Solar Algae Dryer

User manual

Instituto Superior de Engenharia do Porto

Contents

1. Introduction

Solar algae dryer is a project realized during European Project Semester at ISEP. The device is devoted to dry algae for the use of ISEP chemistry lab.

1.1. System overview

The equipment is meant to be used outside using both direct and indirect solar radiation. The system works as a distiller. Algal solution is placed inside PCV container in which part of it evaporates thanks to solar radiation and high temperature leaving condensed (up to 10% of water) solution, which afterwards is collected.

1.2. Way of functioning

As already mentioned, solar algae dryer works as a distiller. That means that condensed algae solution is obtained thanks to water evaporation process, which takes place in closed transparent container. The simplified way of operation is shown in Figure 1.

1. The device must be filled up with algal solution.
2. The intensive solar radiation rises up the temperature inside the transparent PCV container. Also fans mounted inside move the air speeding up evaporation process. Evaporated water is collected into the attached container.
3. After several hours algal solution is condensed to 10% of water and 90% of algae, which gives around 10% of the amount of the poured in liquid.

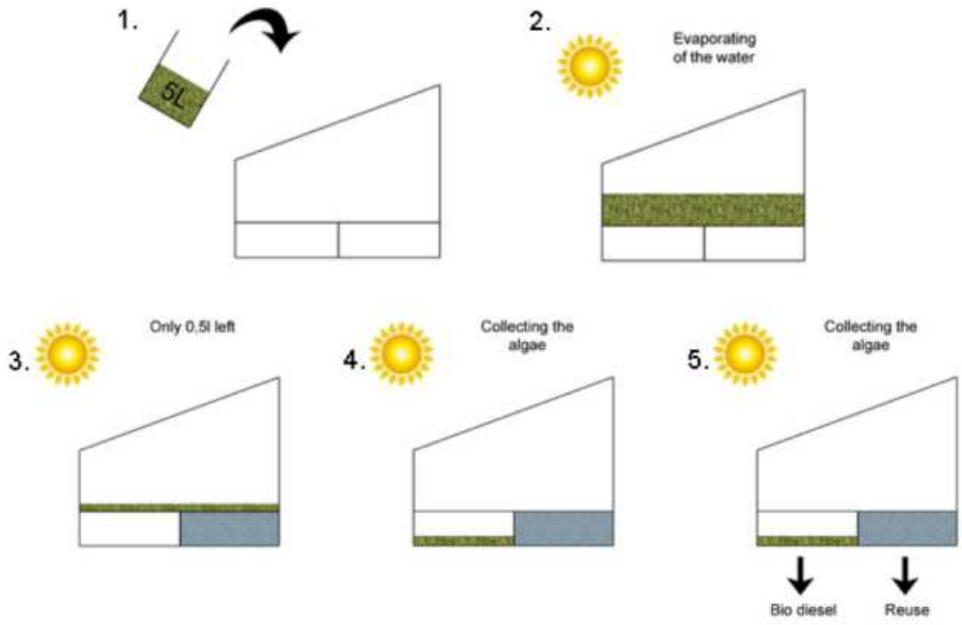


Figure 1. Way of operation schematics

4. Algae are ready to be collected from the device.
5. Algae may be used to extract biodiesel out of them, water can be recovered and reused.

1.3. Solar algae dryer components diagram

Figure 2. and 3. presented below shows all the components connected together. All the devices are shortly described below.

Figure 2. All the components of Solar Algae Dryer

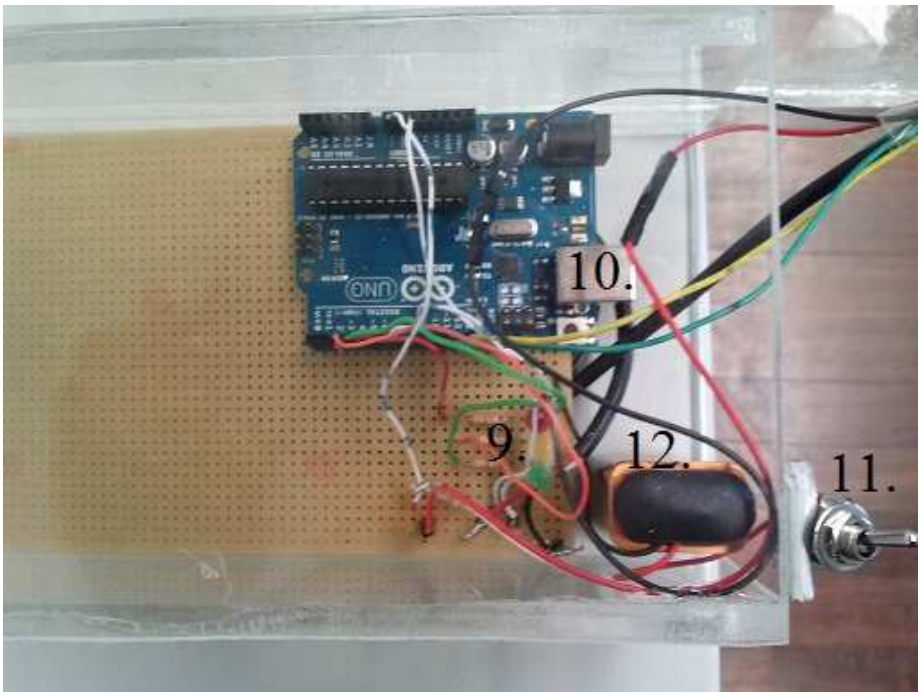


Figure 3. Appliances on soldering board

1. Portable stand
2. Tank made out of Poly(methyl methacrylate) (PMMA)
3. Rubber washers
4. Guideways for blinds
5. Blinds
6. Valves
7. Temperature sensor: DS18B20
8. Devantech SRF04 Ultrasonic Range Finder
9. LEDs
10. Microcontroller Arduino Uno
11. Switch on/off
12. 9V alkaline battery
13. Water collected and dried algae containers

2. Safety and proper usage

Important safety instructions:

1. Carefully read all the instructions before using the equipment
2. Do not set up the solar algae dryer where it will be exposed to water and/or weather while installation process.
3. Use the solar algae dryer only for drying, so its intended purpose.
4. Do not utilize the dryer with removed or broken parts.
5. Make sure the power supply is hidden inside the box on the side of tank.
6. Always disconnect electrical appliances while cleaning the equipment.
7. Do not charge or dispose the battery of in fire.
8. Insert correctly (+,-).

3. System specifications

Waterproof temperature sensor DS18B20

Operating Temperature Range: -55 to 125°C
Resolution: 9 to 12 bit
Power/data: 3.0 V to 5.5 V
Accuracy: ±0.5°C from -10°C to +85°C
Query time is less than 750ms
Temperature-limit alarm system

Devantech SRF04 Ultrasonic Range Finder

Voltage: 5 V
Current: 30 mA typically, 50 mA maximum
Frequency: 40 kHz
Input Trigger: 10 µS minimum, TTL level pulse
Weight: 11.33 g
Connection Type: Digital

Microcontroller Adruino Uno

Microcontroller: ATmega328
Operating Voltage: 5 V
Input Voltage (recommended): 7-12 V
Input Voltage (limits): 6-20 V
Digital I/O Pins: 14 (of which 6 provide PWM output)
Analog Input Pins: 6
DC Current per I/O Pin: 40 mA
DC Current for 3.3V Pin: 50 mA
Flash Memory: 32 kB (ATmega328) of which 0.5 kB used by bootloader
SRAM: 2 kB (ATmega328)
EEPROM: 1 kB (ATmega328)
Clock Speed: 16 MHz

Mustang Super Power Alkaline Battery

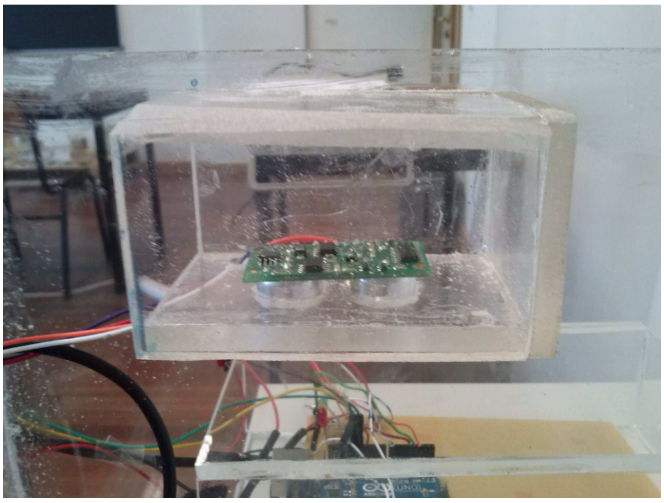
Model: 6LR61
0.00% mercury and cadmium

4. Operating instructions

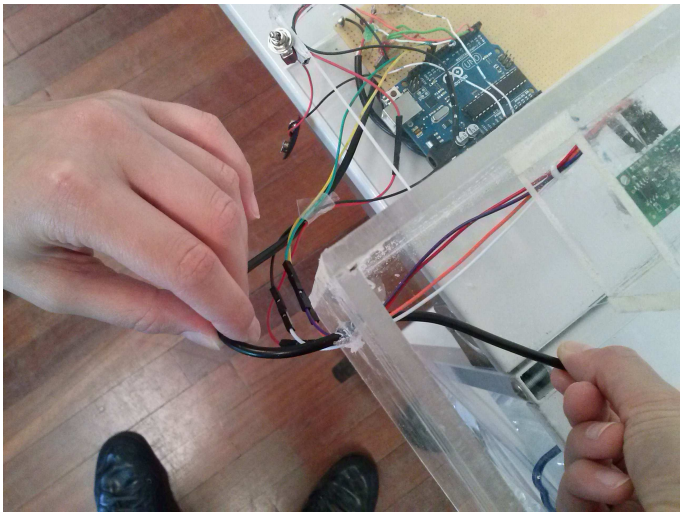
4.1. Installation

In order to install solar algae dryer you are advised to follow given instructions:

1. Place the tank on the portable stand.
2. Fit the rubber pipes into valves.
3. Place level sensor in the box inside the container.

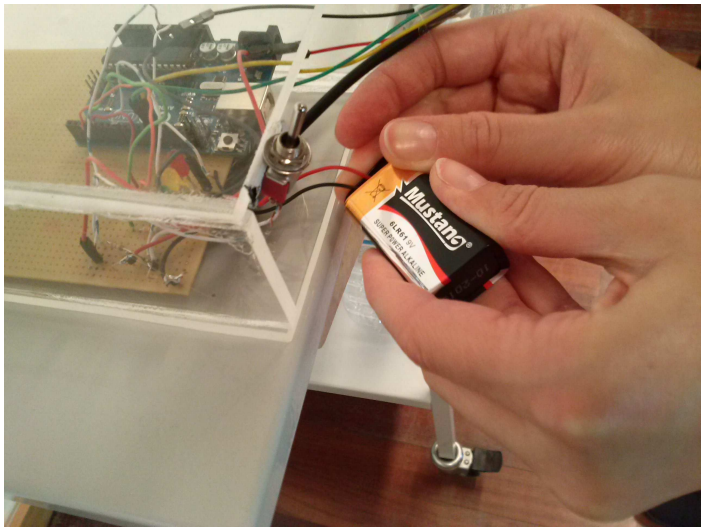


4. Put the cables of the level sensor through the hole inside the box and side of the container.



5. Put the temperature sensor through the hole on the side of the container.
6. Fit the temperature sensor as close to the side as possible.

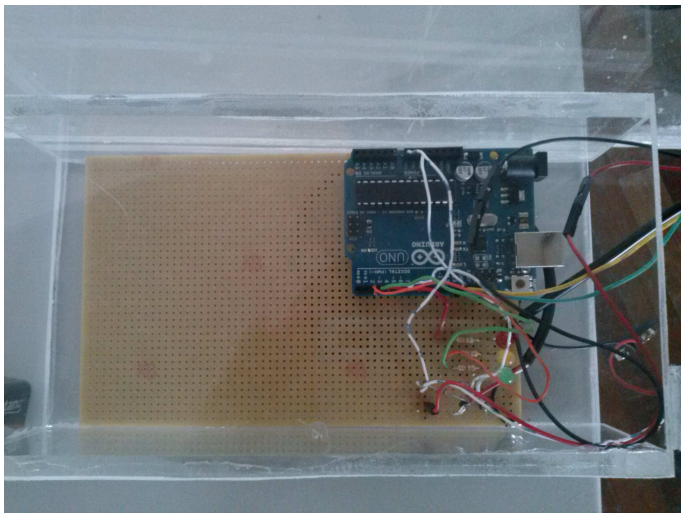
7. Plug in the battery.



8. Connect the cables with Arduino Uno:
    - Level sensor:
        - Orange – Pin 13
        - Blue – Pin 12
        - Red – cable red coming from level sensor
        - Black – cable black from level sensor
    - Soldered board
        - Temperature sensor – Pin 7
        - Diodes:

        - Green – Pin 3
        - Yellow – Pin 2
        - Red – Pin 4
    - Black cable for Ground – Pin GND
    - Red cable for power – Pin Vin.

9. Place the soldered board inside the box outside the tank.

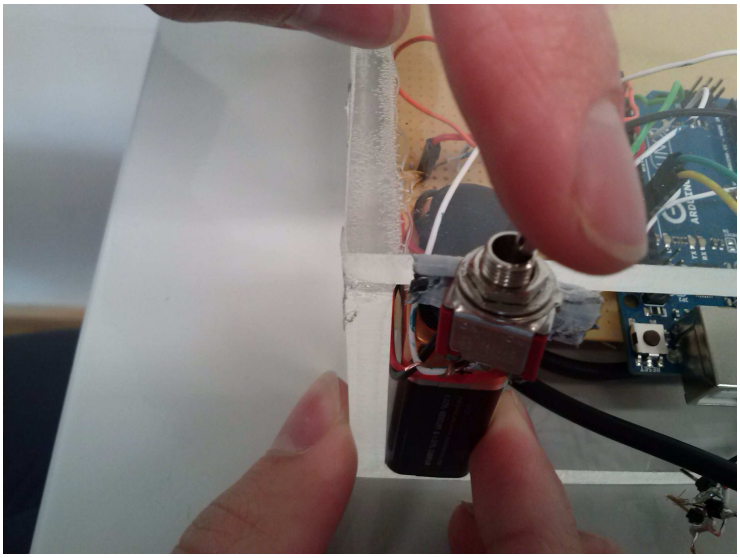


10. Put algae and evaporated water containers underneath the tank.
11. Put pipes into the containers.

12. Place the top of the tank on it.
13. Place open blinds on top.

4.2. Starting the system

1. Place set up solar algae dryer in the desired location outside.
2. Make sure the blinds are open.
3. Turn on the system by moving the switch to the left.

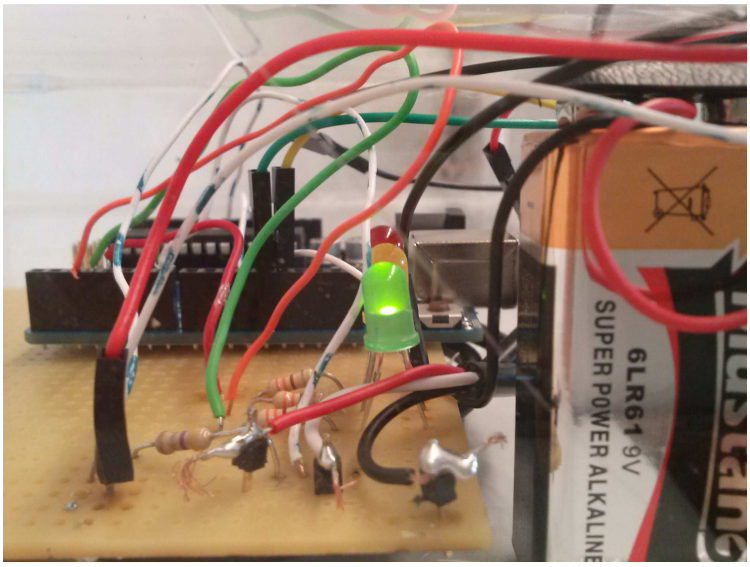


4. Check if the yellow diode went on.
5. Check if the valves are closed.
6. Pour in algal solution through the valve on the side of the container taking advantage of funnel.

4.3. Continous operation mode

Solar algae dryer is aimed to work on continuous operation mode. That suggests that once the equipment is placed outside and properly installed, it may run all the time. In order to keep process going, it is necessary to refill the container with algal solution, remove and collect the condensed one. To collect the outcome after solution has been poured in, mind the following instructions:

1. Wait until the green diode indicates that the process is over.



2. Open the valves on the bottom of the tank.
3. Gently lift up the device.
4. Let the solution flow to the special container.
5. Put the device down.
6. Refill the container with new algal solution.
7. Repeat the steps given in points: 1-5
8. Check the process from time to time.
9. Make sure that when the red diode goes on, the blinds are closed.
10. Turn off the system by moving the switch to the right.

4.4. Removing the equipment

Once the drying season is over, solar algae dryer does not have to be disassembled. It is placed on portable stand, so can be stored, waiting for the next season. Yet, if the disassembling is needed, it is advisable to follow installing instructions in the reverse manner.

4.5. Maintainance

The inner and outer part of the PMMA tank should be wiped with soft cloth and water or gentle detergent.

Frequently check the boxes for level sensor and Arduino board to make sure they are totally waterproof.

Try not to place portable stand directly on the ground to avoid sand getting into the wheels.

Always turn off the device when not operating.

Change the battery when it is needed.

5. Frequently Asked Questions

1. Do I have to control the blinds?

   Yes, whenever the red diode indicates that the temperature is too high the blinds must be closed.

2. How much volume of condensed algae solution will I get from 5 l?
   Approximately, 0,5 l of condensed solution is obtained after drying process. The equipment is programmed to obtain 10% of water algal solution.

3. What happens if I forget to remove algae?
   The diode indicating end of process would be on and blinds should be shut down to prevent solar radiation to get into the tank. The system will keep on drying the algae, but on a smaller scale. The solution should be more condensed, but equipment would not be able to determine the percentage of the solution. There should be no harm done concerning the usability of the solution.

Do not hesitate to contact EPS Team 1 in case of any problem occurring during usage or maintaining the device.