

# AQUEMFREE EQUIPMENT

## USER MANUAL



**Operation protocol for the decontamination of water  
on farms using solar photocatalysis.**



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# 1. CHARACTERISTICS OF COMMERCIAL FORMULATIONS

Pesticides are prepared for use as formulations. In other words, they are appropriately packaged and prepared such that the user obtains maximum efficiency during use. The components in any formulation consist of the following:

- **Material or active ingredient:** the substance or part of the product that actually attacks the pest itself. The quantity of active ingredients in all formulated plant protection products must be indicated on the label. The same active ingredient may be present in various pesticides.

Active ingredients are expressed through two factors: the concentration level and the state.

*-The concentration level indicates the quantity of the active ingredient as a percentage (%), parts per thousand (‰) or parts per million (ppm). The latter is used when the material is present in very small quantities.*

*-The state indicates the initial physical state of the active ingredient and how it is diluted. It is expressed using one of the following relationships: weight/volume (w/v), weight/weight (w/w) or volume/volume (v/v).*

For example, if the words 'active ingredient 10% (w/v)' are written on a label, it means that it is a solid material diluted 10% in liquid. In other words, 100 grams of the active ingredient per litre of commercial product. If it says 10% v/v, then the active ingredient is liquid (100 ml/L).

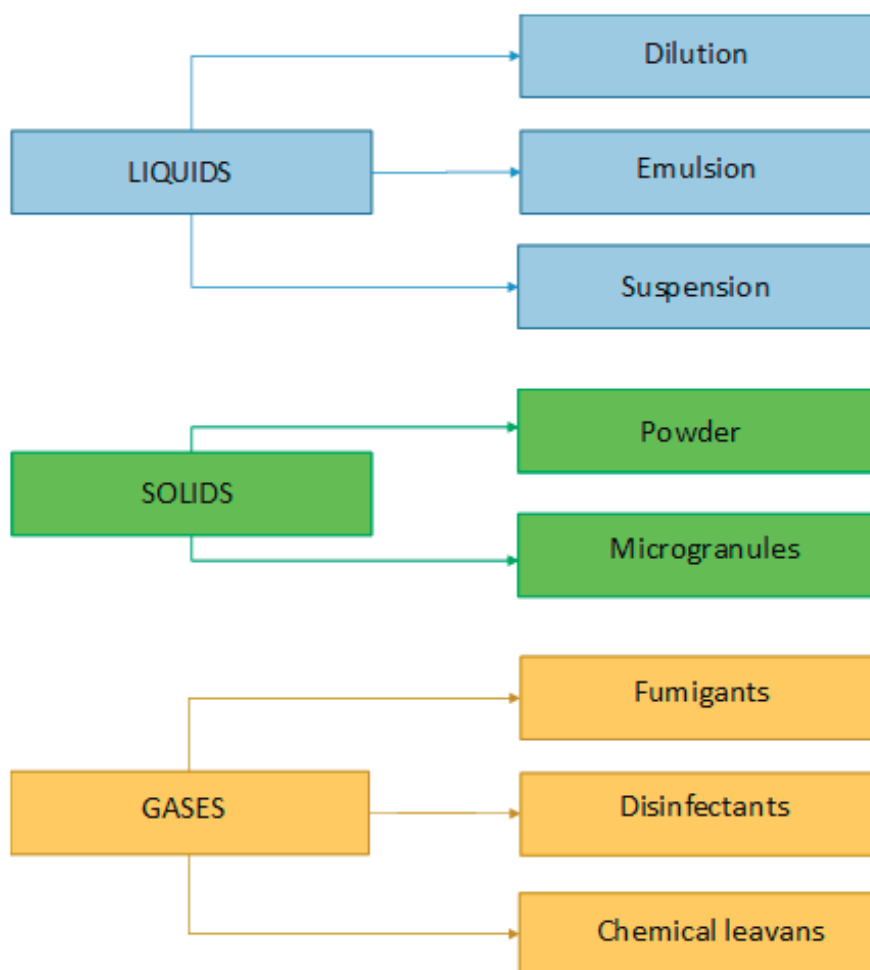
- **Inert ingredients:** substances that, when added to the active ingredient, facilitate pesticide dosage and application because the active ingredient is present in such small quantities that otherwise it would be very difficult to manage.

- **Additives:** a group of substances such as colourings, repellents or irritants that help to identify the product or ensure that certain fauna are not affected by it. They do not, on the whole, have an impact on the effectiveness of the active ingredient.

- **Adjuvants:** substances that help improve the efficiency of plant protection products. These include substances that increase product adherence to leaves (stickers), substances that increase the homogeneity of the pesticide (dispersants), substances that provide protection against rapid deterioration (stabilisers), substances that increase the area of the droplet that comes into contact with the plant (wetting agents), etc.

## 2. PLANT PROTECTION PRODUCT PACKAGING

Depending on their characteristics, plant protection products are packaged in different types of containers for sale. Liquid, solid and gaseous products are available and they can be presented in different formats:



Plant protection products are mainly packaged in liquid format. In accordance with European regulations, the acronyms (taken from their abbreviation in English) that are used to identify them are as follows:

- **Soluble (liquid) concentrate (SL).** As is the case with soluble powder, it becomes an absolute solution when in contact with water.
- **Emulsion in water (EW).** When added to water it creates a milky mixture. However, after a more or less significant period of time, the product and water tend to separate.
- **Emulsifiable concentrate (EC).** When mixed with water it creates an emulsion.
- **Suspension concentrate (SC).** This is a paste-like product made of small particles of suspended powder in liquid.
- **Capsule suspension (SL).** This consists of small suspended capsules in liquid.



### 3. PLANT PROTECTION PRODUCT DOSAGE AND TREATMENT MIXTURE VOLUME

Royal Decree 1311/2012 on Sustainable Use of Plant Protection Products published in September 2012 incorporates Directive 2009/128/EC establishing the EU framework for sustainable use of pesticides into Spanish legislation. It establishes a number of obligatory measures so that mixture preparation and the quantity of product in treatment equipment tanks do not pose a danger to human health or to the environment.

On the other hand, correct pesticide dosage is essential in achieving good performance during use. As such, understanding the recommended dose on the product label, the surface area to be treated and the type of machinery to be used, amongst other factors, is important.

Correct dosage helps reduce the risk of:

- Toxicity exposure for the user
- Environmental contamination
- Residue on crops
- Toxicity exposure for the consumer

Recommended manufacturer doses are tested so that pest control and diseases in crops are appropriately dealt with. Applying additional quantities of product is not of any advantage. Such practice only increases contamination and the risks mentioned above, as well as increasing costs.

The belief that increasing the dose applied helps to improve pest control is totally unfounded. It is usually the case that attempts are made to cover up insufficient and inconsistent applications.

The machinery used generally has a system providing the user with information on the dose applied per unit of surface area based on the working pressure, the nozzles used and speed.

#### □ Dosage and Mixture Volume for Herbicides Applied Directly to Soil

When herbicides are applied directly to the soil, the dose consists of applying the recommended quantity of product per unit of surface area. In order to apply the correct dose and keep this consistent, the quantity of mixture applied by the machine per unit of surface area must be understood and an appropriate regulating system needs to be applied.

In applications of this kind, ground wetness and the volume of mixture applied are essential in ensuring that the product works efficiently.

The volume of herbicide mixtures applied directly to soil must be in excess of 300 to 400 L/ha. The worse the conditions of the land (for example, very uneven land), the greater the volume that will be required.

## □ Dosage and Mixture Volume for Plant Protection Products Applied Directly to Vegetation

In these cases, product labels recommend a quantity of commercial product per hectare or a dose of product diluted in water. They do not, on the whole, indicate the volume of mixture per unit of surface area because this depends on how developed the crop is.

Best practice consists of an application that wets plant foliage uniformly but without reaching what is known as run-off. Beyond this point or volume, the sprayed product begins running along the leaf apex and drips onto the ground. Any quantity of product applied in excess of this volume is product that is wasted.

The following table provides an indication of guideline mixture volumes at run-off point. It should be taken into account that these volumes correspond to fully grown crops and that the volume of mixture at run-off point depends on how developed each crop is<sup>1</sup>.

Volumen of mixture at run-off point (L/Ha)		
Crop	Herbicides	Fungicides/Insecticides
Extensive crop farming	150	200
Horticultural products and ornamental plants	150	600
Vines and fruit-bearing trees	150	400
Citric fruits	150	1000
Intensive olive groves	150	900
Extensive olive grove farming	150	700
Lowlying horticultural crops	150	500
Staked horticultural crops	150	700

On the whole, herbicides are generally applied at a volume of 150 L/ha but always taking the crop condition (for herbaceous crops) or quantity of weeds into account.

Very dense products can be used. These generally require elevated quantities of water for appropriate dilution. Manufacturer instructions on the label should always be followed in order to avoid blockages in filters and even in nozzles.

Recent trends for calculating the volume of mixture to be applied tend to adapt the volume to crop vegetation at the point when treatment is to be applied. This can be done with simple calculations taking foliage into account or using more complex devices with artificial vision systems that adjust the spray in real time.

The necessary volume for each application will depend on the crop, the vegetation and the part of the crop to which the product is to be applied. An application for citric fruits with external pests (for example, fruit flies) will require a smaller volume of mixture than applications for internal pests (for example, mussel scale).

<sup>1</sup> Qualified handler application of pesticides. 2013. Institute of Agricultural and Fishing Research and Training. Department of Agriculture, Fishing and Rural Development. Autonomous Government of Andalusia.

## 4. MANAGING EXCESS AMOUNTS OF MIXTURE AND THE RINSE WATER FOR THE MACHINE USED DURING TREATMENT

Rinse water from machinery used to apply pesticides and remnants from leftover mixtures must be eliminated in a controlled manner without putting the health of human beings and the environment at risk. Remains of diluted pesticides have traditionally been eliminated by spraying the treated area once again, beginning once again at the initial start point and, where possible, doing so at a greater speed. However, in order to avoid phytotoxicity issues in plants and filtration of plant protection products into subsurface soil, leftover treatment mixtures and rinse water from washing treatment equipment should be eliminated or degraded using specially-designed facilities or devices. **AQUEMFREE** technology, a sustainable system for the removal of surplus plant protection products using solar heterogeneous photocatalysis is suggested for this purpose.

## 5. FUNDAMENTALS OF THE PHOTOCATALYTIC PROCESS

During heterogeneous photocatalysis, semiconductor solids that act as a photocatalyst directly or indirectly absorb UV irradiation and generate highly reactive transitory species, mainly hydroxyl radicals ( $\cdot\text{OH}$ ). This radical is a strongly oxidising agent and can quickly degrade many organic compounds into carbon dioxide, water and mineral salts when in contact with water. The reactions that eliminate the contaminants take place during the excited solid/solution interface and the catalyst, meanwhile, does not undergo any chemical changes. Semiconductors are materials that increase electrical conductivity when the temperature increases but at an inferior value to metals. The semiconductors used in photocatalysis are solids, mainly chalcogenides (oxides and sulphides) such as  $\text{TiO}_2$ ,  $\text{ZnO}$ ,  $\text{ZrO}_2$ ,  $\text{SrO}_2$ ,  $\text{ZnS}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{WO}_3$  and/or  $\text{CdS}$ . The majority of these substances can be excited by light of not very elevated energy levels and this has an additional advantage: they can absorb a significant part of the Earth's solar radiation spectrum. Titanium oxide ( $\text{TiO}_2$ ) is of particular relevance. It has elevated chemical stability meaning that it can work across a wide pH range and can produce electronic transitions through light absorption in near ultraviolet (300-400 nm).  $\text{TiO}_2$  can be found in three natural crystalline forms: anatase, brookite and rutile. The two most important phases in photocatalysis are anatase and rutile. The first has better photocatalytic activity. The titanium dioxide sold by Degussa ( $\text{TiO}_2$  P25) is the most commonly used. It is made of a hybrid mix of rutile and anatase (30R/70A) and has elevated photocatalytic activity.

improves the efficiency of the process.

On the other hand, adding an oxidising agent such as  $\text{S}_2\text{O}_8^{2-}$ ,  $\text{Fe}^{+3}$ ,  $\text{H}_2\text{O}_2$ ,  $\text{BrO}_3^-$  or  $\text{Ag}^+$  to a water suspension that contains a semiconductor generally increases the speed of photodegradation in organic contaminants. When sodium persulfate ( $\text{Na}_2\text{S}_2\text{O}_8$ ) is used, sulfate radicals ( $\text{SO}_4^\bullet$ ), a highly oxidising species, and more hydroxyl radicals are generated and this improves the efficiency of the process.

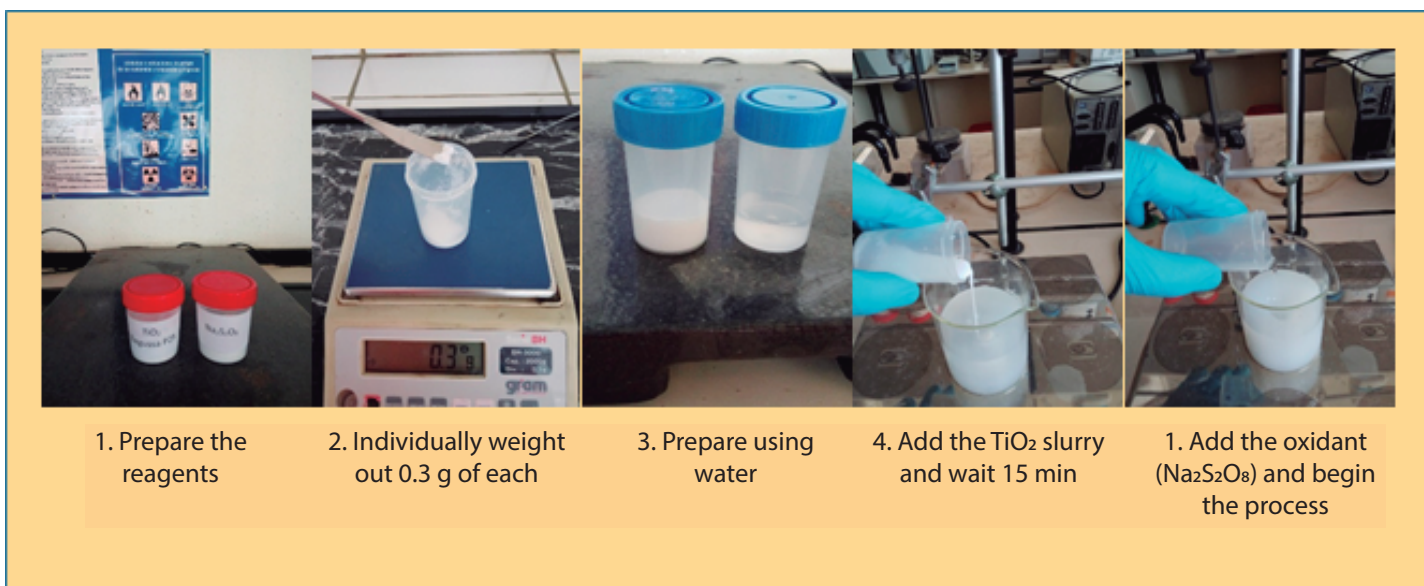
Since photocatalytic systems are activated by light, they do not need to be heated and can, therefore, be performed at room temperature. Indeed, as the temperature increases, the solubility of the oxygen in dilution decreases and this has a negative impact on the photocatalysis process.

## 6. CHEMICAL PRODUCTS TO BE USED

CHEMICAL PRODUCTS		
	Titanium Dioxide (Degussa P25)	Sodium Persulfate
<i>Physical and chemical properties</i>		
<i>Molecular formula</i>	$\text{TiO}_2$ (70 % Anatase, 30 % Rutile)	$\text{Na}_2\text{S}_2\text{O}_8$
<i>CAS number</i>	13463-67-7	7775-27-1
<i>Molecular weight</i>	79.9	238.1
<i>Melting point</i>	1850 °C	1855 °C
<i>Density</i>	4.26 g/ml	1.1 g/ml
<i>Solubility (<math>\text{H}_2\text{O}</math>)</i>	Insoluble	556 g/L
<i>Purity</i>	99.5 %	98 %
<i>Surface area</i>	50 $\text{m}^2/\text{g}$ (BET)	
<i>Particle size</i>	21 nm	
<i>Physical state</i>	Crystalline white powder	White crystals
<i>Safety</i>		
<i>Exposure limit</i>	10 $\text{mg}/\text{m}^3$	0.1 $\text{mg}/\text{m}^3$
<i>Dangers</i>	Not combustible. Reddening of the eyes	Not combustible but enhances combustion of other substances. Difficulty breathing due to inhalation. Causes redness when in contact with skin. Diarrhoea and nausea due to ingestion.
<i>Prevention</i>	Avoid the powder from spreading. Respiratory protection. Safety goggles. Do not eat or drink when in use.	Avoid contact with combustible materials. Avoid the powder from spreading. Use protection gloves and safety goggles. Do not eat or drink when in use.
<i>First aid</i>	Rinse and wash skin with soap and water for several minutes. Rinse your mouth should the product be ingested.	Clean air, rest and rinse with abundant water. Provide medical assistance if necessary.
<i>Storage</i>	Store in a ventilated and properly closed place	Store away from combustible and reducer substances, strong bases and powdered metals. Store carefully sealed

## 7. OPERATION PROTOCOL

**Treatment 1:** Weigh 0.3 g of  $\text{TiO}_2$  for every litre of water to be treated (30 g for every 100 litres) and add the product to 100 ml of water to form a 'milky white mixture' since  $\text{TiO}_2$  is insoluble in water. Next, pour this into the water to be treated and keep stirring for at least 10 minutes. After this, add a previously prepared sodium persulfate ( $\text{Na}_2\text{S}_2\text{O}_8$ ) solution. In order to do so, weigh out 0.3 g of product for every litre of water to be treated (30 g for every 100 litres) and dissolve in around 100 ml of water. Keep stirring the treatment deposit for whatever length of time is necessary.



**Treatment 2:** As above, but without adding  $\text{TiO}_2$ . In this case, sodium persulfate is added to the concentrate.

Treatment 1 should be used if there is an elevated concentration of contaminants in the water. If not, treatment 2 should be performed.

**Duration of treatment:** In order to achieve the expected results, solar irradiance exposure time will vary depending on the accumulated irradiation. The estimated UV-A irradiation level (320-400 nm) for eliminating 90 % of the initial level of contaminants in the water is  $7,000 \text{ kJ/m}^2$ . The farm will need to have a pyranometer in order to measure this.

$$1 \text{ W/m}^2 = 2,4 \times 10^{-5} \text{ cal cm}^{-2} \text{ s}^{-1} = 0,61 \text{ Kcal m}^{-2} \text{ h}^{-1} = 1 \text{ J m}^{-2} \text{ s}^{-1}$$

It should be taken into account that the maximum UVA irradiation level during summer months at midday is around  $30 \text{ W/m}^2$ . AQUEMFREE equipment directly transforms  $\text{W/m}^2$  into  $\text{kJ/m}^2$ . Measurements correspond to accumulated irradiation.

Once treatment has finished, if  $\text{TiO}_2$  was used then it will need to go through an ultrafiltration membrane as indicated in the system's instructions manual.

## 8. THEORETICAL ESTIMATION OF CONCENTRATION IN WATER AFTER WASHING WATER TREATMENT TANKS

Taking into account the concentration level of the plant protection product, the usage dose, the volume of remnant following application and the volume used to wash and clean the machinery used, an approximate estimation of product concentration can be made.

As indicated above, in liquid formulations, the concentration is generally written as p/v whilst there are two main ways of indicating the dose:

- In ml of product per hectolitre (100 L)
- L of product per Ha.

### EXAMPLE 1:

Chlorantraniliprole 20 % p/v, SC, remnant, an insecticide used to treat leaf miners in citric fruits, amongst others.

- Concentration: 0,2 g/mL
- Dose of mixture: 10 mL/100 L
- Application: 500 L/Ha
- Volume of remnant mixture: 20 L
- Wash volume: 50 L

Based on this data, an estimation of concentration in residual water can be made, as follows:

$$C_{PW} = D \times C_{PF} \times 10^3 \times (V_L/V_L + V_w)$$

$C_{PW}$  = Concentration of the pesticide in water (mg/L)

$D$  = Application dose (ml/100 L)

$C_{PF}$  = Concentration of the pesticide in the formulate (g/L)

$V_L$  = Volume of leftover mixture (L)

$V_w$  = Wash volume (L)

Therefore, the concentration of chlorantraniliprole in the water to be treated would be:

$$C_{PW} = 0,1 \times 0,2 \times 10^3 \times 0.28 = 5,7 \text{ mg/L}$$



## EXAMPLE 2:

Remnant of chlorothalonil 72 % p/v, SC, a fungicide used to treat various types of fungi (alternaria, canker, botrytis cinerea, mildew and septoria) in aubergine plantations, amongst others.

-Concentration: 0,72 g/mL

-Dose of mixture: 160 mL/100 L

-Maximum recommended application: 1,73 L/Ha

-Therefore, the maximum volume of mixture to be used per hectare is  $1730/160 = 10,81$  HL (10.810 L)

-Volume of remnant mixture: 10 L

-Wash volume: 50 L

In this case, the concentration level of chlorothalonil after washing equipment would be:

$$C_{PW} = (C_{PF} \times V_p \times 10^6) / V_M \times (V_L/V_L + V_W)$$

$C_{PW}$  = Concentración del plaguicida en el agua (mg/L)

$C_{PF}$  = Concentration of the pesticide in the formulate (g/L)

$V_p$  = Maximum volume of product to be used (L/Ha)

$V_M$  = Total volume of mixture (L)

$V_L$  = Volume of leftover mixture (L)

$V_W$  = Wash volume (L)

Therefore,

$$C_{PA} = (0,72 \times 1.73 \times 10^6) / 10.812 \times 0.17 = 19,58 \text{ mg/L}$$

Both the surplus quantity and water from rinsing are stored in the 1,000 L tank that is part of the AQUEMFREE equipment. Therefore, in a full tank, the theoretical concentrations would be as follows:

**Example 1:**  $5.7 \times 70/1000 = 0.4$  mg/L

**Example 2:**  $19.58 \times 60/1000 = 1.17$  mg/L

When estimated concentration levels in the accumulation tank are below 0.1 mg/L for each individual pesticide, irrespective of the total concentration of all the pesticides, treatment 2 can be performed (only with  $\text{Na}_2\text{S}_2\text{O}_8$ ). Where the concentration level is between 0.1 and 1 mg/L for each individual pesticide and the total concentration of all the pesticides is not greater than 10 mg/L, treatment 1 must be used. Last of all, if the concentration is above 1 mg/L for each individual pesticide or above 10 mg/L for the total concentration of all the pesticides, before proceeding with the treatment, the water to be treated should be diluted in an appropriate proportion (1:2 or 1:3) so that treatment 1 can be used (0.1-1 mg/L for each individual pesticide and <10 mg/L for the total concentration of all the pesticides). Should dilutions above 1:2 or 1:3 be required, this particular case would need to be studied and procedure would depend on the pesticides to be used.

>> **TREATMENT USING PEROXYDISULFATE ( $\text{Na}_2\text{S}_2\text{O}_8$ ):** <0.1 mg/L for each individual pesticide, irrespective of the total concentration of all the pesticides

>> **TREATMENT USING TITANIUM OXIDE ( $\text{TiO}_2$ )/PEROXYDISULFATE ( $\text{Na}_2\text{S}_2\text{O}_8$ ):** 0.1-1 mg/L for each individual pesticide and <10 mg/L for the total concentration of all the pesticides.

>> **WATER DILUTION + TREATMENT USING TITANIUM OXIDE ( $\text{TiO}_2$ )/PEROXYDISULFATE ( $\text{Na}_2\text{S}_2\text{O}_8$ ):** > 1 mg/L for each individual pesticide and >10 mg/L for the total concentration of all the pesticides.

**EXAMPLE 1:** If the highest concentration level found is 2.5 mg/L for pesticide A and the total concentration level for all the pesticides found is 8.7 mg/L, a 1:3 solution is recommended.

Following dilution:

Pesticide A: 0.83 mg/L.

The total sum of all the pesticides: 2.9 mg/L

**EXAMPLE 2:** If the highest concentration level found is 0.5 mg/L for pesticide A and the total concentration level for all the pesticides found is 18.8 mg/L, a 1:2 solution is recommended.

Following dilution:

Pesticide A: 0.25 mg/L.

The total sum of all the pesticides: 9.4 mg/L

**EXAMPLE 2:** If the highest concentration level found is 2.6 mg/L for pesticide A and the total concentration level for all the pesticides found is 18.8 mg/L, a 1:3 solution is recommended.

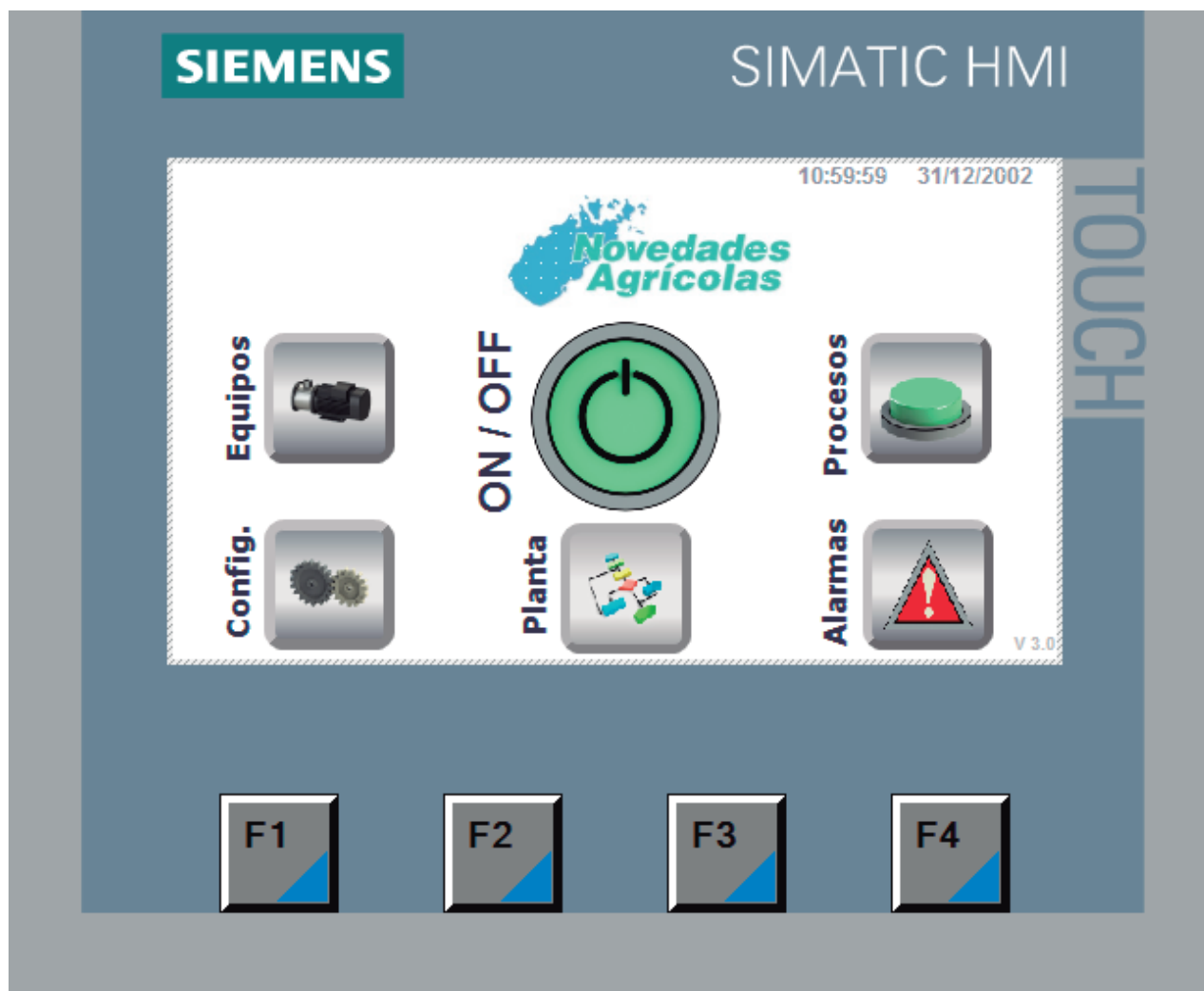
Following dilution:

Pesticide A: 0.83 mg/L.

The total sum of all the pesticides: 6.3 mg/L



## 9. AQUEMFREE EQUIPMENT USER MANUAL



### 9.1 ADJUSTABLE SOLAR SYSTEM DEPENDING ON THE MONTH

The top part of the equipment consists of an adjustable inclined support, the purpose of which is to achieve the highest possible solar irradiation level. It should be adjusted depending on the month of the year, as indicated below:

POSITION 1 (0°)	POSITION 2 (19°)	POSITION 3 (43°)	POSITION 4 (53°)	POSITION 3 (43°)	POSITION 2 (19°)
June	August	September	November	March	April
July		October	December		May
			January		
			February		

## 9.2 SIEMENS AUTOMATON WITH TOUCHSCREEN

Description of how it works.

### 9.2.1 Equipment

- **Pit Pump (P1):**

Operation in manual, on stop and automatic conditions is indicated on the EQUIPMENT (EQUIPOS) screen. It can start up in automatic when the right level is present in the washing water collection pit for taking water to the accumulation tank. If the accumulation tank is full or if the sand is being cleaned, automatic performance will not function.

- **Re-lift Pump (P2):**

Operation in manual, on stop and automatic conditions is indicated on the EQUIPMENT (EQUIPOS) screen. It can start up in automatic when the required level is present in the accumulation tank, when treatment is not ongoing and when the process start button for filling the tank is selected on the treatment screen. It stops when the tank is full.

- **Recirculation Pump (B3):**

Operation in manual, on stop and automatic conditions is indicated on the EQUIPMENT (EQUIPOS) screen. It can start up in automatic when the required level is present in the accumulation tank, when treatment is ongoing within the operation schedule and the blowing pump is not in operation.

- **Blower Pump (BP):**

Operation in manual, on stop and automatic conditions is indicated on the EQUIPMENT (EQUIPOS) screen. It can start up in automatic when a treatment process is ongoing within the operation schedule and, depending on the ON and OFF timers, activation and stop cycles will be performed.

- **Heat Exchanger-Cooler (E):**

Operation in manual, on stop and automatic conditions is indicated on the EQUIPMENT (EQUIPOS) screen. It can start up in automatic when the required level in the cooler tank is reached, when treatment is ongoing within the operation schedule and the recirculation water temperature thermostat indicator has been activated. The equipment stops at a set time following disconnection of the thermostat.

## 9.2.2 Processes

### ● Cleaning the sand filter

Change the manual valves to the filter cleaning position, open V1 in the pit and open V12 and close V2 and V13 on the equipment. Following this, change the position of the sand filter control valve from filtration to washing. Next, press the sand cleaning button on the screen. Pump P2 will connect for the duration of the cleaning process or until the minimum level in the accumulation tank has been reached. The pump in the pit will not operate during this process. Once the cleaning process has ended, position valves V1, V2, V12 and V13 in the normal operation position once again and change the sand filter control valve from the wash position to the filter position.

### ● Filling the treatment tank

Select the treatment tank filling button on the screen. Pump P2 will connect until the treatment tank fills up or reaches the minimum level for the accumulation tank. This process will not be possible if a treatment process is ongoing.

### ● Treatment

The treatment tank needs to be full and the treatment process button on the screen needs to be selected. The process begins and once the operation schedule range has been reached, recirculation pump P3 will connect in order to pump the water in the tank through the solar reactor tubes. The blowing pump (BP) will inject air into the treatment tank, starting up and stopping in cycles, and the heat-cooler interchanger will connect and disconnect depending on the temperature, as controlled by the thermostat. When the blowing pump is activated, the recirculation pump will disconnect so that air does not get into the circuit.

The solar irradiation probe measures the UVA instantaneous irradiation in  $W/m^2$  and it is accumulated in  $KJ/m^2$  in order to be compared with a process end value. When it is reached, the user is informed that the treatment has come to an end and, following this, the treatment tank will need to be emptied in order for a new process to begin.

In order to empty the reactor pipes, open V41 until the 3 pipes have been cleared.

The water level in the cooler is replenished using V40 and samples of the treatment are taken through V25.

Treatment reset: this returns process values to 0 so that a new course of treatment can begin.

### ● Emptying the treatment tank

Change the manual valves to the tank emptying position and close V22 and open V23 on the equipment. Next, press the switch for emptying the tank on the screen. Pump P3 will function until the treatment tank minimum is reached. Once the cleaning process has finished, return valves V22 and V23 to the normal operation position.

### 9.2.3 Indicators

- **Treatment duration meter**

Counts the total number of hours that the system is operating.

- **Treatment duration meter**

Counts the number of treatment hours within the operation schedule range.

- **Completed process meter**

Counts a process each time it is completed and resets the treatment process.

- **Instantaneous UVA irradiation indicator**

This is the instantaneous UVA irradiation measurement provided by the probe in  $W/m^2$ .

- **Accumulated UVA irradiation indicator**

This is the accumulated UVA irradiation measurement from when treatment begins and indicated in  $KJ/m^2$ .

- **End UVA irradiation indicator**

This is the value that the accumulated UVA irradiation must reach in  $KJ/m^2$  in order to conclude the treatment process.

### 9.2.4 Alarms

- **SETA Emergency Stop**

When active, it indicates that the EMERGENCY stop button on the electrical panel has been activated. This stops the system. Unlock the physical button and press the RESET ALARMS button in order to deactivate the notification.

Once turned off, the system can be started up again using the main switch.

- **Engine thermal trip**

When it is on, it indicates that one of the engines' thermal trips have gone off. This stops the system. Lift the corresponding thermal trips up and press the RESET ALARMS button in order to deactivate the notification.

Once turned off, the system can be started up again using the main switch.

### 9.2.5 Thermostat

Regulates the temperature that activates the cooler (C).

## 9.2.6 Notifications

- **Minimum level in the accumulation tank**

When this indicator is on it means that the accumulation tank has not got any water in it and, consequently, the re-lift pump (P2) will stop. The notification will disappear when the level in the tank increases.

- **Maximum level in the accumulation tank**

When this indicator is on it means that the accumulation tank is full of water and, consequently, the pit pump (P1) will stop. The notification will disappear when the level in the tank decreases.

- **Minimum level in the treatment tank**

When this indicator is on it means that the treatment tank has not got any water in it and, consequently, the recirculation pump (P3) will stop. The notification will disappear when the level in the tank increases.

- **Maximum level in the treatment tank**

When this indicator is on it means that the accumulation tank is full of water and, consequently, the re-lift pump (P2) will stop. The notification will disappear when the level in the tank decreases.

- **Level in the cooling tank low**

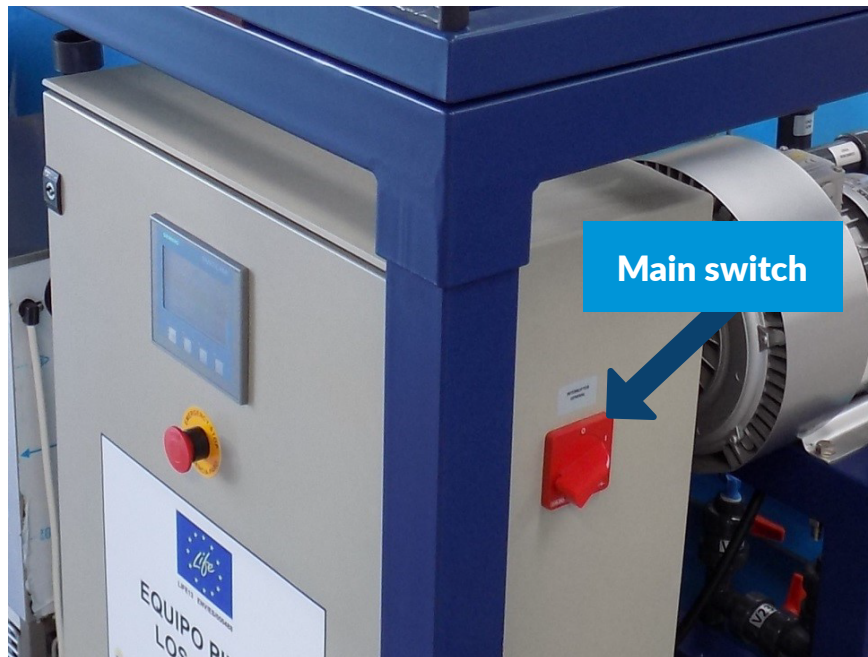
When this indicator is on it means that the cooler tank has a low water level and the cooler will disconnect. The notification will disappear when the level in the tank increases. The water level is replenished using V40 until the notification disappears.

- **Elevated treatment temperature**

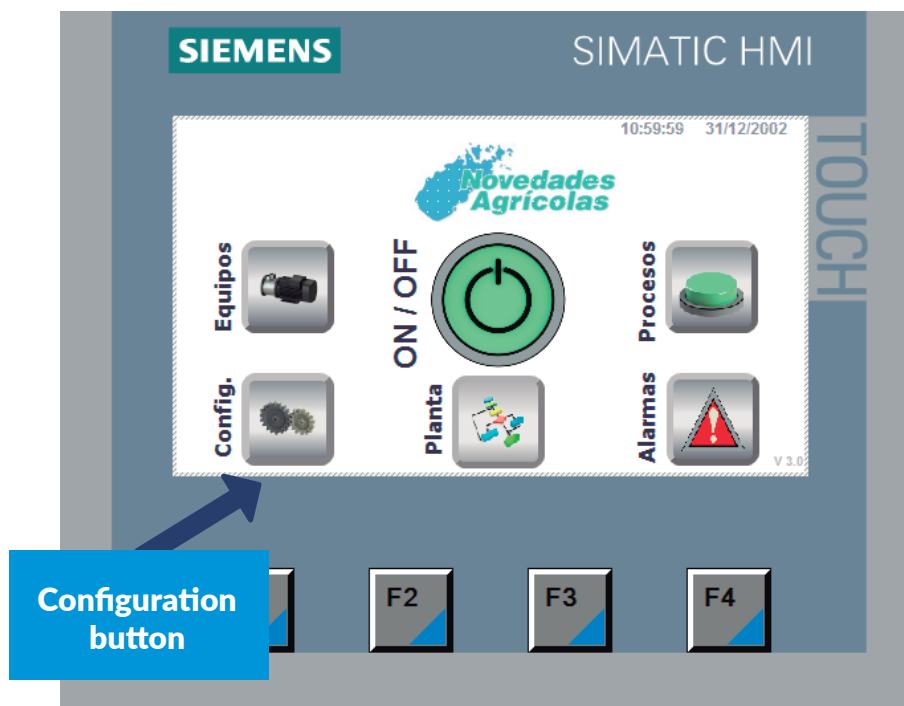
When this indicator is on it means that the treatment process water temperature is above the maximum level and the cooler will start up. The notification will disappear when the temperature drops and a cooler disconnection delay has gone by.

## 10. OPERATING THE EQUIPMENT

- Electrical activation of the cabinet: check that the circuit breaker guards and circuit breaker switches inside the cabinet are in operation position and turn the main switch on the outside of the cabinet to position 1. Wait 1 minute for the screen to turn on.



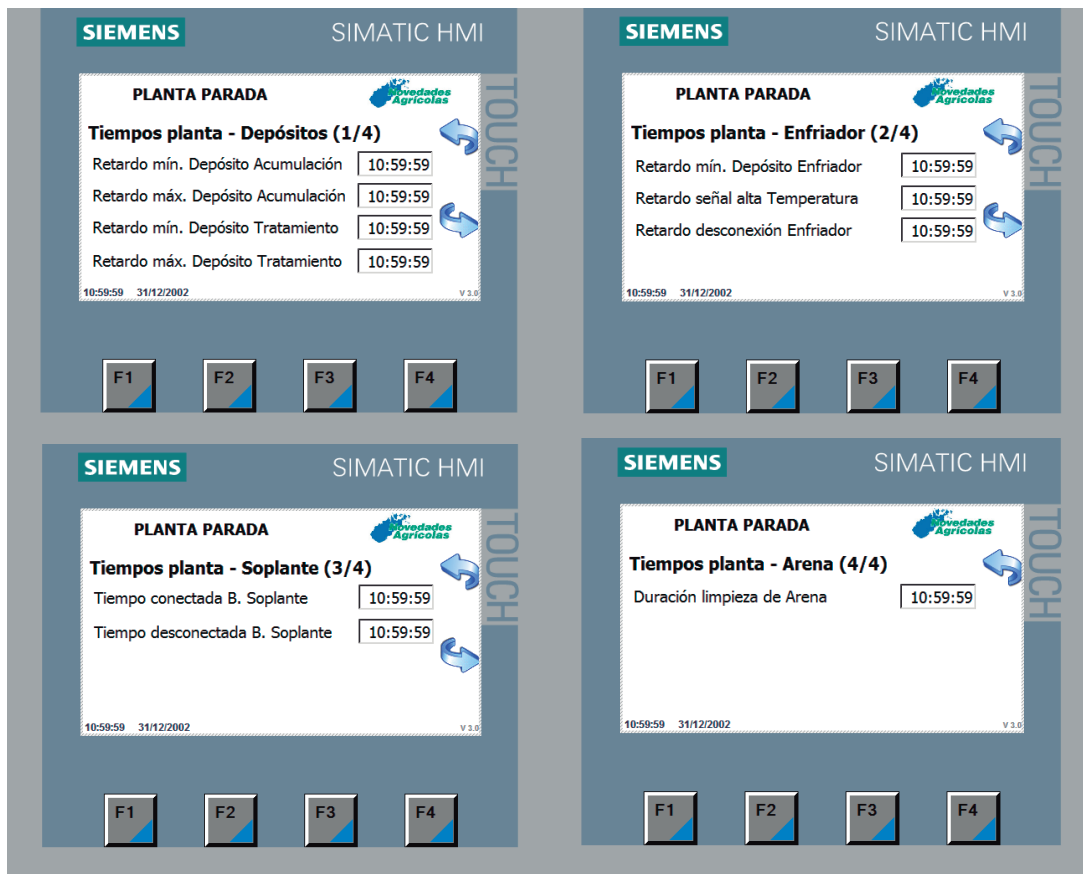
- Configuration button: operation parameters can be established using the configuration screen.



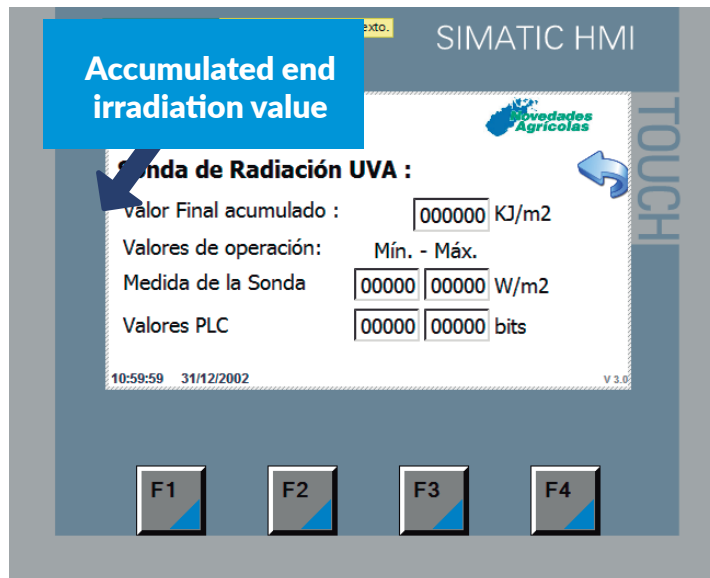
- Processes button: this button takes the user to parameters (Parámetros) and timers (Temporizadores).



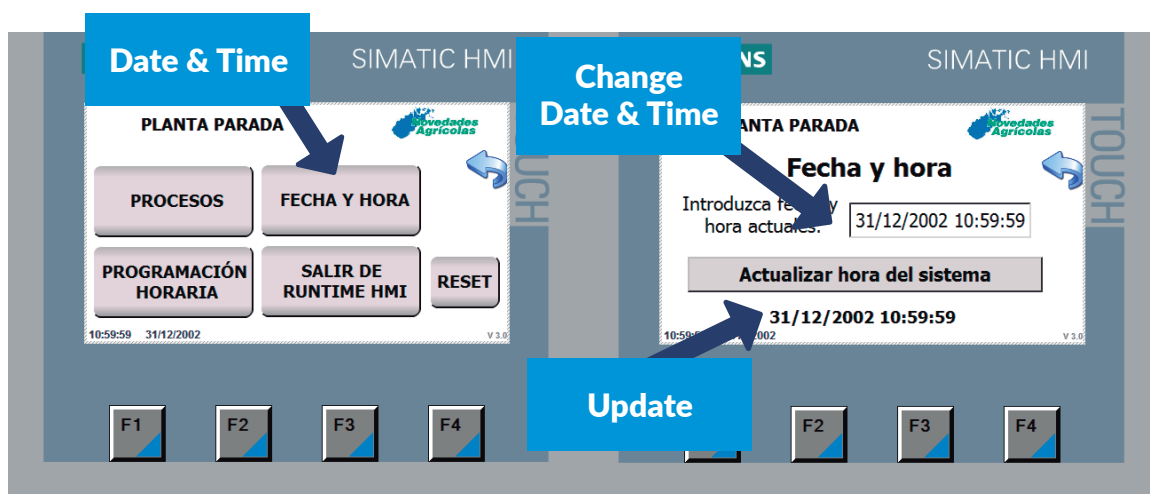
- Timers (Temporizadores) button: users may change the times that they are able to access (for example, the sand cleaning time or the blower operation time) on the 4 configuration screens. These are set up by the manufacturer and should not be touched unless necessary.



- **Parameters button:** the accumulated irradiation value that the process needs to reach in order for treatment to be labelled as completed should be introduced on this screen. The value is indicated in Kilojoules/m<sup>2</sup>. The probe measurement values are set up by the manufacturer and should not be touched unless necessary.

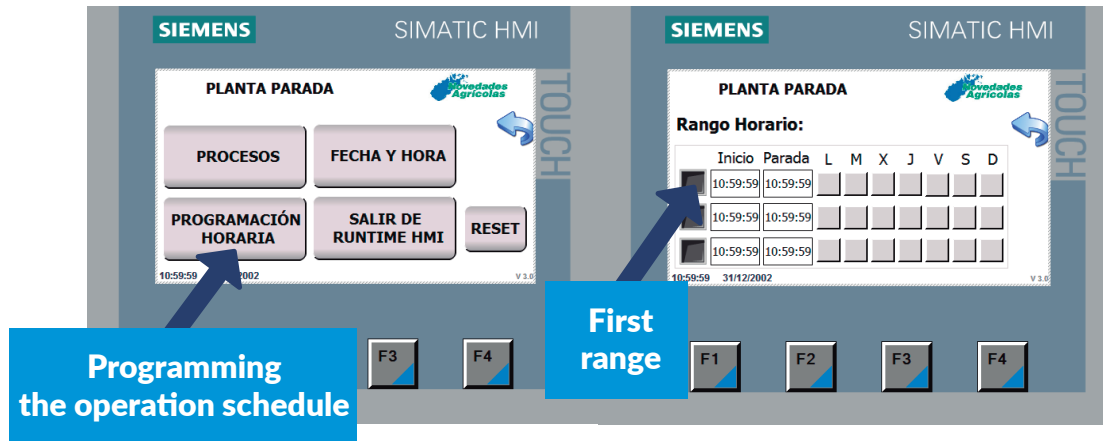


- **Date and time button:** in order to update the date and time, select the input button, make the necessary changes and then press the system time update button.

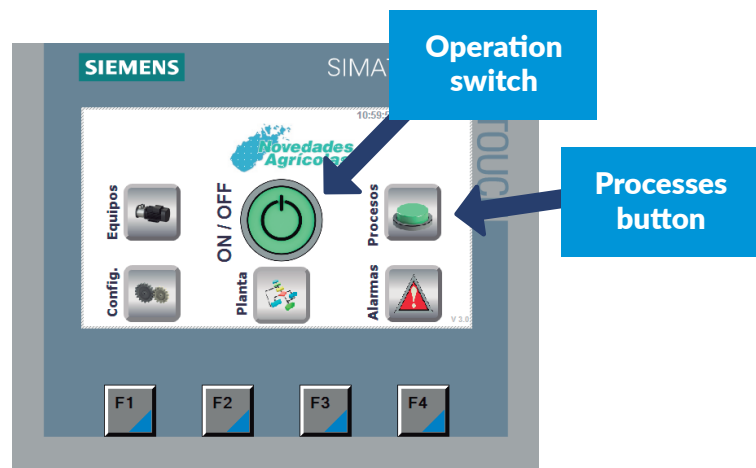




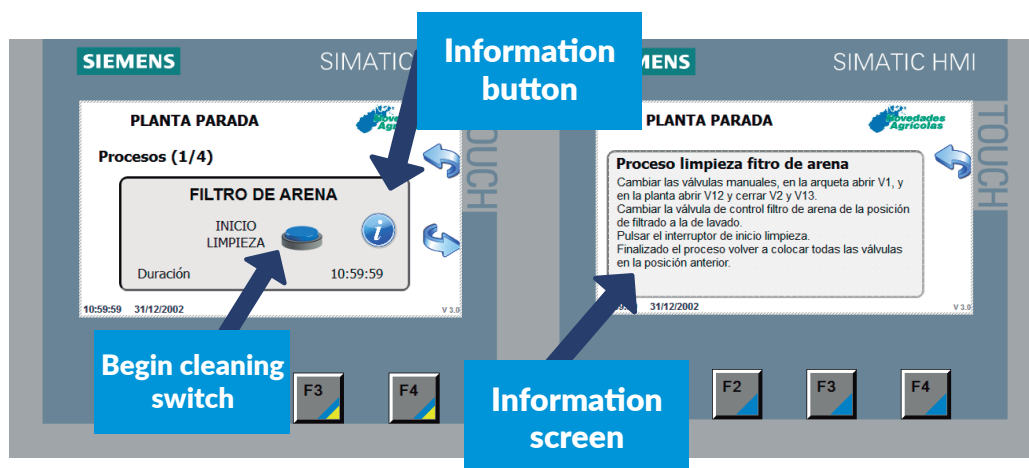
- Programming the schedule (Programación Horaria) button: for setting up the operation schedule. There are 3 possible options. Select the button for the first range and it will turn green. Select the days of the week, the start time and the stop time.



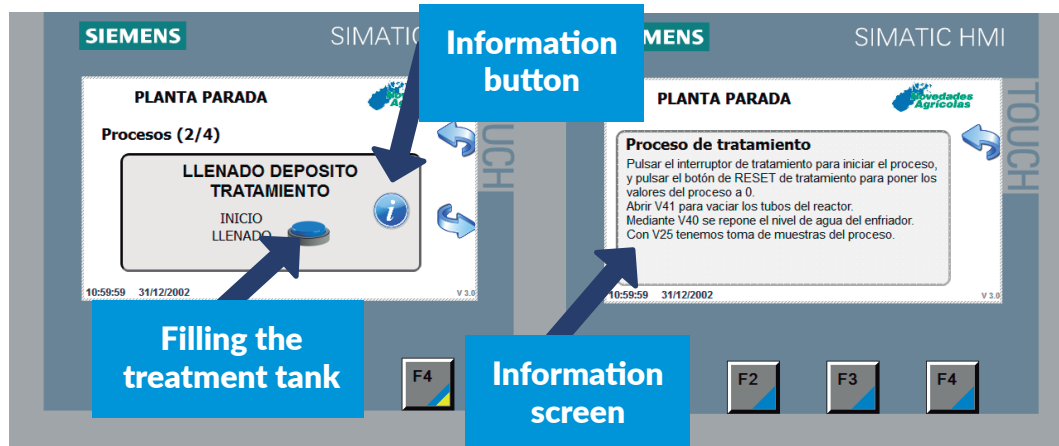
- Start button. In order to start the equipment up, press the ON/OFF button on the main screen. It will turn bright green. Next, press the processes button.



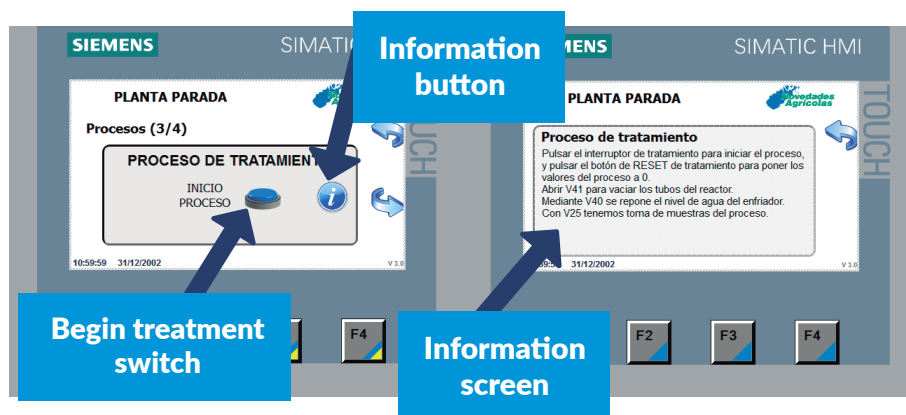
- Button for starting the sand filter cleaning process and the information button: the button for starting to empty the sand filter and the button providing information on this process are found on screen 1 of 4.



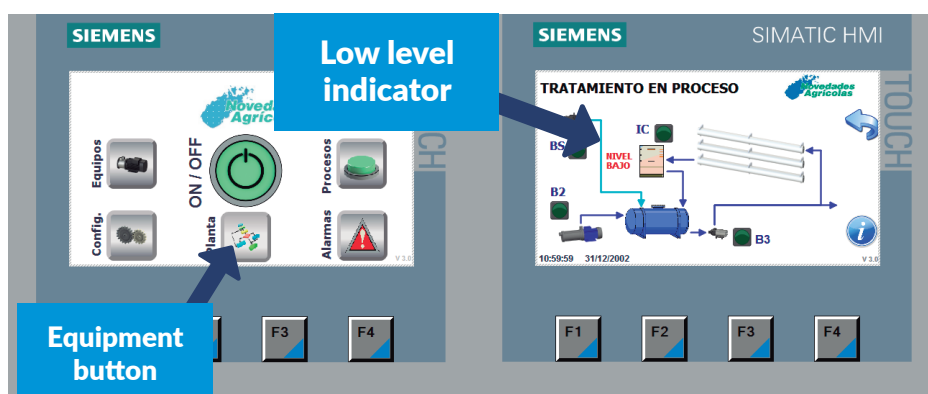
- Button for starting to fill the treatment tank and the information button: the button for initiating filling the treatment tank and the button providing information on this process are found on screen 2 of 4. The treatment tank needs to be at maximum capacity in order to begin a treatment process.



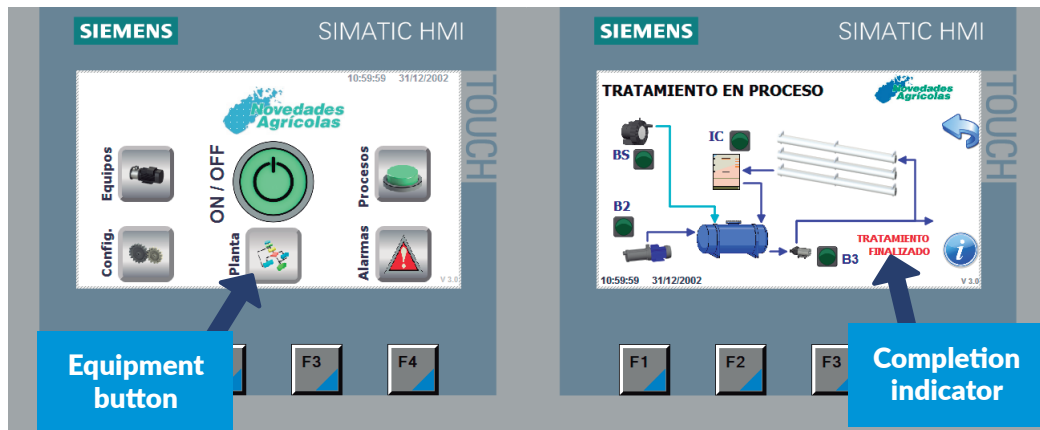
- Button for starting the treatment process and the information button: the buttons for initiating treatment and the button providing information on this process are found on screen 3 of 4.



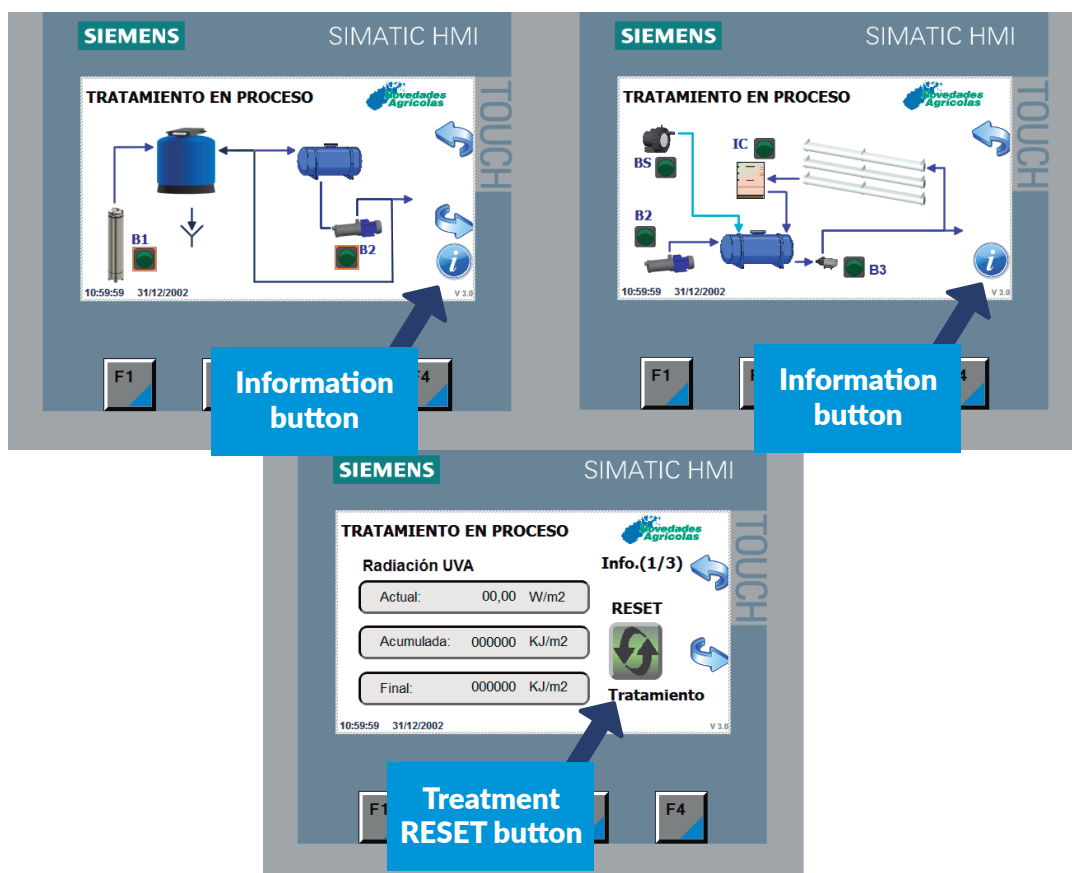
- LOW LEVEL indicator. On selecting the equipment button, the user can access a general outline of the equipment. When the level of the cooler tank is low, a LOW LEVEL indicator appears on this screen. When it fills up with water, the indicator disappears.



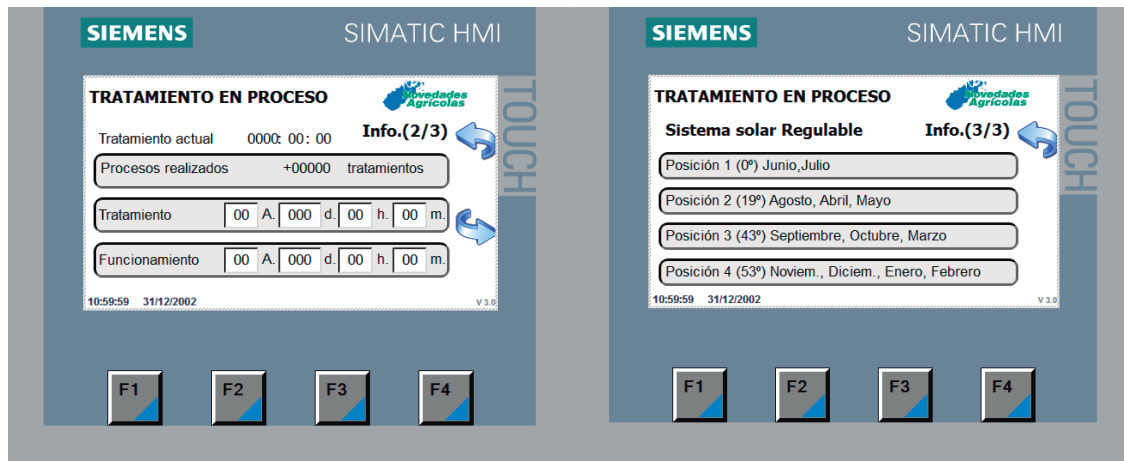
- **TREATMENT COMPLETED indicator.** On selecting the equipment button, the user can access a general outline of the equipment. When the process has reached an accumulated irradiation value exceeding the final value, a TREATMENT COMPLETED indicator appears on this screen. The values can be observed by selecting the information button.



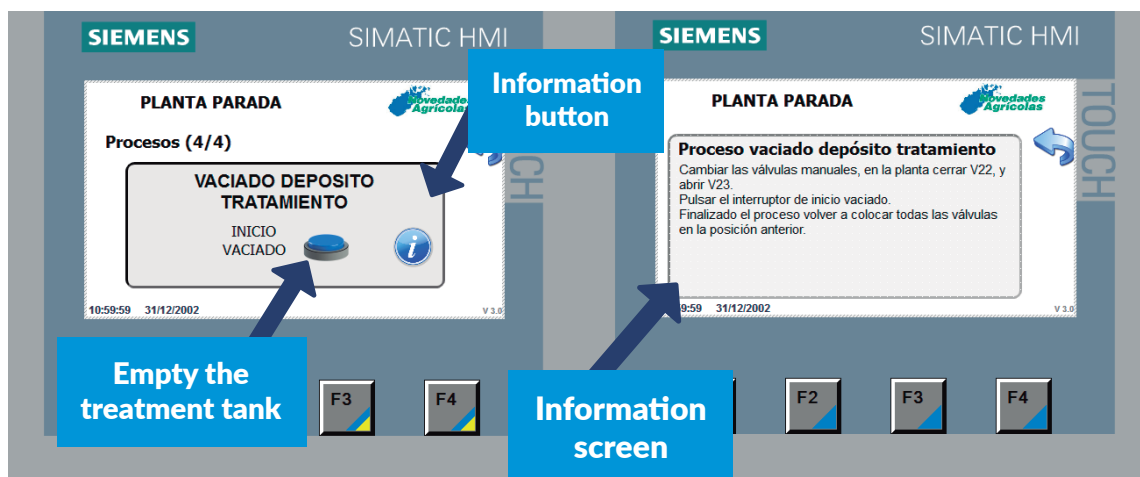
- **Information button.** On selecting this button, the user is taken to screen 1 of 3 providing information on the accumulated irradiation and the one that was programmed for completion of the process. By selecting the RESET button, the treatment parameters go back to zero and it is understood to have come to an end. This button must be pressed before the treatment tank is emptied.



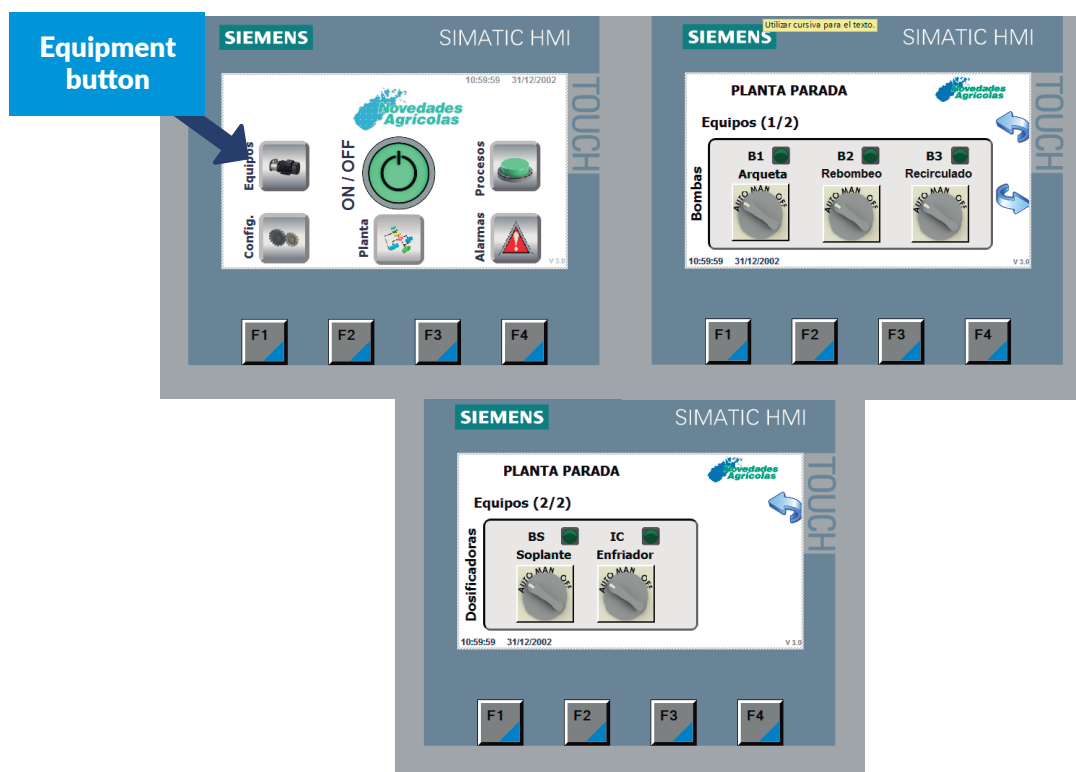
- Information screens 2 and 3 provide information on times, processes performed and the necessary degree of inclination for the solar system depending on the month of the year when treatment is carried out so that solar irradiation can be exploited to the full.



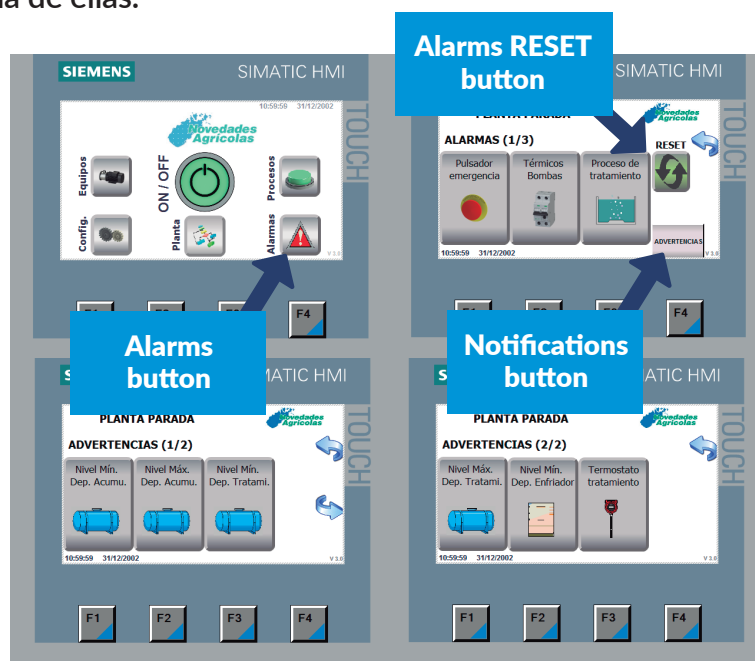
- Button for starting to empty the treatment tank and the information button. The button for starting to empty the treatment tank and the button providing information on this process are found on screen 4 of 4.



- **Equipment button.** When it is pressed, the user is taken to the equipment screen where the engine and cooler manual, stop and automatic selectors can be found. The selectors should be in automatic during normal operation.



- **Interruptor de Alarmas:** Al pulsarlo accedemos a la pantalla de alarmas, donde se puede ver si alguna está activa y donde se puede anular la alarma mediante el botón de “RESET”. Mediante el botón de Advertencias podemos acceder a las 2 pantallas donde se puede ver la información de los niveles y termostatos activos. Pulsando sobre los iconos de alarmas o advertencias tenemos la información relacionada con cada una de ellas.





## 11. PHOTOS





## INFORMATION ABOUT AQUEMFREE PROJECT

### WHAT IS THE LIFE-AQUEMFREE PROJECT?

LIFE-AQUEMFREE (<http://www.life-aquemfree.eu>) is a European project that is co-financed by the LIFE+ programme. It aims to commission a system for decontaminating water from washing containers and equipment used for plant protection product treatments using solar photocatalysis so that this water can then be re-used in agriculture.

### WHAT IS THE LIFE+ PROGRAMME?

The LIFE+ programme finances projects that make a contribution towards development and use of environmental policies and laws. The programme makes a considerable contribution towards the integration of environmental aspects in all other policies and, in more general terms, contributes towards sustainable development.

### WHAT IS THE PROBLEM REQUIRING A SOLUTION?

Part of the objectives of the Sustainable Use of Pesticides Directive 128/2009/EC and its transposition to Spanish legislation through Royal Decree 1311/2012 include protection of aquatic environments and drinking water. They also ensure that agricultural practise does not put the health of human beings and the environment at risk. Article 39 of the royal decree on cleaning treatment equipment indicates that

*'Dumping remnants of leftover treatment mixtures is prohibited. They shall be eliminated by using them on the same area of land already treated before being diluted in a sufficient quantity of water so as not to exceed the maximum permitted dose. However, where available, preference shall be given to the elimination of remnant using facilities or devices specially prepared for eliminating or degrading plant protection product waste.'*

### WHAT ARE THE PROJECT OBJECTIVES?

To highlight an alternative and financially viable technique (solar photocatalysis) for degrading pesticides in waste water from farms due to remnants in treatment containers and phytosanitary treatment equipment tanks and the rinsing of tanks following use, washing of treatment equipment, etc. using an innovative device in situ, thus providing a solution to an existing European issue, particularly along the Mediterranean.

### WHO ARE THE PARTICIPANTS AND WHERE IS IT CARRIED OUT?

