PEM Fuel Cell Unit

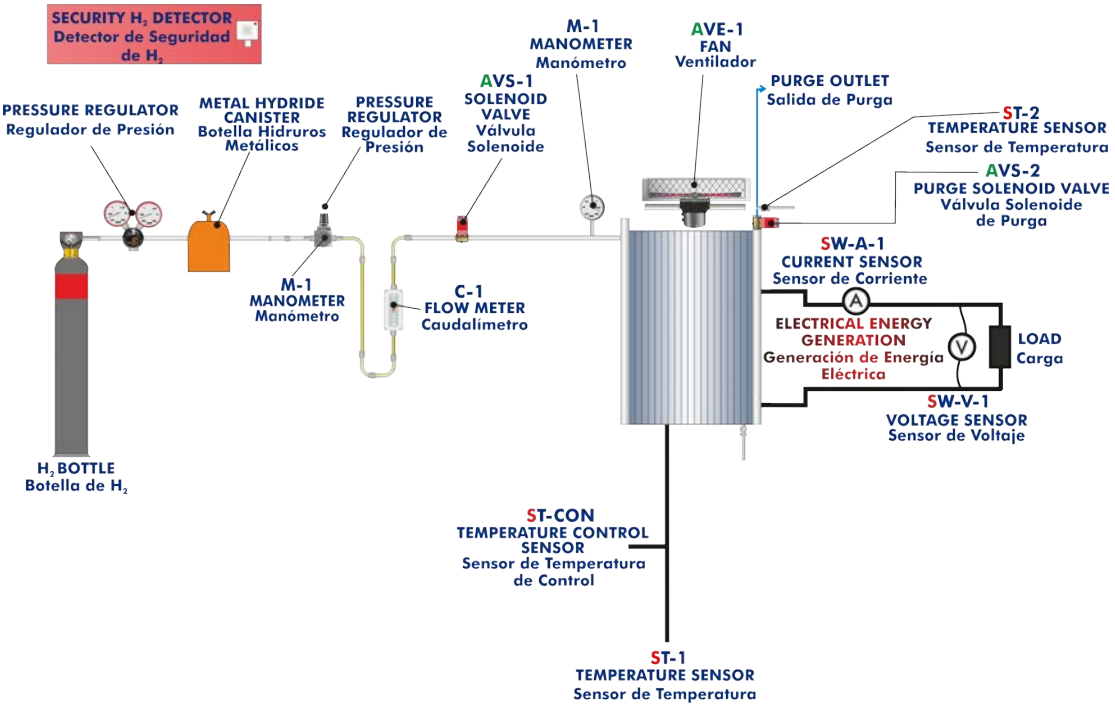
EC5B

Engineering and Technical Teaching Equipment

www.edibon.com
PRODUCTS
5.- ENERGY

Electronic console

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)

"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

The current energetic situation is based on an unsustainable model from the economic and environmental points of view. Fuel cells technology offers the possibility of having energy in an efficient, clean and abundant manner, since hydrogen used for their operation is obtained from different sources.

A fuel cell is an electrochemical device that transforms chemical energy from a reaction directly into electrical energy.

Although there are several types of fuel cells, each one with advantages, disadvantages and ideal applications, the PEM fuel cell is nowadays the one which offers the best characteristics for portable and automobile applications. This type of device can generate electricity from hydrogen coming from different sources and oxygen from the atmosphere, generating only heat and water as a residue.

The main operation principles of a fuel cell PEM type (proton exchange membrane) can be studied with the PEM Fuel Cell Unit, "EC5B".

GENERAL DESCRIPTION

The PEM Fuel Cell Unit, "EC5B", has been designed to allow the students to understand the fuel cells technology; especially that of a proton exchange membrane fuel cell (PEM). It also enables to calculate several fundamental parameters of a PEM type fuel cell, such as power density, polarization curves, efficiency, etc., and the variation of some of these parameters in function of the consumption of reagents and the developed power.

The "EC5B" unit is supplied with a stack of proton exchange membrane fuel cell (PEM) with a rated power of 100 W. The stack is composed of 24 cells with the shape of channeled plates that allow the air flow through the membrane. The membrane facilitates the hydrogen flow, generating the electrons release. There are separating plates which conduct electricity, allowing thus such electrons flow, between each pair of cells.

EC5B detail

Cells are self-humidifying and do not require any type of external humidification.

The stack has an integrated fan able to provide the required air for good operation and to maintain the appropriate temperature.

Hydrogen storage represents one of the essential points regarding the hydrogen economy. For that purpose, a cylinder of metal hydride (300 NL) is included. Thanks to the absorption of the hydrogen inside, hydrogen is stored in a safe and certified way. Since the discharge pressure of the metal hydride cylinder is 15 – 20 bar, the "EC5B" unit includes two pressure regulators; one of them is prepared to be installed in the H_2 cylinder in order to regulate the outlet pressure at 5 – 50 bar; the other is placed at the outlet of the metal hydride cylinder in order to regulate the inlet pressure to the stack in a range from 0.50 to 0.55 bar.

Two solenoid valves are included. One of them is located before the stack and controls the hydrogen inlet and when the unit is switched off, the valve is closed to avoid any possible hydrogen leakage. The other valve, placed at the stack outlet, purges the excess of water and hydrogen towards the exterior for a proper operation. A load regulation system enables the study of the generated electrical energy. It includes a variable power rheostat, which enables to vary the generated power.

A battery supplies 12 V to the unit electronic console.

The whole electrical circuit of the stack is protected by a short circuit unit in case of an over current (12 A) and low voltage shut down (12 V).

It includes a hydrogen leak detector with a detection range from 0 to 2% Vol. and from 0 to 100% L.E.L respectively.

The unit is supplied with the suitable sensors and instrumentation for the most representative parameters measurements and controls (electronic console).

SPECIFICATIONS

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

Diagram in the front panel with distribution of the elements similar to the real one.

Cylinder of metal hydride for the storage of H_2 of 300 NL of capacity.

Pressure regulator of the metal hydride. Variable inlet adjustable to the hydride and outlet range from 0.50 – 0.55 bar.

Pressure regulator of the H_2 cylinder. Inlet at 200 bar and outlet at 5 – 50 bar.

Solenoid valve to supply H_2.

Purge solenoid valve.

Suitable tubes and hoses for their use with H_2 with a high safety factor: up to 210 bar.

Load module: Rheostat: 22R 760 W.

Battery and charger (12 V).

Detail of the pressure regulator of the H_2 cylinder and hose

Fuel cell stack:

- 24 cells self – humidifying (do not require any type of external humidification).
- Rated power: 100 W.
- Integrated fan in the stack

Instrumentation:

- Flow meter to measure the inlet H_2 flow to the stack, range: 0.2 – 1.3 l/min.
- Pressure meter (manometer) to measure the H_2 pressure at the stack inlet, range: 0 – 1 bar.
- Control temperature sensor type "J" to measure the temperature purge current.
- Temperature sensor for the purging flow to measure and control the temperature in the stack.
- Current and voltage sensors.

Safety measures and protections:

- Failure protection with solenoid valve at the stack inlet.
- Over current shut down.
- Low voltage shut down.
- Over temperature shut down in the stack.
- Hydrogen leakage detector (4 – 20 mA; Ip65).

Electronic console:

- Metallic box.
- Temperature sensors connectors.
- Selector for the temperature sensors.
- Digital display for the temperature sensors.
- Voltage digital display and current digital display.

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Study of the fundamental principles of how the PEM based fuel cell operates.

2.- Study of the structure and main principles of a metal hydride cylinder.

3.- Calculation of a fuel cell efficiency.

4.- Study of the influence of air consumption and hydrogen in the efficiency of a fuel cell.

5.- Study of the influence of generated power in the efficiency of a fuel cell.

6.- Determination of the current density-voltage characteristics of a fuel cell.

7.- Power density from a single cell and a stack of cells.

8.- Representation of the polarization curve of a fuel cell.

9.- Study of the influence of the reagents' flows in the generation of electrical power.

10.-Study of the use of reagents and transport phenomena.

REQUIRED SERVICES

- Electrical supply: single-phase 220 V/50 Hz or 110 V/60 Hz.

RECOMMENDED ACCESSORIES (Not included)

- EDILAB-ELEC1. Electrolyzer (3 Nl/h).

REQUIRED CONSUMABLES (Not included)

- Cylinder of compressed hydrogen of degree 4.0 (purity of 99.995 %) at a pressure of 150 – 200 bar.

DIMENSIONS AND WEIGHTS

EC5B:

Unit:

-Dimensions: 700 x 400 x 550 mm approx.
(27.56 x 15.75 x 21.65 inches approx.)

-Weight: 20 Kg approx.
(44 pounds approx.)

Load module:

-Dimensions: 490 x 330 x 310 mm approx.
(19.29 x 12.99 x 12.20 inches approx.)

-Weight: 10 Kg approx.
(22 pounds approx.)

Electronic console:

-Dimensions: 490 x 330 x 310 mm approx.
(19.29 x 12.99 x 12.20 inches approx.)

-Weight: 10 Kg approx.
(22 pounds approx.)

AVAILABLE VERSIONS

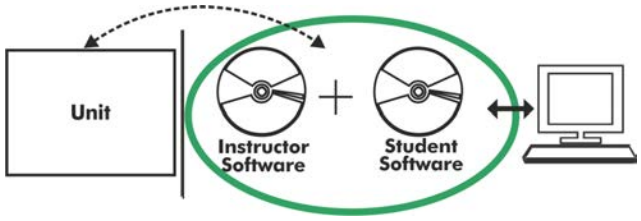
Offered in this catalog:

- EC5B. PEM Fuel Cell Unit.

Offered in other catalog:

- EC5C. Computer Controlled PEM Fuel Cell Unit.

EC5B/ICAI. Interactive Computer Aided Instruction Software System:



With no physical connection between unit and computer, **this complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF).** Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

Instructor Software

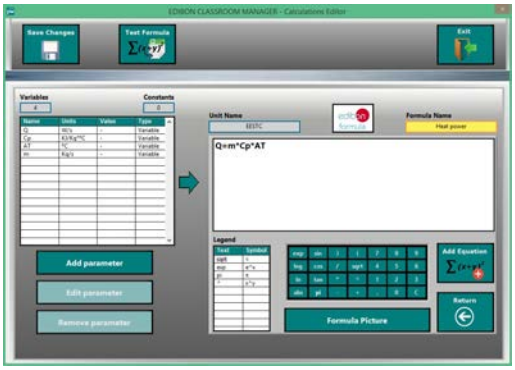
- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

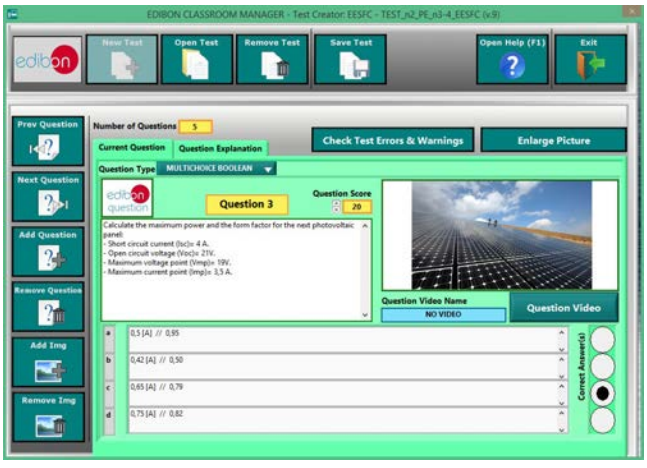
Innovative features:

- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**

ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

Optional

Student Software

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

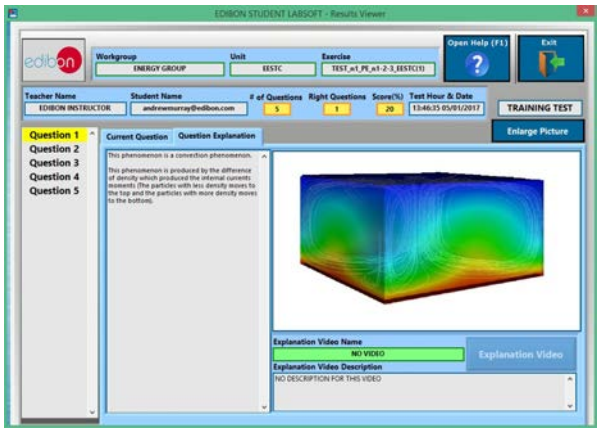
Innovative features:

- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**

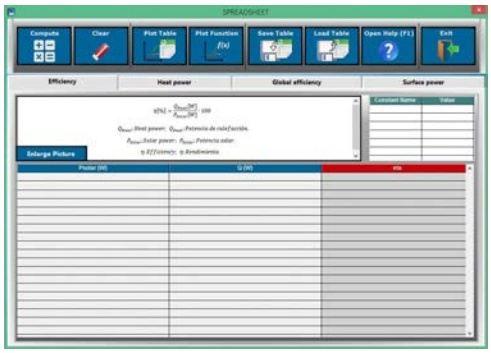
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen

For more information see **ICAI** catalogue. Click on the following link:
www.edibon.com/en/files/expansion/ICAI/catalog

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

✱ Specifications subject to change without previous notice, due to the convenience of improvement of the product.

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REPRESENTATIVE: