant • Sustainable solar energy • Maintenance • Calibration

INTRODUCTION

The Great Nile is the main source of fresh water in Egypt, providing 95% of total water use. However, Egypt faces a threat of severe water shortages over the next decade. According to a report by the Future Directions International Research Institute in November 2012, Egypt suffers from a water shortage of about 7 billion cubic meters per year and water demand is expected to grow by

about 25% in 2025. A national study on water resources in Egypt Prepared by the United Nations Environment Program in 2011 that the demand for water has reached 80 billion cubic meters per year, while Egypt's share of the Nile water, under the Nile Water Convention in 1959, up to 55 billion cubic meters per year.

The amount of water available to Egypt from the waters of the Nile is stable, despite the population growth and rapid development in Egypt, as a result of treaties

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with the countries located on the river, "adding that the increasing demand for water in those countries, especially Ethiopia, exacerbates the problem Water Shortage. Traditionally, the provision of fresh water in Egypt depends on the exploitation of groundwater, the reuse of sewage water, the recycling of irrigation water and agricultural drainage, the addition of desalination, the process by which salts are removed from sea water for fresh water for use in agriculture for human consumption.

Although desalination technology has been used for decades in many countries, the limitations of using the technology are high energy consumption and high cost of installation. Desalination technology uses huge amounts of energy and requires a specific and expensive infrastructure. Hydrothermal desalination also relies on the burning of fossil fuels, leading to increased carbon dioxide emissions and air pollution. Thus, global attention has grown to devise other low-cost and environmentally sustainable desalination methods.

Most desalination plants in Egypt are located in the coastal areas of the Red Sea and the Mediterranean Sea, to meet the needs of the tourism sector in the first place, in addition to the industrial sector to a lesser degree. Egypt is also in the best areas of the solar belt because it has the highest solar brightness in the world. The water deficit can be blocked through desalination using solar energy.

Solar energy is renewable, available and used to reduce emissions of greenhouse gases that cause climate change. Saline desalination has been applied in Egypt over the last 30 years to provide drinking water in cases where there is no other freshwater resource [1-3].

The need for sustainable sources of energy to operate high energy - consumption desalination systems is mandatory. Future, in remote coastal and arid areas, the use of renewable energy for powering desalination plants could be a feasible option in view of several technical, economic and environmental considerations. In this paper, the issue of integration of desalination technologies and renewable energy from specified sources is addressed. The features of Photovoltaic (PV) system combined with reverse osmosis desalination technology, which represents the most commonly applied integration between renewable energy and desalination technology, are analyzed. Further, a case study for conceptual seawater reverse osmosis (SW-RO) desalination plant with 1000 m³/d capacity is presented, based on PV and conventional generators powered with fossil fuel to be installed in a remote coastal area in Egypt, as a typical developing country. The estimated water cost

for desalination with PV/ SW-RO system is about \$1.21 m³, while ranging between \$1.18-1.56 for SW-RO powered with conventional generator powered with fossil fuel. Analysis of the economical, technical and environmental factors depicts the merits of using large scale integrated PV/RO system as an economically feasible water supply with an autonomous power supply (Figure 1)[4-6].

This paper explains how to control the desalination plant using solar energy.

Factors to Choose the Appropriate Method of Desalination

Sea Water Quality (Total Soluble Salt Concentration):

The amount of dissolved solids in the Mediterranean waters amounts to about 38,000 ppm in the North Coast and ranges from 35,000 to 45000 ppm in the Red Sea waters of Sharm El Sheikh.

The Temperature of the Sea Water and the Natural Factors Affecting it:

It should be taken into account when designing the stations. The plant produces the required production at the selected temperature of the design. If the temperature increases or decreases, this affects the quantity of the product by increasing or decreasing. The natural factors affecting the tidal, sea depth, water outlet and environmental pollution.

The Cost of the Product Unit of Water and Electricity: By monitoring the latest global developments in desalination and power generation in order to achieve the best economic means in terms of capital cost and operating and maintenance costs.

The use of modern technology to clean the solar cells as the main source of energy is useful in raising its efficiency and ability to perform the primary purpose of the absorption and synthesis of solar energy and converted into electrical energy. As the accumulation of dust on the surface of solar cells causes the reduction of efficiency by 35% In the Arab countries where the rate of wind sand and low rainfall and the accumulation of dust in reducing the efficiency of solar cells to 80%. These solar panels are automatically cleaned using the robot's timer programming system, which specifies the time periods of the system to clean the solar cell. In turn, the cell will increase energy production by assuming that there is some dust covering the cell surface or anything that can hinder the production process.

It is also possible to use self-cleaning glass by gradually dissolving the dirt, dust and suspended organic blocks using the static electrostatic energy generated by

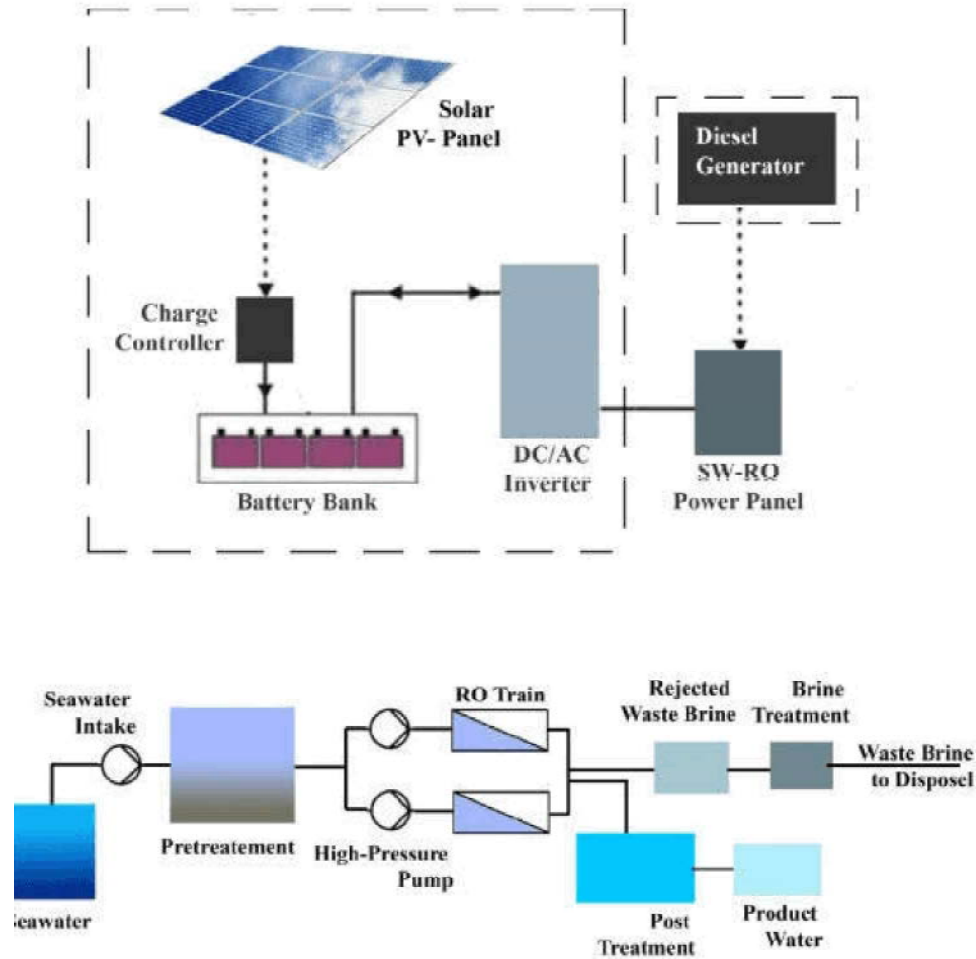


Fig. 1: A Schematic for the SW-RO desalination plant with PV and diesel power options (Credit: Authors)

these cells. This makes these materials easy to remove automatically when rain falls or when spraying with water without leaving any traces or which makes the glass surface look clean. It also reduces the costs of chemicals used in conventional cleaning services and is therefore an environmentally friendly product (Figures 2 -3).

The rise in global nickel prices will also raise the cost of desalination plants to allow nickel-based water desalination plants to be built. The use of plastic or composite materials in desalination plants reduces erosion in desalination plants and will increase the life span of some parts of the plants. The life span of the desalination plants was 20 years and currently 25 years and the use of nanotechnology reduce the cost of desalination of water by 50% [7-15].

Production of Electricity in Desalination Plants: A part of the steam produced from desalination plants is usually used for the production of electric power to feed the

needs of the desalination plant, the residential complex and the pumping stations. Therefore, the rest of the energy produced from this plant is used to the electrical grid (Figure 4).

In view of the power plant, it is mainly composed of a group of boilers that roast the steam produced by the desalination plant and the steam turbines connected to generators that produce electricity. The station includes some auxiliary equipment, fuel pumps, fuel systems and firefighting systems, electric batteries to supply the necessary devices in the event of a network failure, in addition to the computer, which can control all the measuring devices, control and control of all equipment station.

Operating Instructions and Warning of Pumps [16-18]

Mechanical Instruction: Mechanical instruction is a key factor in evaluating the efficiency of plant pumps. Please make sure of the following:

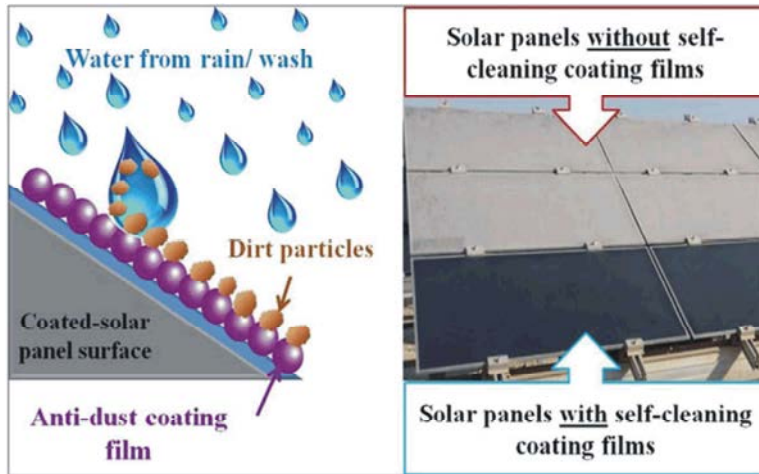


Fig. 2: Schematic showing self-cleaning coating effect on solar panels in dusty regions.

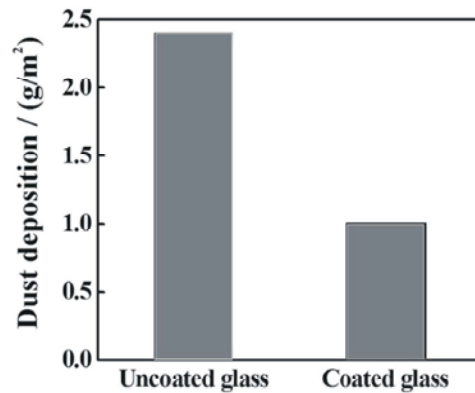


Fig. 3: The average of dust deposition rate for seven days on uncoated versus coated



Fig. 4: Solar thermal station with dissolved salt system for storage

- The water tank is filled.
 - All the valves on the main and branch pull lines are fully open.
 - All gaskets on the expulsion lines are open to the pressure to open.
 - There are no apparent obstacles blocking pumps.
 - The fuel tank is finished and filled.
- Electrical Instructions:** In this item, the following should be ascertained:

- The presence of electricity current in the operating panel with the emergence of main feeding bulbs.
- All key and sub keys on ON mode.
- The three lugs in the voltage switch are intact and all read 380 volts between the discharges and read 220 volts between each phase.
- All pump operation switches are set to automatic mode.
- If any pump is stopped, the power switch is set to OFF.
- When the red light appears on the indicator light, it means that there is an over load.
Reset is an internal position on the control panel until the red indicator light disappears. When it is repeated again, the pump is stopped and maintenance is reported for detection to remove the cause.
- When you hear any sound other than the normal sound of the operation, the pump is stopped and maintenance is reported.
- The optimal amp reading should be observed to operate each pump separately at normal operation. In the case of high amps, the pumps are stopped and maintenance is reported.
- When there is no sign of water the yellow indicator light is lit and the pump is stopped.
- When the green indicator light shows that the pump is working in good condition.

Operating Warnings:

- It is strictly forbidden to operate pumps without water to prevent the damage of gaskets.
- When a pump is maintained, the sub-trailer shall be locked to the pump and pull for the pump to be serviced while leaving the rest of the other valves open to ensure continuous operation of the system.
- Clean the water tanks constantly and disinfection of all solid materials so as not to cause damage to the pumps and make sure that the main drawers are not blocked with any suspended materials.
- The need to vent the pumps good ventilation.

Performing Mechanical and Electrical Works

Before Installation of Tasks: When performing mechanical and electrical works for desalination plants, the following elements shall be considered:

- Review the executed civil works to ascertain the design dimensions in the executive drawings, levels and tendencies and all elements of the civil finishes mentioned drawings and specifications of these

works. The dimensions and axes of the openings and their levels and the requirements for the installation of the mechanical tasks shall also be reviewed in accordance with the executive drawings of the mechanical works.

- Supervision of the installation of mechanical tasks according to the dimensions specified by the manufacturer according to catalogs and drawings approved and taking into account the use of raw materials in accordance with instructions and horizontal control and leveling surfaces.
Review the mechanical tasks in terms of quantity and quality and match them to the supply order in terms of model, serial numbers, certificate of origin, inspection and testing certificates and verify the components and parts of each equipment and their conformity to the list of contents and detailed mechanical drawing.
 - Visible examination of the tasks to ensure that there is no breakage or damage resulting from the transfer process.
Purge ponds and canals from the remains of construction and concrete works.
Ensure that the work of insulating paints and high salt resistance to ensure the safety of civil works.

The Work of the Outlet (Sea - Geophysical - Surface):

Review the design principles that have been calculated from the point of view of hydraulics and taking into account natural factors such as tide and root.

Mechanical Strain: Review the design capacity of mechanical separators and take into account the marine factors of calcareous deposits with the availability of a convoy method to periodically clean the outlet and consider the future expansions.

Initial Sterilization (Chlorination): One of the most important methods of initial sterilization of the water outlet (chlorination) and initial chlorination is the most effective and low cost method.

Primary Filtration: Primary flattening should be observed when needed for the large plank chamber and act as secondary filter protection.

Secondary Filtration: A secondary filtration stage that eliminates all obstructions and the processing of water used to enter the treatment phase (desalination).

Micronutrient Filtering: It shall protect against the escape of any of the filtration media and its entry into the membranes and their destruction.

Primary Chemical Treatment:

Control of the Pelvis: It shall be on the basis of design and review of the plant (membranes) in order to determine the most appropriate pH control.

Plankton Synthesis: The chemicals used in plankton assembly and their suitability for use in drinking water are reviewed.

Primary Chlorination Phase: The chemicals used to remove residual chlorine in water and prior to arrival are reviewed to reverse osmosis membranes to ensure water is free of oxidants.

Sedimentation Agent: It shall be added by a substance preventing the deposition of salts into the osmosis membranes, which will damage and affect the production of the plant.

Feeder Pump Units: Review designs, capacities, rates of disposal and manometer lift for compliance with supplies.

Checking materials manufactured from pumps to match them with the design bases.

High Pressure Pump Units: Review pump specifications with preliminary calculations and weighted by the osmosis membranes factory to ensure the pressure of the required production in addition to the required behavior.

Valves: Ensure the matching of the supplied valve to the required specifications and provide the possibility of controlling the different behaviors.

- The main rate of access.
- Rate of production behavior.
- Average reaction rate.
- To ensure that the process of production according to the initial designs, taking into account that the valves are suitable to withstand pressure differences.

Chemical Opening Units: The capacities of the supplied units shall be reviewed and matched with the design capacities, taking into account the review of the materials, including the chemical pumps in terms of their resistance to the chemicals they are handling.

Reverse Osmosis Units: The design calculations approved by the factory shall be reviewed and the preparation of all the elements in all reverse osmosis stages (first phase - second - third) according to the approved design of the plant.

Final Chemical Processing:

- Determination of acidity (pH)
- Control salts
- Sterilization

Each phase needs to check the pumps' capacities and the materials manufactured to suit the chemically treated materials.

Surveillance Devices:

a- Pressure measuring devices

- Pressure indicators
- Digital devices for measuring pressure
- Pressure protection devices (high - low)

b- Flow meters

- To show the flow rates in the different paths to facilitate the operation of the operation according to the approved designs

c - A measure of acidity

- To demonstrate and control the pumping of chemicals to adjust the pH during operation to maintain the stability and continuity of reverse osmosis process.

d- Measuring devices for salts

- To show the level of salts in the different stages of operation of production and return and raw water.

Pre-startup Tests

Pumps: The engine is separated from the pump in the case of dry pumps and the work of the test of the load for long enough and measure the value of change in the temperature of the axes of the axes to reach the state of stability and also measure the power consumed in the engine to put the load as well as measuring the value of vibrations and compare all this In the approved schedules in addition to ensuring the correct rotation direction as it is sure the number of winding motor and voltage and current and conform to the approved specifications and design.

b - Sand filters: Samples are taken from different sizes of the experimental media and lab tests to ensure that they conform to the approved specifications and design.

- All vibrators and their levelers are checked to ensure uniformity and equal flow at the level of all filters.
- Insulation tests shall be carried out in the case of metal filters and leak test in the case of concrete filters to ensure that the water does not leak to the walls.
- A hydraulic test is performed in the case of closed filters.

Gaskets: A test is carried out to show the direction of opening and locking and adjust the speed of opening and locking the valves in the case of automatic valves.

Microscopic Filters: Perform a hydraulic test to ensure that there is no leakage from any of the ligament flanges.

Install the filtration instructions and ensure their safety.

Chemical Pumps: Test all pumps to ensure the behavior and pressure and compliance with design foundations.

Test safety devices to ensure that chemical lines do not explode at high pressure.

Pipe Lines: Conduct hydraulic test on all pipe lines and each stage according to the rated pressure during operation to ensure that there is no leakage during flanges at welds.

Reverse Osmosis Units: A hydraulic test is performed on the osmotic pressure vessels and pipe lines. The units are then washed and rinsed and the reverse osmosis membranes are loaded in preparation for start-up.

Measurement and Control Devices: Calibration and control devices are checked, exit signals, operating and washing rates are checked and performed mechanically, chemically and electrically.

Electrical Panels: All the protection devices are set on the meters for each equipment separately and review all connections to ensure that all electrical signals arrive from and to the equipment of their own.

Control and Operation Software: The drivers and control panels are reviewed according to the approved design.

Maintenance and Calibration

Steps of the Maintenance Process: The steps of the maintenance process are summarized in laying the foundations and means to make all machinery, equipment and equipment for the desalination plant and the solar power unit in the best condition of operation and maintain constant increase in performance and efficiency.

- Periodic inspection of all equipment and equipment of the desalination plant and the solar power unit as included in the preventive maintenance program.
- The program to detect early faults and determine the life span of each part of the machinery and equipment of the desalination plant and the solar power unit.
- It is important to inform the competent authority about the existence of machines or equipment or equipment requiring spare parts. A quotation from the company shall be submitted for the required spare parts. This offer shall be examined technically and financially before being approved by the competent authority.
- Always ensure the health and safety of maintenance and repair.
- Paying attention to achieving industrial security in all equipment, machinery and equipment.
- Provide a detailed weekly report on maintenance work.

Equipment Repair and Maintenance Program:

Maintenance of all parts of the machine / equipment as follows:

- a- Detect parts and electrical accessories.
- b- Detection of mechanical parts and accessories.
- c- Detection of parts and auxiliary accessories.

Detection of Electrical Parts and Accessories:

- The electrical circuit (connections - cables) is detected if the current is connected or not.
- The On and Off keys are detected.
- The control circuit is detected (the conductor - the key to increase the load....)
- All of the above is reviewed before operating.

Detection of Mechanical Parts and Accessories

(Mechanical Connectors): The rotary mechanical parts and accessories (roller bearings, oil pump, taps, pump gaskets, etc.)

Detection of Parts and Accessories Assistance:

Detectors (pressure gauge counters - current and voltmeter - temperature scale - temperature sensor).

Maintenance and Repair of Machinery, Equipment and Equipment

Purpose: Is to ensure the quality of the condition of equipment and machinery and equipment and maintenance and repair of all devices and machines to ensure the continuity of work without a sudden stop.

Scope of Application: All desalination plant and equipment and solar module.

Responsibilities:

- a- Head of Maintenance Unit.
- b- General Supervisor of Maintenance.

Models:

- a- List of desalination plant equipment and solar module
- b- Preventive and periodic maintenance program
- c- Service record
- d- Laboratory examination
- e- Request replacement of a spare part
- f- weekly report
- g- Installation Record
- h- Record return items

Maintenance Work Instructions: All machine and devise catalogs.

Steps to Implement Maintenance:

- a- The general supervisor of maintenance shall identify and equip the equipment and machinery subject to the preventive maintenance program of the desalination plant and the solar power unit.
- b- The head of the maintenance unit shall ensure that a maintenance record is prepared for a machine or device and records the device's data and specifications.
- c- Based on:
 - Specifications of the machine.
 - Catalog maintenance instructions.
 - The life history of the machine listed in the maintenance log
 - Experience of maintenance.
 - Existing desalination plant equipment and solar power unit

The head of the maintenance unit reviews and approves the maintenance program at the beginning of the year.

d- In accordance with the maintenance plan, the maintenance team will carry out the maintenance work under the supervision and follow up of the maintenance supervisor of the desalination plant and the solar power unit.

e- After completing the maintenance work on the machine or the unit, the technician of the unit to complete the minutes of the examination and then signed and presented to the General Supervisor of maintenance work, which is sure to finish all the elements of maintenance required work instructions and then the confirmation of the examination.

f- The general supervisor shall ensure that the maintenance program is implemented.

g- The station manager updates the data in the maintenance record of a machine or equipment that has been regularly maintained.

h- In the case of the need for new parts to complete the maintenance work, the maintenance technician to take the approval of the head of the desalination plant saline water on the model of replacement parts, which contains the estimated price of the piece.

i- The technician uses each device or machine to report sudden breakdowns. The technician of the maintenance unit checks the equipment and completes the form and submits it to the general supervisor of maintenance.

j- The general supervisor of the maintenance works to analyze the technical and financial quotations, inspect the equipment, prepare the technical inspection and return parts with the maintenance unit.

k- Weekly reports shall be prepared periodically by the general supervisor of Maintenance and approved by the Head of the Saline Water Desalination Plant and the solar power unit and submitted to the board of directors through the executive review meetings including:

- Develop scenarios for the development of equipment and machinery for future needs.
- Sudden breakdowns and causes.
- Commitment to maintenance plan.
- The state of the machines and the need for replacement.
- Resources and additional costs to implement the maintenance and repair plan.
- The most important problems and obstacles faced by maintenance work.

m- Put files on the computer for maintenance work by the computer operator and back up these files.

Conducting the Calibration and Calibration of Measuring, Testing and Testing Equipment

Purpose: Is to ensure that all measuring and testing equipment used by the desalination plant and the solar power unit can be relied on on their measurements and indications by the planned calibration and control.

Scope of Application: All measuring and testing equipment at the desalination plant.

Calibrating Responsibilities:

- a. Head of calibration unit.
 - b. General supervisor of calibration work.
- 6.5.4. Models:
- a- List of devices subject to calibration
 - b- Follow-up card for a calibration device

Work Instructions: Hardware Catalogs.

Calibration Process Steps:

1. The calibration supervisor shall prepare a list of the devices to be calibrated.
2. The head of the calibration unit will then determine the required measurements book, its measurements and the periodic calibration of the incoming devices. The calibration is carried out as follows:
 - Selection of the appropriate machine / machine-stomach calibration device.
 - Ensure the validity of the calibration device and the existence of its calibration certificate.
 - The scale of the machine or the machine - the required device - is divided into 10 points where the machine / machine reading is prepared with the reading of the calibrator and the process is repeated three cycles.
 - Calculates the average reading at each point.
 - A table or calibration curve for the machine / machine-stomach.
 - The operation is repeated if the machine-machine-stomach is more than a scale.

Calibration Implementation: The calibration supervisor shall perform the calibration in the scheduled dates according to the periodicity received.

The calibration supervisor shall record the equipment and machinery data and record the actual calibration date and the following calibrations. The machine follow-up card shall be subject to calibration and the issuance of the calibration certificate, which shall be approved by the head of the calibration unit.

Calibrate the hardware of the site Under the supervision of the head of the calibration unit and applying all previous steps and maintaining the calibration certificate.

Additional emergency calibration shall be performed on any faulty device after repair.

The date of the last calibration and the date of the next calibration and the device number shall be determined according to the calibration certificate data on a label affixed to the machine (except for hard-to-paste devices).

If the calibration results are outside the measurement accuracy limits and do not conform to the specifications of the device (its catalog), it is necessary to inspect, repair and re-calibrate the device.

In this case (step 7.2.6), the user of the machine (s) responsible for it shall review all measurements made using the device - the machine or the machine during the period of its departure outside the calibration limits.

The head of the calibration unit shall submit a monthly report on the saline desalination plant to the station's board of directors for:

- The extent of compliance with calibration patrol.
- Condition of machinery, equipment and how much replacement process is needed.
- Resources and additional costs to perform the calibration process.
- The most important problems and obstacles faced by the calibration work.
- Presenting this report to the Chairman of the Saline Water Desalination Plant and the Solar Energy Unit through the Board meetings (senior management reviews of the work system).

CONCLUSION

Based on the results of the study conducted on the desalination plant using sustainable solar energy can be drawn as follows:

- Instructions must be clear and run periodically.
- Adopt the maintenance program and control the application to maintain the station.

- Regularly inspect the system, calibrate the equipment and ensure all procedures are strictly followed
- Taking into account the latest global developments in the field of desalination and power generation to reach the best way economically.
- Compliance with the mechanical and electrical works in execution.

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