H-Genie™ - High Pressure Hydrogen Generator

User Manual

H-Genie-1.0

Contents

1. General Description

1.1. Introduction

The use of hydrogen gas in chemistry is limited due to the hazards associated with utilizing compressed gas cylinders. The H-Genie™ is designed to overcome these hazards, but also help the chemist in their chemistry too.

The main features include:

- On-demand generation of 4.0 purity hydrogen (at 100 bar) from water to make use of hydrogen gas safer.
- A pressure range of 1-100 bar (14.5-1450 psi) to expand your chemistry capabilities.

An accurate gas flow-rate range of 100-1000 NmL/min for connection with flow reactors and to log how much hydrogen is consumed during a reaction.

1.2. H-Genie™ System Overview

The H-Genie™ high pressure hydrogen generator works by generating hydrogen gas up to 4.0 purity from deionized water using a patented electrolytic cell. The hydrogen gas is dried through a two-stage water separation system, mechanical separation and thermal separation. The water removed is then drained through an external vent. The now dry hydrogen gas enters the mass flow controller (MFC), which controls precisely the flow rate of hydrogen out of the H-Genie™ between 100 and 1000 NmL/min. The H-Genie™ generates hydrogen gas to the required pressure (up to 100 bar) by continuously generating hydrogen until this pressure is reached. In flow mode, it will do this internally first, before releasing the hydrogen at the set pressure. The H-Genie™ will then continuously generate hydrogen to maintain that pressure.

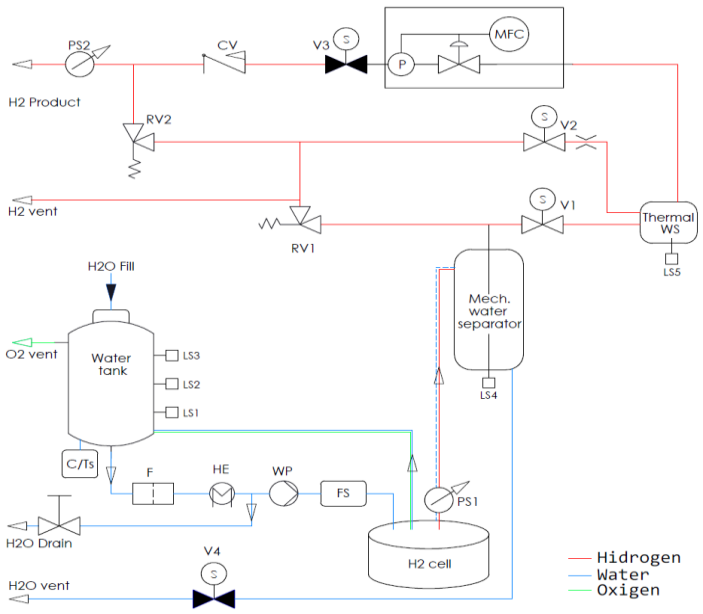

Figure 1: Schematic design of the H-Genie™

2. Overview of Parts

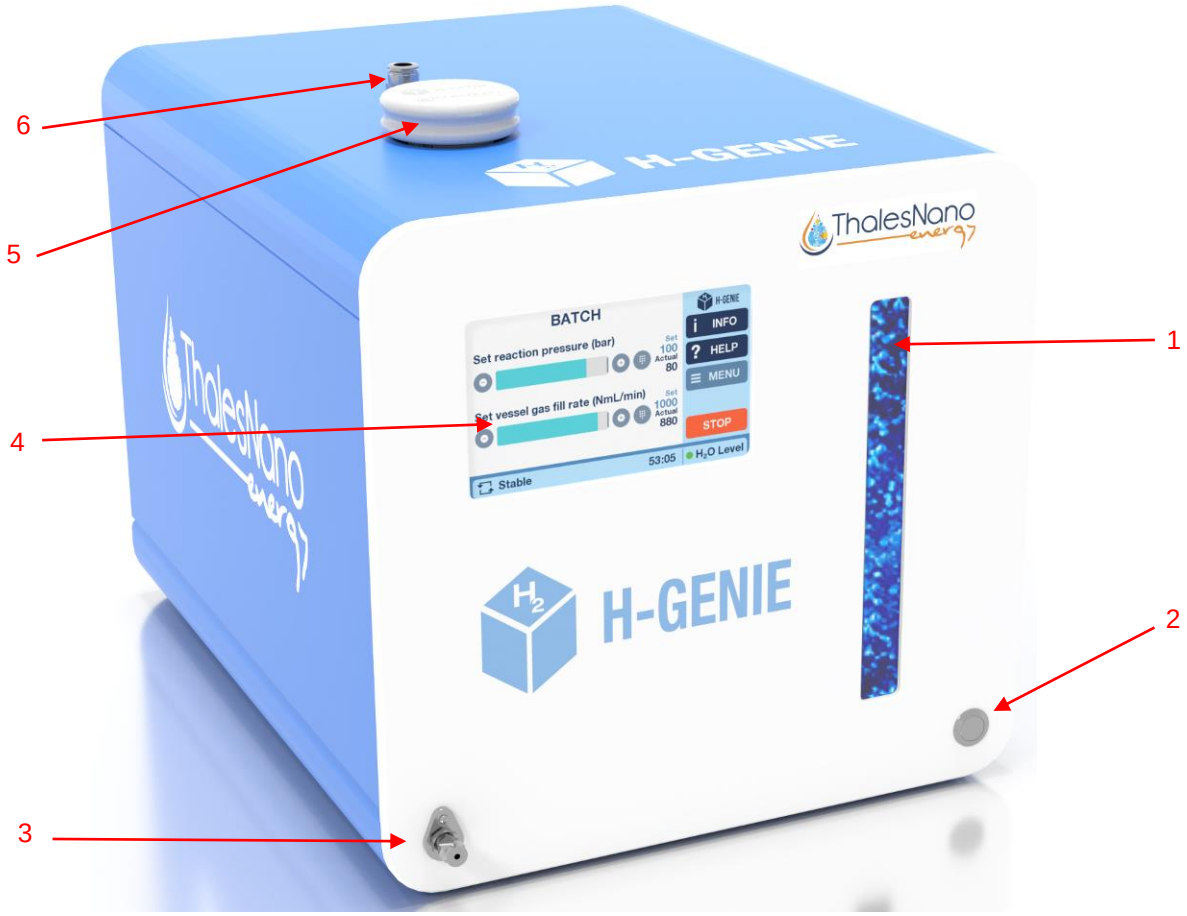

Figure 2: Front view of H-Genie™

1. Air bubble tank decoration
2. Shutdown button
3. Hydrogen gas outlet
4. Touch-screen
5. Water tank cap
6. Oxygen gas outlet

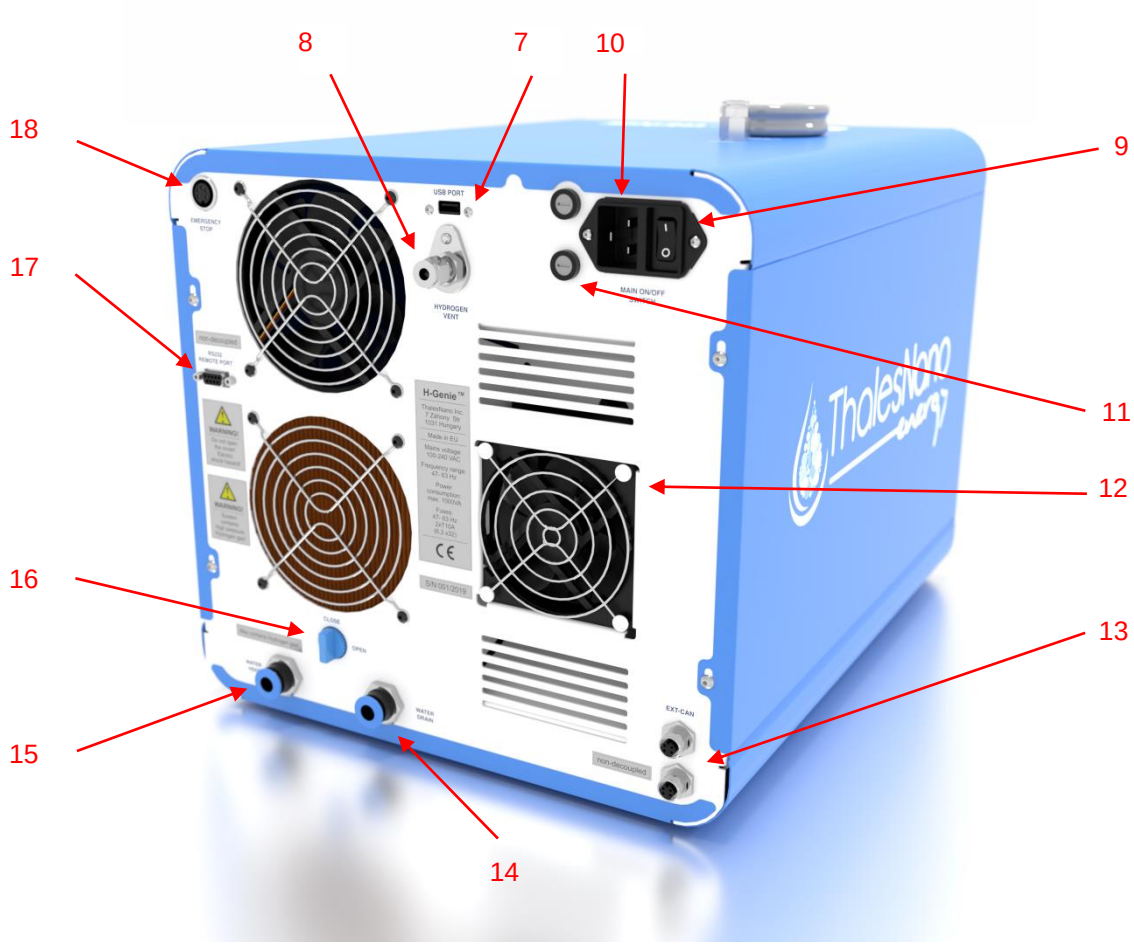

Figure 3: Rear view of H-Genie™

7. USB port
8. Hydrogen vent
9. Main ON/OFF switch
10. Power cable socket
11. Fuse sockets
12. Cooling vent (1 of 3)
13. External CAN connector sockets (for service purposes only; max cable length 3m)
14. Water drain outlet
15. Water vent from the mechanical water separator
16. Water drain open-close hand operated ball valve (horizontally-opened, vertically-closed)
17. RS-232 remote port (NON-DECOUPLED, max cable length 3m, user recommended use THSE purchased optical isolator to function-contact THSE for details)
18. Emergency Stop button connector socket (must use original THSE device)

2.1. Touch-screen Interface

The touch-screen interface consists of a series of windows that enable you to manually control all aspects of operation.

After turning on the equipment, the main window features a number of different options.

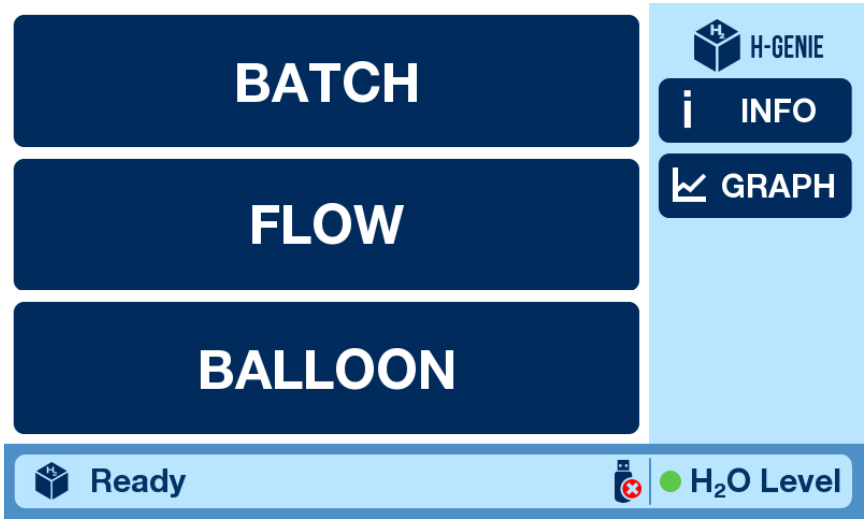

Figure 4: The Main screen

From the main screen you can choose three different options to start a reaction:

- Batch: To supply hydrogen to a batch reactor.
- Flow: To supply hydrogen to a flow reactor.
- Balloon: To supply hydrogen to a balloon.

There are also other options available:

- Info Screen: Displays technical information and data about the H-Genie™. The Info Screen may be accessed from any screen and under any status:

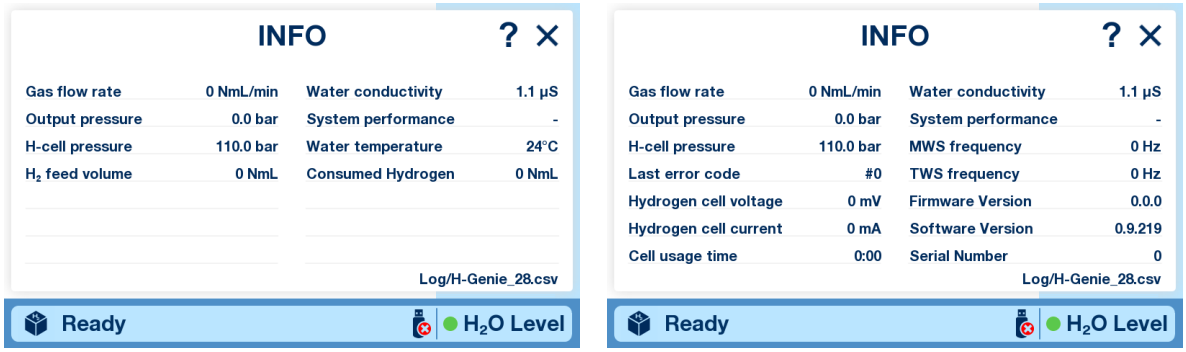

Figure 5: Info Screens

The information displayed is as follows:

- Gas flow rate: The flow rate of hydrogen leaving the H-Genie™.
- Output pressure: The pressure of hydrogen leaving the H-Genie™.
- H-cell pressure: The pressure of hydrogen inside the H-Genie™.
- H_2 feed volume: The amount hydrogen that has been released through the MFC since the Start button was pressed.
- Water conductivity: States the purity of the water in the H-Genie™ in µS/cm. If water purity decreases to below 20 µS/cm, then the H-Genie will not function until the water has been replaced.
- System performance: The software checks the hardware inside the H-Genie™ and determines the performance level of the system. This is a value for a service engineer.
- Water temperature: Temperature of the internal water system.
- Consumed hydrogen: The amount of hydrogen consumed since the batch reactor reached set pressure.

Additional parameters can be displayed with pressing the touch screen continuously for 1s (for service purposes only):

- Hydrogen cell voltage: Cell voltage measured in volts.
- Hydrogen cell current: Cell current in amperes.
- Cell usage time: The amount of time, in hours and minutes, the cell has functioned.
- MWS frequency: Measured water level frequency of the mechanical water separator.
- TWS frequency: Measured water level frequency of the thermal water separator.

- The Graph Screen 

: displays H-Genie™ parameters in graph form over time.

- Help Screen ? : Displays information of a descriptive nature about how the H-Genie™ works, how to install and use it, and what to do if there's a problem. The Help Screen may be accessed from any screen and under any status. The touch screen language can also be changed here.

Figure 6: The Help Screen

Status Bar: Displays the status of the H-Genie™, the water (H_2O) level, and whether there is a USB connected.

Figure 7: The Status Bar with disconnected and connected USB drives

The status messages are:

- Self-diagnostic: internal system check upon switching on.
- Ready: Ready to start generating hydrogen for a reaction.
- Preparation: Building hydrogen for the reaction.
- Running: Producing hydrogen for the reaction.
- Shutting down: Releasing internally stored hydrogen and shutting down the system.
- Emergency shutdown: Releasing hydrogen and shutting down after an emergency event is triggered.
- You can turn the device off: Ready to switch off.
- Poor water quality
- Too high external pressure
- Water level is too low

3. H-Genie™ Safety Features

The H-Genie™ has the following safety features to ensure safe and reliable operation:

1. The H-Genie™ is equipped with an internal hydrogen sensor, so in the unlikely event of a hydrogen leak the system will automatically shut down.
2. If the H-Genie™ cannot generate hydrogen pressure internally, then the system will automatically go into emergency shutdown mode.
3. Water leak detection at the base of the instrument.
4. The flow of air inside the H-Genie™ is enforced using 3 fans to ensure that the temperature inside the unit does not rise excessively and to prevent any build of hydrogen or oxygen in the event of a leak.
5. Upon power-up the H-Genie™ performs a self-check for internal leaks.
6. The hydrogen pressure inside the generator should only reach a maximum of 115 bar (1668 psi) and this is controlled electronically via a pressure sensor and mechanically using a pressure relief valve (Fail Safe).
7. There is a water level detector to ensure that the cell never runs dry.
8. Water separator malfunctions are checked to avoid high water content in the high-pressure system
9. Water purity is checked to avoid the degradation of the electrolytic cell
10. When the H-Genie™ is in emergency status the following occurs:
    a. The current to the cell is stopped.
    b. The internally stored hydrogen is evacuated into the fumehood.
    c. An audible and visual alarm will be heard

4. Installation

4.1. Delivery Content

The H-Genie™ delivery package includes the following items:

1 pc of H-Genie™ - Generator _____	☐
1 pc of Emergency Button and cable	☐
1 pc of Metal water tank cap	☐
1 pc of water gas outlet tube (10mm OD) 2m length	☐
1 pc of oxygen gas outlet tube (10mm OD) 2m length	☐
1 pc of H-Genie™ User Manual	☐
1 pc of Declaration of Conformity	☐
1 pc of H2 silencer assembly	☐
1 pc of check valve	☐
1 pc of power cable – check type EU ☐ UK ☐ CH ☐ USA ☐	☐
2 pcs of ss 1/8" tube, 0.1m and 1m lengths	☐
1 pc of ss 1/8” to 1/16” reducer	☐
1 pc of ss 1/16” tube (1m length)	☐
2 pcs of ss 1/16” nuts with ferrules	☐
1 pc of Vici PEEK finger tight 1/16” nut	☐
1 pc of ScavCart™	☐

Please ensure that all of the items listed above are present in the delivery package. Check for any visible damage to H-Genie™ components. Should any item be missing or any parts visibly damaged, please contact your nearest ThalesNano representative or techsupport@thalesnano.com.

4.2. Location

- The H-Genie™ **must** be located on a flat, level surface inside a fully functional ventilated cabinet or ventilated area, such as fumehood. This minimizes any risk related to a hydrogen leak into the environment.
- The fumehood or ventilated cabinet must be equipped with a standard electrical socket and a water hole.
- The oxygen and hydrogen vent tube outlets should be positioned as far apart as possible within the fumehood.
- It is recommended that any objects be placed a minimum of 15 cm away from the rear and the sides of the H-Genie™ to avoid any obstruction to the airflow in the cabinet and to allow any warm air from within the generator to be released freely into the environment. Ensure that none of the rear vents are obstructed. Failure to ensure this may result in damage to the H-Genie™.
- Dimensions of the H-Genie™ can be found in the Technical Data section.
- Please adhere to the operating temperatures below:
    - Minimum Operating Ambient Temperature: 10 °C (50 °F)
    - Maximum Operating Ambient Temperature: 35 °C (95 °F)

4.3. Installing the H-Genie™

Open the packaging and remove all the contents.

4.3.1. Place the H-Genie™ reactor box inside the selected fume hood cabinet.

4.3.2. Remove the temporary black water reservoir cap and fill the water reservoir with high-purity de-ionized water. Cover the water reservoir hole with the metal cap provided.

Attention

The H-Genie™ generates hydrogen by in-situ high pressure water electrolysis. The operation of high pressure cells requires high purity, de-ionized water. Millipore Milli-Q®: <1µS/cm is strongly recommended!!!

Using low quality water can cause irreparable damage of the instrument.

The volume of the water reservoir is an approx. 3500 mL. Take care not to overfill. The maximum water level should be 1 cm below the water tank neck.

Ensure the water tank is topped up every day before using H-Genie™.

4.3.3. Attach the oxygen gas outlet tube to the outlet at the top of the H-Genie™. Ensure the other end is attached to the rear of the fume hood cabinet to ensure the tube does not move when oxygen gas is released.

Do not impede or block the oxygen gas outlet at the top of the water reservoir while the machine is switched on. Only use the cap provided with the machine.

4.3.4. Insert the power cable into the rear of the H-Genie™ and connect it to the mains power supply.

The electric cables must be guarded against moisture.

4.3.5. Connect one end of the water drain outlet tube to the water drain outlet and the other end to a sink located in the fumehood.

4.3.6. Attach the hydrogen vent tubes and water vent tubes to their respective outlets and the other ends to the rear of the fumehood and the fumehood sink

respectively. Please ensure the end of these tubes are fastened to avoid movement when hydrogen gas is released.

Important! The hydrogen vent tube and the water vent tube will release hydrogen into the fumehood. Please ensure that the ends of these pipes are at least 1.5m away from the outlet of the oxygen outlet to ensure hydrogen and oxygen do not mix or, if possible, in separate fumehoods.

4.3.7. Attach the emergency stop button to the connector at the rear of the H-Genie™ and ensure that the button is located in an easily accessible place.

4.3.8. Finally, switch the main On/Off switch, located at the rear of the H-Genie™ to the on position.

5. Performing a reaction with the H-Genie™

Safety instructions:

During use the fume hood MUST be switched on, and the fume hood door pulled down.

The H-Genie™ generates hydrogen internally. In normal operation, hydrogen will be released from the rear ports. It is essential that adequate precautions are taken to allow this to be safely ventilated by a fume hood cabinet.

Ensure that the reactor vessel is connected to the H-Genie™ and gas tight. Check to ensure that there are no leaks.

Please ensure the water reservoir is topped up at all times. It is vital that the electrolysis cell membrane is kept constantly wet. The cell must not be allowed to run dry or the cell will immediately and irreversibly cease to function.

Once the installation is complete, turn on the H-Genie™ using the „On" button on the front of the system. The following screen will appear. Press „Ok" to begin the H-Genie™'s selftest.

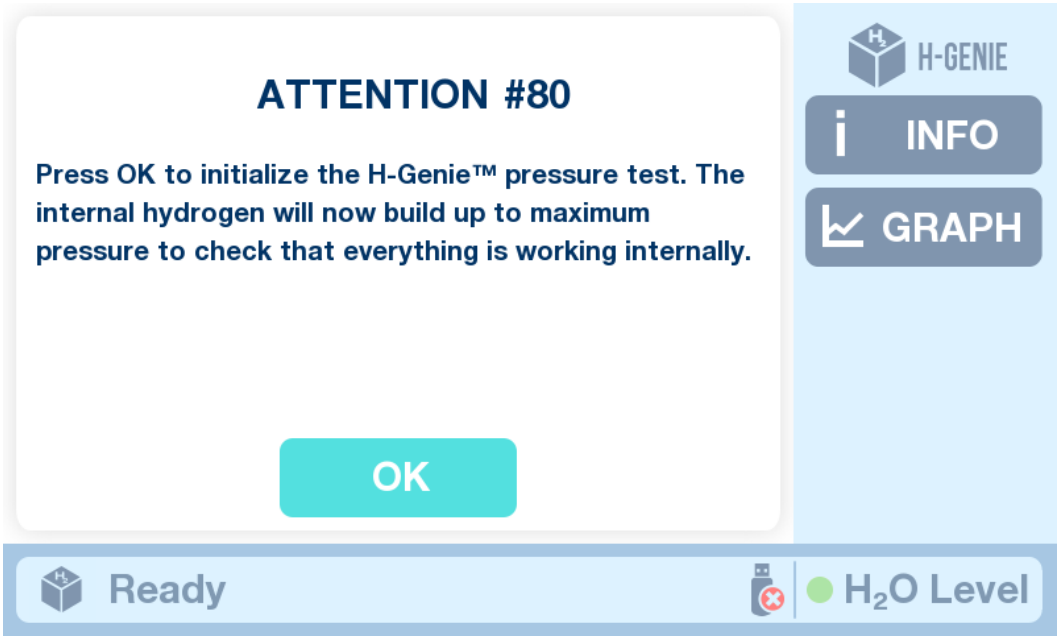

Figure 8: Selftest

The screen will then change to the following, while the system will run through a self-test in order to check that the internal H-Genie™ hydrogen system can build pressure to the maximum settable limit. Do not switch the H-Genie™ while the system is initializing.

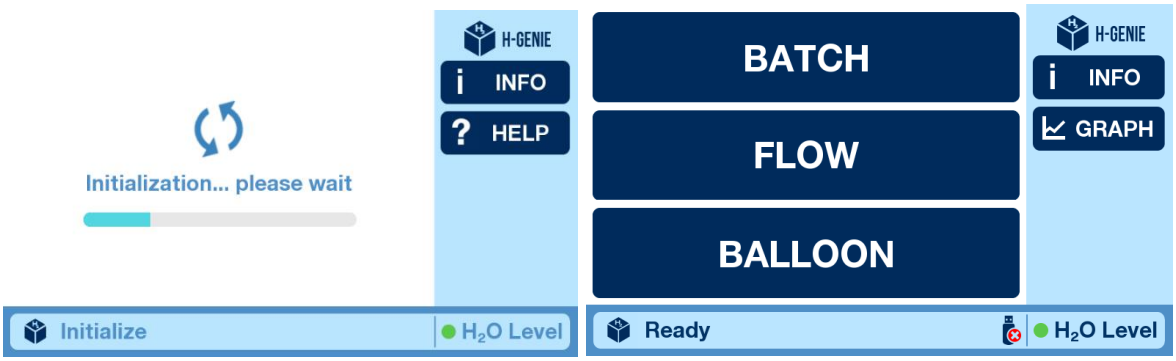

Figure 9: Initialization screen and Ready screen.

Once the system has finished the self test and the initializing, the main screen will appear and the term „Ready" will appear in the status bar. You're ready to get started.

Please note!

During hydrogen production, the H-Genie™ will, from time to time, release the water extracted from the hydrogen gas out the back of the system. A small amount of hydrogen may also be released and make a noise. This is completely normal and you shouldn't be alarmed.

- The H-Genie™ is designed to run on a single tank of water for a minimum of 12 hours at maximum consumption. Before running out of water the below warning screen will appear. Once the water level of the H-Genie™ reaches the critical level, an error message will appear and the H-Genie™ will shutdown to ensure the hydrogen generation cell is not harmed.

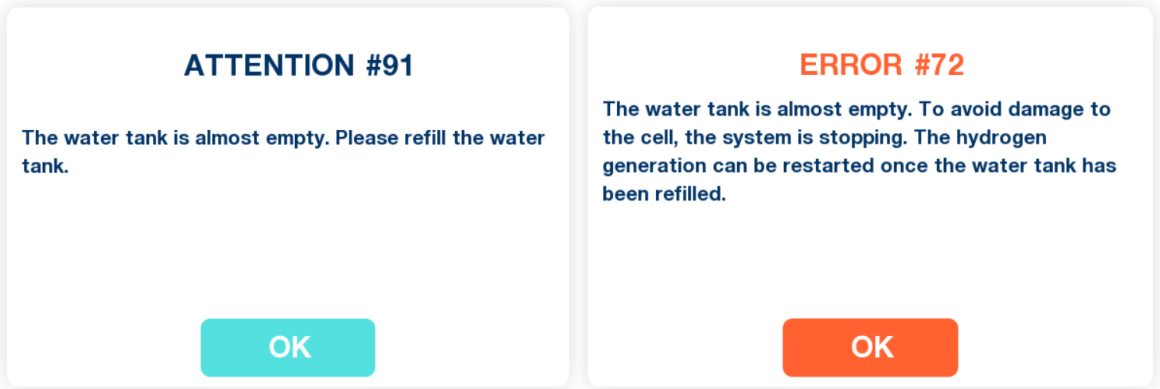

Figure 10: Warning and Emergency stop low water tank message

Please note!

The external vessel attached to the H-Genie™ must be at 1 bar or the H-Genie™ will not allow the reaction to proceed.

5.1 Setting a BATCH reaction

5.1.1 Connect your batch reactor to the front of the H-Genie™ using the appropriate tube and connection. Ensure there are no leaks and connections are tight.

5.1.2 Press the BATCH function on the main screen.

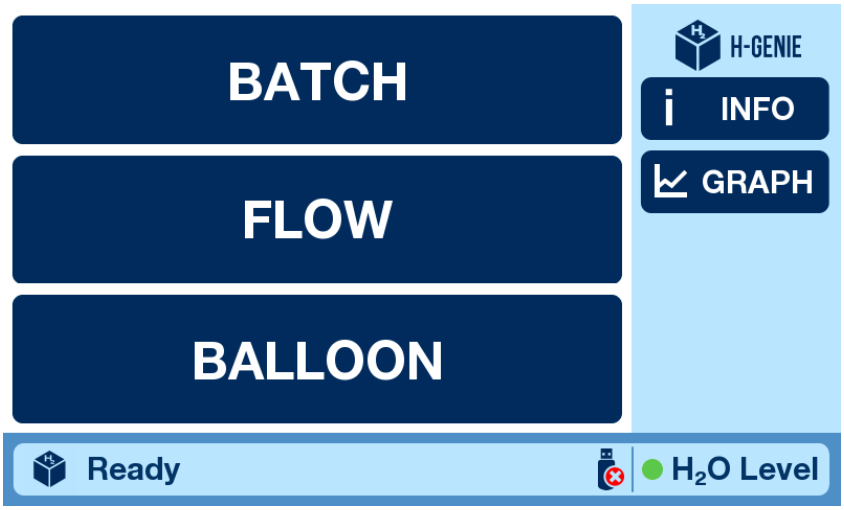

Figure 11: Main Screen

5.1.3 Press the button to enter a reaction pressure and hydrogen gas flow rate value. Press OK after you have set the appropriate value. The or buttons may be used to raise the set value by + or – 1 value.

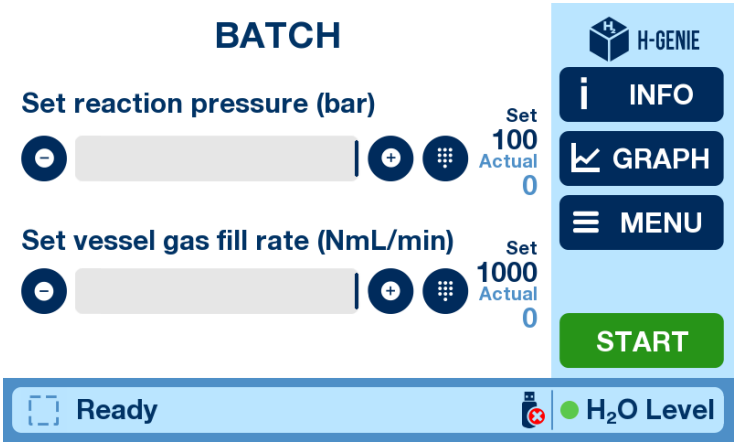

Figure 12: Batch mode ready to start

5.1.4 Once all the parameters have been set, then press START.

5.2 Setting a FLOW reaction

5.2.1 Connect the check-valve to the front of the H-Genie™. **Ensure that the arrow on the check-valve is pointing "out" from the H-Genie™.** This is the direction of the hydrogen flow.

5.2.2 Connect your flow reactor to the check-valve using the appropriate tube and connection. Ensure there are no leaks and connections are tight.

5.2.3 Press the FLOW function on the main screen.

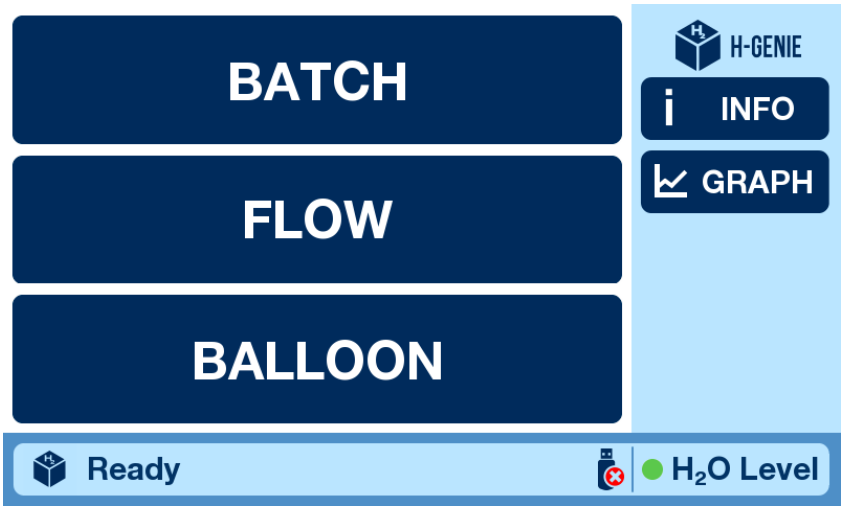

Figure 13: Main Screen

5.2.4 Press the button to enter a reaction pressure and hydrogen gas flow rate value.

The set value should be 10 bar above your planned flow reaction pressure to ensure a positive flow of hydrogen out of the H-Genie™ and into the flow reactor.

5.2.5 Press OK after you have set the appropriate value. The or buttons may be used to raise the set value by + or – 1 value.

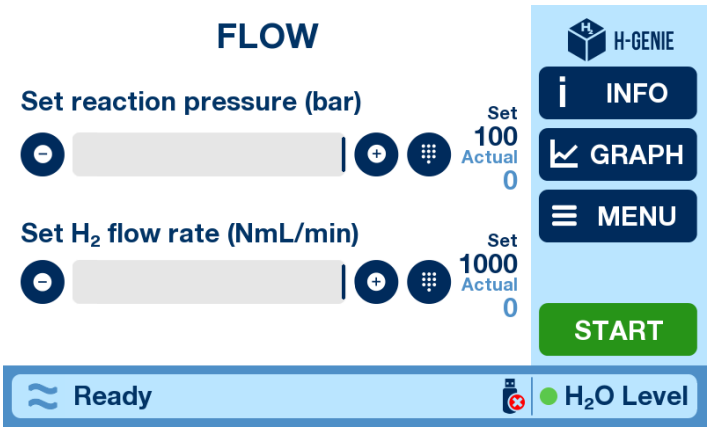

Figure 14: FLOW mode ready to start

5.2.6 Once all the parameters have been set, then press START.

5.2.7 Once the H-Genie™ has generated the set pressure and the hydrogen is eluting from the system, pressurize your flow reactor.

5.3 Setting a BALLOON reaction

5.3.1 Press the BALLOON function on the main screen.

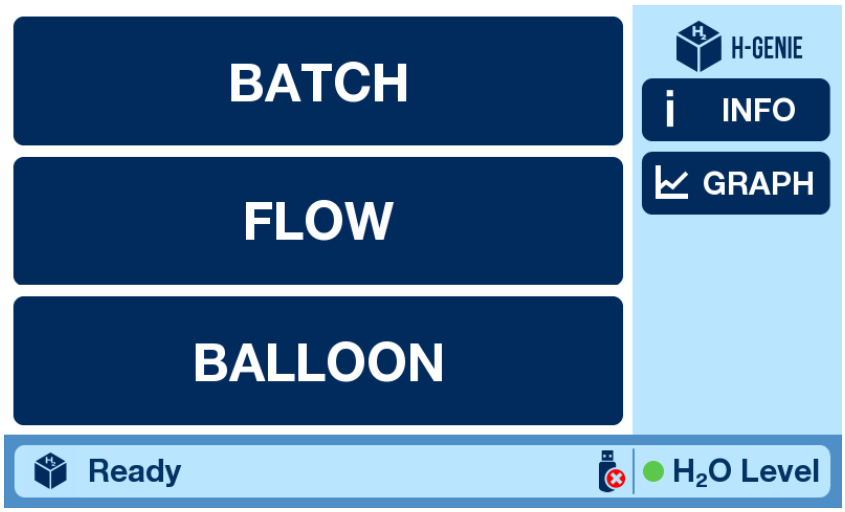

Figure 15: Main Screen

5.3.2 For the BALLOON mode, the pressure is limited to 1 bar and the hydrogen flow rate is set to maximum automatically (and cannot be changed). The user need only set a balloon volume.

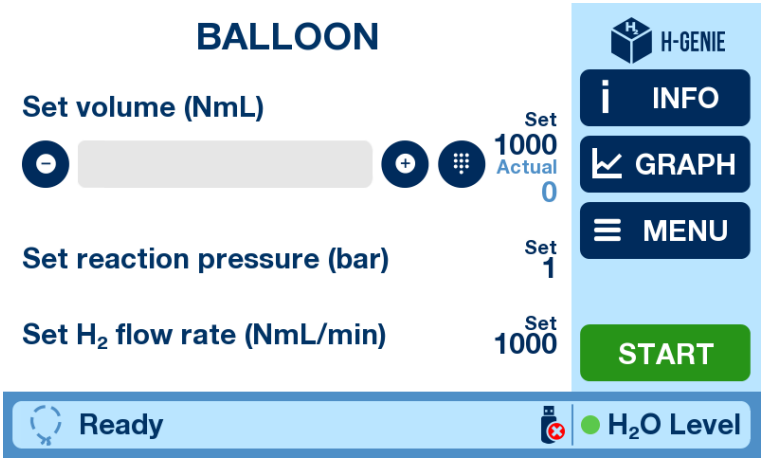

Figure 16: Balloon mode ready to start

5.3.3 Press the button to enter a balloon volume.

5.3.4 Press OK after you have set the appropriate value. The or buttons may be used to raise the set value by + or – 1 value.

5.3.5 Connect your balloon via a tube to the front of the H-Genie™.
5.3.6 Once all the parameters have been set, then press START.

5.4. The Graph and Exporting the Experimental Data

If you wish to export the data from the experiment, then please ensure that the USB drive you wish to save the data to is plugged into the USB port at the rear of the instrument. Once the USB drive is plugged in the place, the USB symbol in the status bar will change from a red cross to a green tick.

Pressing the GRAPH symbol opens the graph screen.

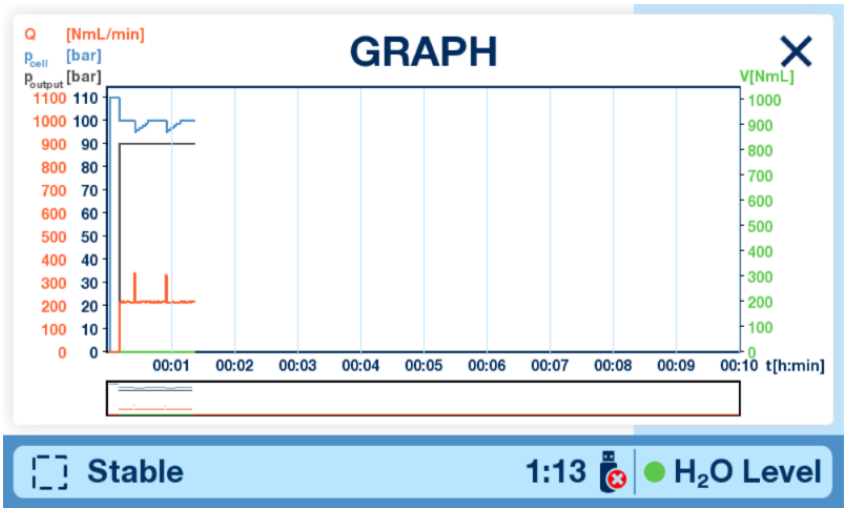

Figure 17: The graph screen

The graph screen will display the following data over time (hours and mins) for the pressure of the cell (bar), the output pressure (bar), the flow rate of hydrogen (NmL/min) out of the system, and the consumed hydrogen (NmL).

Once you have stopped the instrument, you can remove the USB drive. Please take note of the Log.csv file name at the bottom right of the Info Screen. This will be the file name for the experiment you have just run.

5.5. Using and Changing a ScavCart™

In order to maintain water purity at an acceptable level for the H-Genie™ and to ensure a good hydrogen cell longevity, then it is mandatory to use a ScavCart™. The ScavCart™ should be changed monthly. ScavCart™s can be ordered directly from ThalesNano Energy. Contact info@thalesnanoenergy.com for ordering information.

Warning!

Do not use your own resin as a water purity scavenger. Only use official ThalesNano Energy certified products. Failure to do so will invalidate product warranty. A special resin and particle size is used in ThalesNano Energy ScavCart™s. Only use for a maximum of one month. Using ScavCart™s beyond this timeframe may cause leaching of the resin into the water tank.

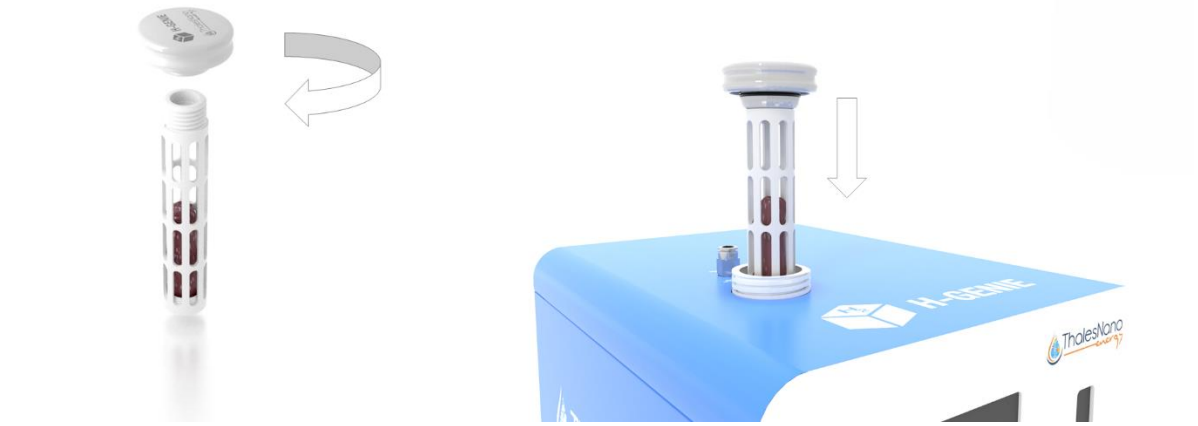

Figure 18: How to attach ScavCart™ to metal cap and how to install it in the H-Genie™

To use the ScavCart™, take the plastic holder and screw it into the metal cap. Place the ScavCart™ into the H-Genie™ water tank. Please ensure water tank is full every day before use.

Once the ScavCart™ has expired after a month, then dispose in solid waste or ship back to ThalesNano Energy for recycling. Address is given below.

5.5. Turning off and shutting down the H-Genie

To turn off/shutdown the H-Genie™. Press the Shutdown button on the front of the system.

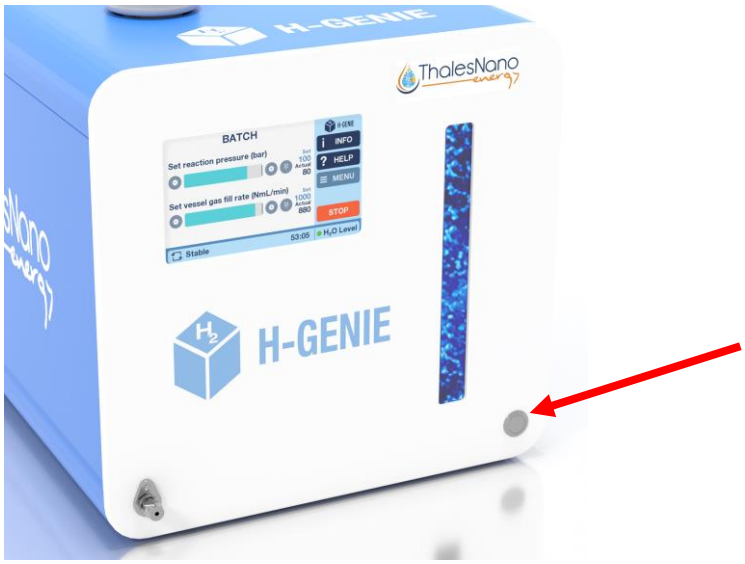

Figure 18. Shutdown button

The H-Genie™ will now start to shutdown. If there is any internal hydrogen present, then it will be released out the back and through the water vent. This will make a noise, but do not be alarmed this is completely normal. The entire procedure takes ~60 seconds. Once it is finished the status change to “You can turn the device off”.

Please note! If you intend to switch back on the instrument straight away after shutting down, then please wait a minimum 30 seconds before switching on.

Figure 19: Shutdown phases.

The same procedure will take place if the emergency button is pressed or the software triggers an emergency shutdown, such as if there is a cell failure or hydrogen leak detected. The below screens will appear.

Figure 20: Emergency shutdown phases.

6 Troubleshooting

Problem	Possible Cause	Corrective Action
The H-Genie™ does not release hydrogen.	There may be a blockage in the MFC.	Call for service.
The H-Genie™ does not build hydrogen internally.	Cell malfunction.	Call for service.
The H-Genie™ won't switch on after Emergency button has been triggered.	The emergency button is in the fixed off position.	Turn the button to release it.
The H-Genie™ fails the initialization start-up.	Internal fault	Turn off the H-Genie™ and try again. If it fails repeatedly, call for service.
Water is seen leaking out the bottom.	Water leak	Switch off immediately and Call for service.
There is a continuous hydrogen gas sound out of the rear of the H-Genie™ during a reaction.	Valve failure	Switch off immediately and Call for service.

If you are experiencing problems with the H-Genie™ and a service engineer is required, please e-mail a short description of the problem, along with your contact details, to the following address: techsupport@thalesnano.com.

We will try and respond within 24 hours on work days.

7. Daily Maintenance Checks

Opening of the H-Genie™ reactor box, and any necessary repairs can only be performed by ThalesNano service experts. Unauthorized opening of the device will render the warranty null and void.

Ensure you check the following on a daily basis.

- Top up the water tank
- Ensure all tube connections and fittings are intact and secure
- There is no water spillage or leak around the device.
- The touch screen and other surfaces are clean and free of chemicals.
- Check the purity of the water on the Info Screen

8 Accessories

For a list of up to date accessories, please visit www.thalesnanoenergy.com or contact sales@thalesnanoenergy.com.

9 Technical Data

Pressure Range of H-Genie™:	From 1 bar to a maximum of 100 bar
Internal hydrogens pressure limit:	115 bar
Hydrogen flow rate range:	100-1000 NmL/min
Water purity at 100 bar:	99.99% (4.0)
Internal hydrogen volume:	< 150 mL
Water consumption rate:	< 200 cm^3/h
Water reservoir capacity:	Internal: 3L
Recommended environment:	Ventilated laboratory fume hood
Power requirements:	Mains: 100V to 240V AC, 47-63Hz
Power consumption:	max. 1500 VA
Unit dimensions (H x W x D):	345 mm x 365 mm x 460 mm
Outlet parameter:	Tubing OD: 1/8” The output valve can accept any connector with a male thread Press 1/8”

10 Warranty Information

The H-Genie™ is delivered in accordance with ThalesNano Energy standard terms and conditions, a copy of which is attached to the purchase invoice and is also available on request.

The guarantee period of H-Genie™ is 12 months, starting from the date of delivery to the client. Operation inconsistent with the manufacturer's instructions is excluded from the warranty, while the unauthorized opening of the device will render the warranty null and void.

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If we find a defect covered by the warranty, repair, or replacement, at our discretion, will be carried out free of charge. Packing and transport costs are borne by the customer.