Computer Controlled **Liquid-Liquid Extraction Unit,** with SCADA and PID Control

UELLC

EDIBON **SCADA** System
and **PID Control** included

Teaching Technique used

② Control Interface Box

③ Data Acquisition Board

④ Software for:
- Computer Control
- Data Acquisition
- Data Management

⑤ Cables and Accessories

⑥ Manuals

* **Minimum supply always includes:** 1 + 2 + 3 + 4 + 5 + 6
(Computer not included in the supply)

Computer
(not included in the supply)

① Unit: UELLC. Computer Controlled Liquid-Liquid Extraction Unit

Key features:

➤ **Advanced Real-Time SCADA and PID Control.**

➤ **Open Control + Multicontrol + Real-Time Control.**

➤ **Specialized EDIBON Control Software based on LabVIEW.**

➤ **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**

➤ **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**

➤ **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**

➤ **Capable of doing applied research, real industrial simulation, training courses, etc.**

➤ **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**

➤ **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**

➤ **Designed and manufactured under several quality standards.**

➤ **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**

➤ **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

**OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL**

POWERED BY NATIONAL INSTRUMENTS
LabVIEW

www.edibon.com
⤷PRODUCTS
⤷11.-CHEMICAL ENGINEERING

For more information about Key Features, click here

INTRODUCTION

Many processes in chemical engineering require the separation of one or more of the components of a liquid mixture by treating the mixture with an immiscible solvent in which these components are preferentially soluble.

The rate at which a soluble component is transferred from one solvent to another will be dependent, among other aspects, on the area of the interface between the two immiscible liquids. Therefore, it is very advantageous for this interface to be formed by droplets and films, the situation being analogous to that existing in packed distillation columns.

The Computer Controlled Liquid-Liquid Extraction Unit, "UELLC", allows to study the extraction of one or several components in a continuous way with a solvent. The contact takes place inside the vertically oriented packed column, in which the two phases circulate in countercurrent. The unit enables to recover the solvent in a distillation process.

GENERAL DESCRIPTION

The Computer Controlled Liquid-Liquid Extraction Unit, "UELLC", is a laboratory scale unit designed to study the separation of the components of liquid mixtures by contact of the mixture with an immiscible solvent in which these components are preferentially soluble.

The extraction process is carried out in the glass liquid/liquid extraction column, which is composed of a jacketed glass packed column with two enlarged end sections. The joints between the three sections of the column are sealed with PTFE gaskets. The column is filled with glass Raschig rings that are supported on a perforated PVC plate.

Feed for the column is stored in the feeding tank from where it is pumped by a computer controlled diaphragm pump. It passes through a flowmeter and enters the base section of the column via an injector mounted on it. Refine (phase with low content of solute) leaves the top of the column through a pipe and is collected in a refined tank.

The solvent supply tank provides the feed for a computer controlled diaphragm pump. The solvent is pumped and passes through a flowmeter, then enters the top of the column via an injector. Extract (phase with high content of solute) leaves the bottom of the column through a pipe and is collected in an extract tank. A drain valve is fitted in the extract line.

The supply circuits and product collection circuits include two pressure switches that switch off the pumps when the pressure is high, two sampling taps to collect samples, three-way directional valves to direct the different currents and a regulation valve to control the height of the interface.

The distillation process is carried out in the distillation column boiler. The distillation column is made up of a glass section and contains Raschig rings made of glass. It is mounted close to the extraction column and fitted at such a height that the solute may be drained into the solute tank.

Heating is done by means of a computer controlled heating mantle (with control of the temperature in the column head) in the base of the boiler and the boiler temperature is indicated on a temperature sensor. The boiler lid is perforated where the distillation column is fitted and a pipeline allows to drain the extract from the extract tank. The boiler-solute tank circuit includes a sampling tap to collect samples.

The dissolvent vapor phase is condensed in the coolant column and re-cycled to the solvent tank to recover the dissolvent and to provide a closed circuit. Then, the solvent can be re-cycled continuously.
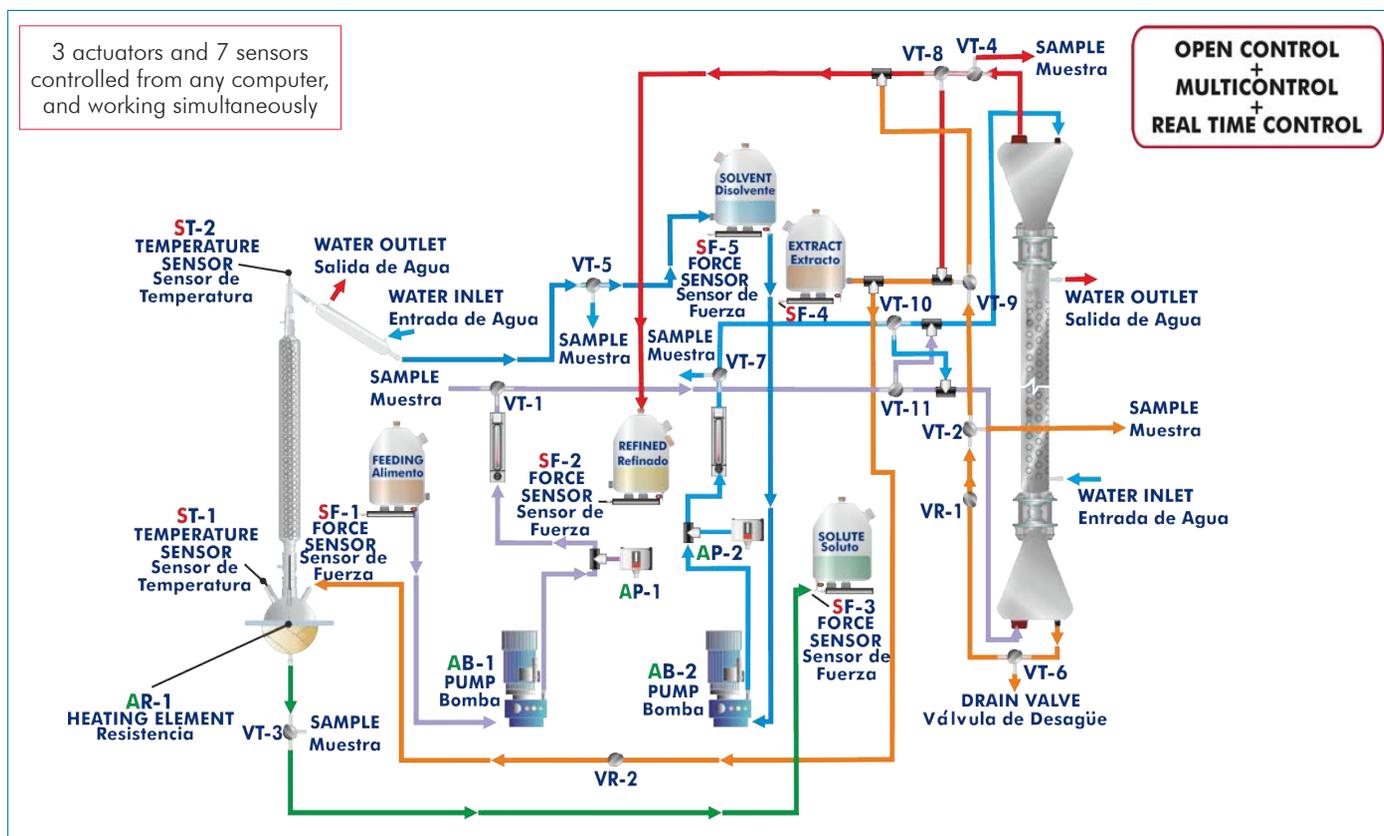
All storage tanks have force sensors to measure the mass in the five tanks (feed, refined, solvent, extract and solute) and to calculate the liquid volume.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + a Control Interface Box + a Data Acquisition Board + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

UELLC detail

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

3 actuators and 7 sensors controlled from any computer, and working simultaneously

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.

Let us describe first the main items (1 to 6):

① **UELLC. Unit:**

Anodized aluminum frame and panels made of painted steel.

The unit includes wheels to facilitate its mobility.

Main metallic elements made of stainless steel.

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

Transparent elements for a better observation of the process.

Extraction process:

    Jacketed glass column packed with glass Raschig rings:

        Length: 1200 mm.

        Internal diameter: 50 mm.

    Two enlargement pieces at the ends, capacity: 2 l.

Distillation process:

    Boiler for the distillation, heated by an adjustable electric heating mantle and with control of the temperature; capacity: 5 l.

    Jacketed glass column packed with glass Raschig rings:

        Length: 500 mm.

        Internal diameter: 25 mm.

    Coolant column.

Five Pyrex storage tanks for the feed, refined, solvent, extract and solute, capacity (each one): 10 l. They include drain valves and force sensors to measure the stored liquid mass; force sensors range: 0 – 15 Kg.

Supply circuits and product collection circuits to connect the different components of the unit. They include five sampling taps, distributed between all the circuits of the unit, to control the process in all the pipelines of fluid, three-way directional valves, drain valves and a regulating valve.

Two computer controlled diaphragm pumps:

    Computer controlled diaphragm pump with stainless steel head to pump the feed, max. flow: 47 l/h, max. pressure: 5 bar.

    Computer controlled diaphragm pump with stainless steel head to pump the solvent, max. flow: 17 l/h, max. pressure: 5 bar.

Computer controlled electrical heating mantle, power: 800 W.

Two "J type" temperature sensors to measure the temperature in the column head and the boiler temperature in the distillation process.

Two flowmeters to measure the feed and solvent flow:

    Flowmeter for acetic acid 4%, range: 0 – 48 l/h

    Flowmeter for trichloromethane, range: 0 – 17 l/h.

The unit includes safety devices in the pumps to avoid shortcomings by overpressure. There are two pressure switches that switch off the pumps when the pressure is high.

The complete unit includes as well:

    Advanced Real-Time SCADA and PID Control.

    Open Control + Multicontrol + Real-Time Control.

    Specialized EDIBON Control Software based on LabVIEW.

    National Instruments Data Acquisition board (250 KS/s, kilo samples per second).

    Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.

    Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

    Capable of doing applied research, real industrial simulation, training courses, etc.

    Remote operation and control by the user and remote control for EDIBON technical support, are always included.

    Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

    Designed and manufactured under several quality standards.

    Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

    This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Unit: UELLC

Additional recommended elements (Not included):
- UELL-CP. Distillation column, 5 plates type.

② UELLC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

<u>Control interface box with process diagram in the front panel</u> and with the same distribution that the different elements located in the unit, for an easy understanding by the student.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

Storage of all the process data and results in a file.

Graphic representation, in real time, of all the process/system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

All the actuators and sensors values and their responses are displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.

Real time PID and on/off control for pumps, compressors, heating elements, control valves, etc.

Real time PID control for parameters involved in the process simultaneously.

Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.

Possibility of automatization of the actuators involved in the process.

Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

UELLC/CIB

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:

Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.

Sampling rate up to: <u>250 KS/s (kilo samples per second)</u>.

Input range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.

Analog output:

Number of **channels=2**. **Resolution=16 bits**, 1 in 65536.

Maximum output rate up to: 900 KS/s.

Output range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0.

Digital Input/Output:

Number of **channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

DAB

④ UELLC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software:

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to <u>250 KS/s (kilo samples per second)</u>.

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.
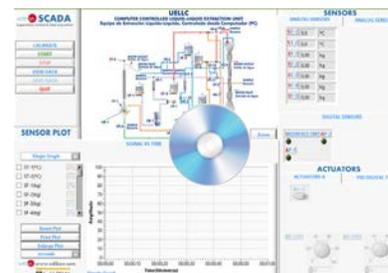
UELLC/CCSOF

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

This unit is **supplied with 8 manuals**: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

﹡References 1 to 6 are the main items: UELLC + UELLC/CIB + DAB + UELLC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

1.- Preparation of acid–base titration of the feed.

2.- Obtaining of the binodal curve.

3.- Study of theoretical and experimental mass balances.

4.- Calculation of the flooding velocity of the extraction column.

5.- Regulation of the height of the interface in the extraction column.

6.- Determination of the critical point existence.

7.- Study of the effect of the temperature in the liquid-liquid extraction process.

8.- Calculation of the mass transfer volumetric coefficient, referred to the continuous phase.

9.- Study of the efficiency of the extraction.

10.-Study of the batch operation regarding the solvent or the supply.

11.-Study of the extraction process for industrial processes.

12.-Calculation of the solvent recovery effectiveness.

13.-Study of the distillation process control.

14.-Repetition of the previous practical exercises for different compounds.

Additional practical possibilities:

15.-Calibration of the pumps.

16.-Sensors calibration.

Other possibilities to be done with this Unit:

17.-Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

18.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

19.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.

20.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

21.-This unit can be used for doing applied research.

22.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

23.-Control of the UELLC unit process through the control interface box without the computer.

24.-Visualization of all the sensors values used in the UELLC unit process.

- By using PLC-PI additional 19 more exercises can be done.

- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: single-phase, 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.
- Air extraction system.
- Computer (PC).

DIMENSIONS AND WEIGHTS

UELLC:
  Unit:
    -Dimensions: 1400 x 700 x 1950 mm approx.
        (55.11 x 27.55 x 76.77 inches approx.)
    -Weight: 100 Kg approx.
        (220 pounds approx.).
  Control Interface Box:
    -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.).

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- UELL-CP. Distillation column, 5 plates type.

-Refractometer.

-Pycnometer.

-Stopwatch.

REQUIRED CONSUMABLES (Not included)

- Trichloromethane (solvent)/ acetic acid / water.

- Trichloromethane (solvent)/ ethanol / water.

- Leksol / Propionic acid / water.

* The unit is ready for working with a wide range of different chemical products. Ask for more information.

SIMILAR UNITS AVAILABLE

Offered in this catalog:
- UELLC. Computer Controlled Liquid- Liquid Extraction Unit.
Offered in other catalog:
- UELL. Liquid- Liquid Extraction Unit.

SCADA and PID Control
Main screen

ⓘ Main software operation possibilities.

ⓘⓘ Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SF=Force sensor.

ⓘⓘⓘ Actuators controls. Actuators: AB=Pump. AR=Heating element (electric heating mantle). AP=High pressure switch.

ⓘⓥ Channel selection and other plot parameters.

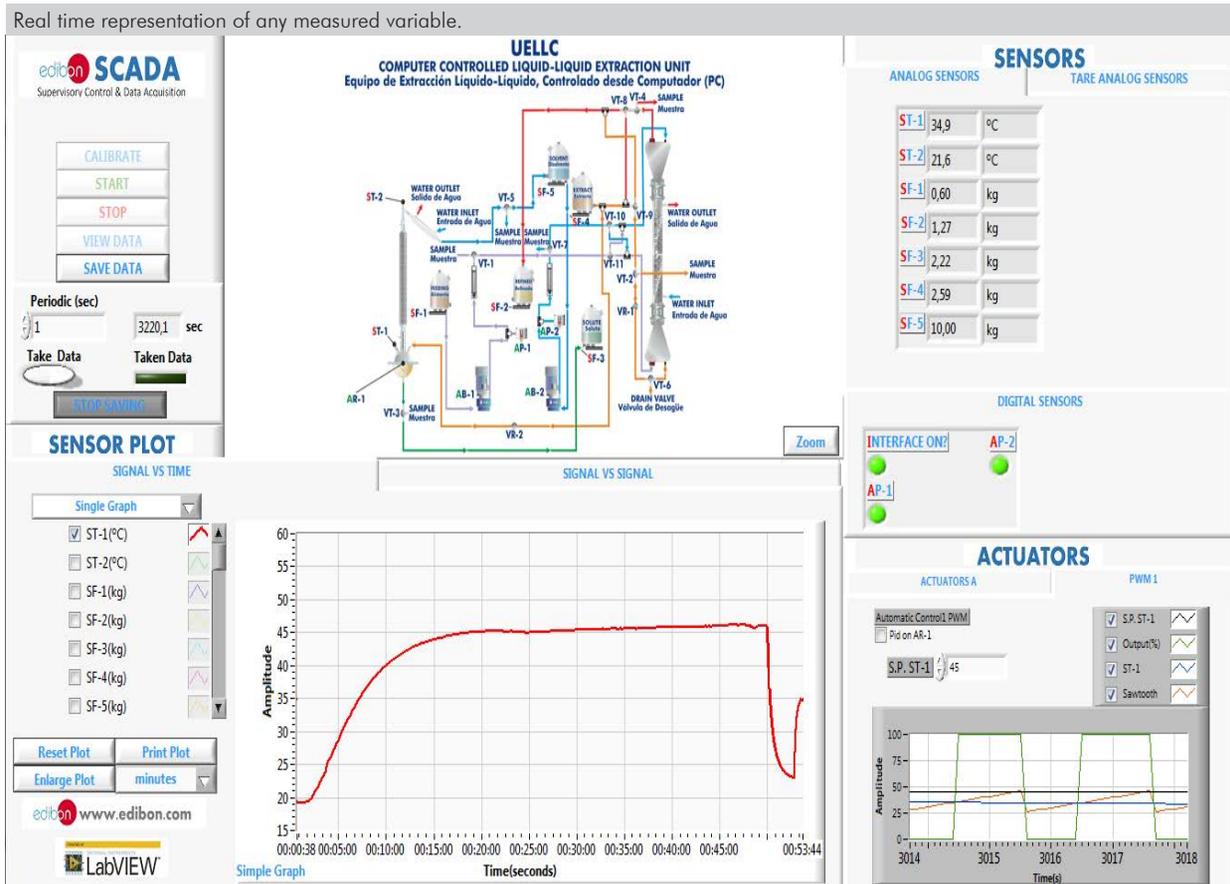Ⓥ Real time graphics displays.

## Software for Sensors Calibration
Example of screen

The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

Real time representation of any measured variable.

Heating temperature control is done through a PID control. When the target temperature is reached at the temperature sensor (ST-1), the heating element is turned off.
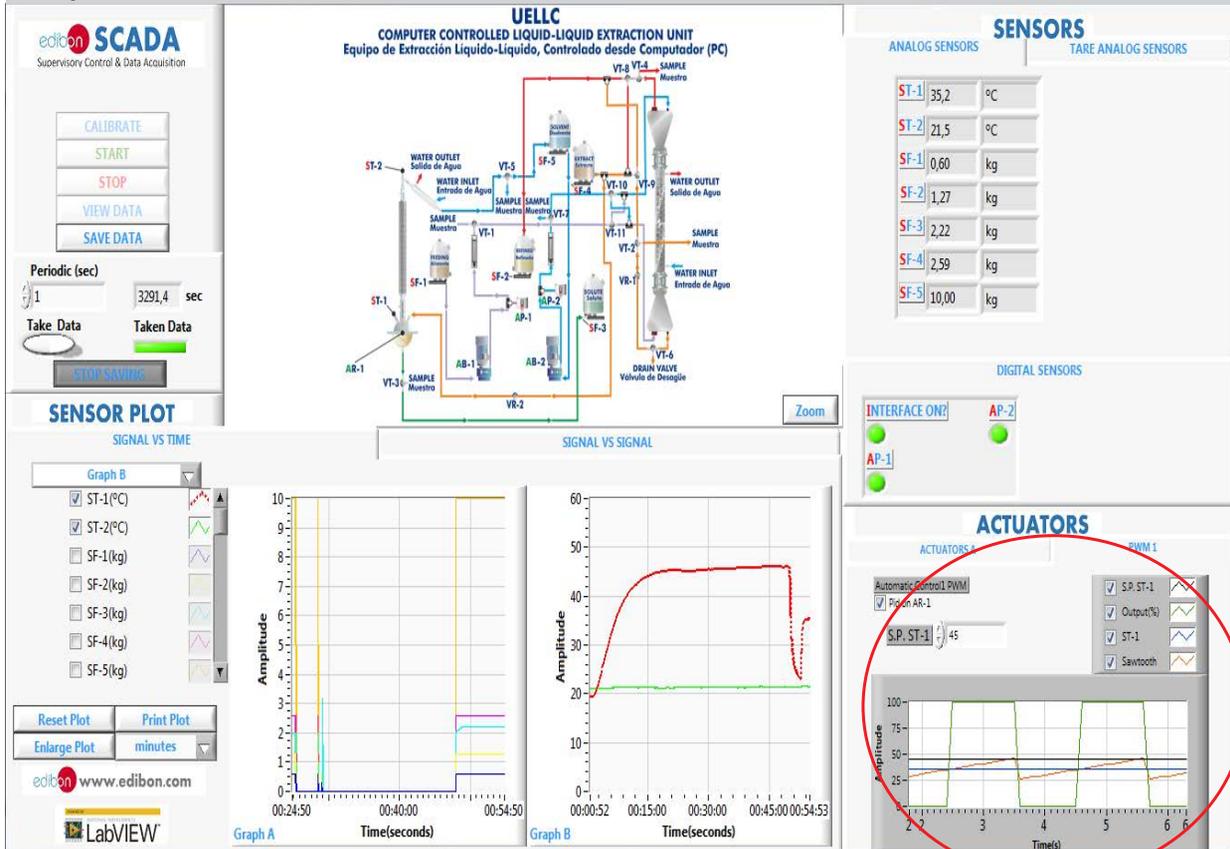
Some **real** results obtained from this Unit

Signal versus signal chart where any of the measured variables can be represented. Force sensors can be tared.

Visualization and representation of saved data.

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 11.

All these items try to give more possibilities for:

    a) Industrial configuration. (PLC)

    b) Technical and Vocational Education configuration. (ICAI and FSS)

    c) Multipost Expansions options. (MINI ESN and ESN)

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module front panel.

Front panel:

    Digital inputs (X) and Digital outputs (Y) block:

        16 Digital inputs, activated by switches and 16 LEDs for confirmation (red).

        14 Digital outputs (through SCSI connector) with 14 LEDs for message (green).

    Analog inputs block:

        16 Analog inputs (-10 V. to + 10 V.) (through SCSI connector).

    Analog outputs block:

        4 Analog outputs (-10 V. to + 10 V.) (through SCSI connector).

    Touch screen:

        High visibility and multiple functions. Display of a highly visible status. Recipe function. Bar graph function. Flow display function. Alarm list. Multi language function. True type fonts.

Back panel:

    Power supply connector. Fuse 2A. RS-232 connector to PC. USB 2.0 connector to PC.

Inside:

    Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

    Panasonic PLC:

        High-speed scan of 0.32 μsec. for a basic instruction.

        Program capacity of 32 Ksteps, with a sufficient comment area.

        Power supply input (100 to 240 V AC).

        DC input: 16 (24 V DC).

        Relay output: 14.

        High-speed counter.

        Multi-point PID control.

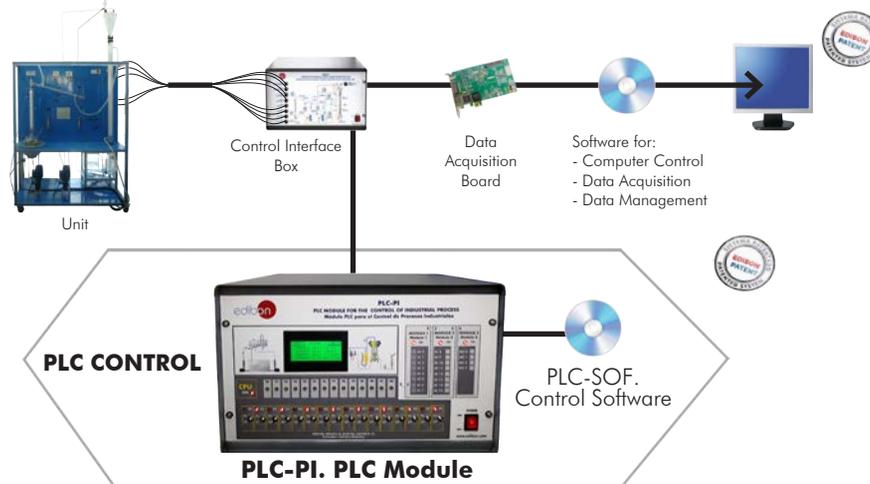   **Digital inputs/outputs and analog inputs/outputs Panasonic modules.**

Communication RS232 wire to computer (PC).

Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).

-UELLC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Liquid-Liquid Extraction Unit (UELLC).

Unit

Control Interface Box

Data Acquisition Board

Software for:
- Computer Control
- Data Acquisition
- Data Management

PLC CONTROL

PLC-SOF. Control Software

PLC-PI. PLC Module

Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.

13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **UELLC/ICAI. Interactive Computer Aided Instruction Software.**
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.

This software is optional and can be used additionally to items (1 to 6).

- 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.

- 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.

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

Instructor Software

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

ECAL. EDIBON Calculations Program Package - Formula Editor Screen

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

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

Student Software

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

EPE. EDIBON Practical Exercise Program Package Main Screen

ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

⑨ **UELLC/FSS. Faults Simulation System.**

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:
- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:
- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
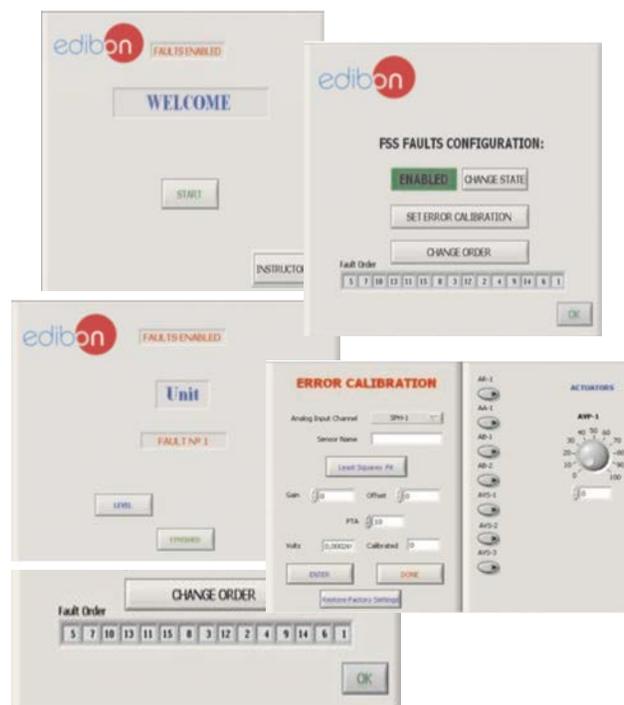- The action of some controls is annulled.

On/off faults:
- Several on/off faults can be included.

Example of some screens

For more information see **FSS** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/FSS/catalog

c) Multipost Expansions options

⑩ **MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.

- Open Control + Multicontrol + Real Time Control + Multi Student Post.

- Instructor controls and explains to all students at the same time.

- Any user/student can work doing "real time" control/multicontrol and visualisation.

- Instructor can see in the computer what any user/student is doing in the unit.

- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.

- This system allows you can save time and cost.

- Future expansions with more EDIBON Units.

MINI ESN.
EDIBON Mini Scada-Net System

1 UNIT= up to 30 STUDENTS can work simultaneously

Computer Controlled Liquid-Liquid Extraction Unit (UELLC)

Control Interface Box

Software for:
- Computer Control
- Data Acquisition
- Data Management

Instructors' Central Computer

Mini Scada-Net Software

LOCAL NET FOR 30 STUDENTS

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL
+
MULTI STUDENT POST

Note: The MINI ESN system can be used with any EDIBON computer controlled unit

For more information see **MINI ESN** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/MINI-ESN/catalog
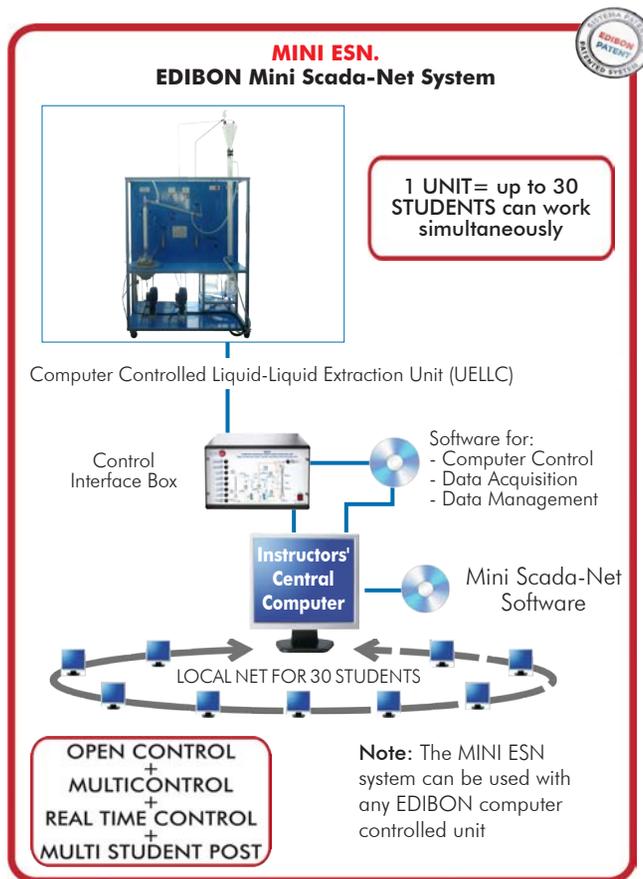
⑪ **ESN. EDIBON Scada-Net Systems.**

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

For more information see **ESN** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/ESN/catalog

Main items (always included in the supply)

Minimum supply always includes:

① Unit: UELLC. Computer Controlled Liquid-Liquid Extraction Unit.

② UELLC/CIB. Control Interface Box.

③ DAB. Data Acquisition Board.

④ UELLC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals.

*IMPORTANT: Under UELLC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

Optional items (supplied under specific order)

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.

- UELLC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑧ UELLC/ICAI. Interactive Computer Aided Instruction Software.

⑨ UELLC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑪ ESN. EDIBON Scada-Net Systems.

① UELLC. Unit:
Anodized aluminum frame and panels made of painted steel.
The unit includes wheels to facilitate its mobility.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Transparent elements for a better observation of the process.
Extraction process:
 Jacketed glass column packed with glass Raschig rings:
  Length: 1200 mm.
  Internal diameter: 50 mm.
 Two enlargement pieces at the ends, capacity: 2 l.
Distillation process:
 Boiler for the distillation, heated by an adjustable electric heating mantle and with control of the temperature; capacity: 5 l.
 Jacketed glass column packed with glass Raschig rings:
  Length: 500 mm.
  Internal diameter: 25 mm.
 Coolant column.
Five Pyrex storage tanks for the feed, refined, solvent, extract and solute, capacity (each one): 10 l. They include drain valves and force sensors to measure the stored liquid mass; force sensors range: 0 – 15 Kg.
Supply circuits and product collection circuits to connect the different components of the unit. They include five sampling taps, distributed between all the circuits of the unit, to control the process in all the pipelines of fluid, three-way directional valves, drain valves and a regulating valve.
Two computer controlled diaphragm pumps:
 Computer controlled diaphragm pump with stainless steel head to pump the feed, max. flow: 47 l/h, max. pressure: 5 bar.
 Computer controlled diaphragm pump with stainless steel head to pump the solvent, max. flow: 17 l/h, max. pressure: 5 bar.
 Computer controlled electrical heating mantle, power: 800 W.
Two "J type" temperature sensors to measure the temperature in the column head and the boiler temperature in the distillation process.
Two flowmeters to measure the feed and solvent flow:
 Flowmeter for acetic acid 4%, range: 0 – 48 l/h
 Flowmeter for trichloromethane, range: 0 – 17 l/h.
The unit includes safety devices in the pumps to avoid shortcomings by overpressure. There are two pressure switches that switch off the pumps when the pressure is high.
The complete unit includes as well:
 Advanced Real-Time SCADA and PID Control.
 Open Control + Multicontrol + Real-Time Control.
 Specialized EDIBON Control Software based on LabVIEW.
 National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
 Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
 Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
 Capable of doing applied research, real industrial simulation, training courses, etc.
 Remote operation and control by the user and remote control for EDIBON technical support, are always included.
 Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
 Designed and manufactured under several quality standards.
 Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
 This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Additional recommended elements (Not included):
- UELL-CP. Distillation column, 5 plates type.

② UELLC/CIB. Control Interface Box:
The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel.
The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.
Real time PID control for parameters involved in the process simultaneously.
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:
The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.
The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

④ UELLC/CCSOF. PID Computer Control +Data Acquisition+Data Management Software:
The three softwares are part of the SCADA system.
Compatible with the industry standards.
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
Analog and digital PID control. PID menu and set point selection required in the whole work range.
Management, processing, comparison and storage of data.
Sampling velocity up to 250 KS/s (kilo samples per second).
Calibration system for the sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

1.- Preparation of acid–base titration of the feed.

2.- Obtaining of the binodal curve.

3.- Study of theoretical and experimental mass balances.

4.- Calculation of the flooding velocity of the extraction column.

5.- Regulation of the height of the interface in the extraction column.

6.- Determination of the critical point existence.

7.- Study of the effect of the temperature in the liquid-liquid extraction process.

8.- Calculation of the mass transfer volumetric coefficient, referred to the continuous phase.

9.- Study of the efficiency of the extraction.

10.-Study of the batch operation regarding the solvent or the supply.

11.-Study of the extraction process for industrial processes.

12.-Calculation of the solvent recovery effectiveness.

13.-Study of the distillation process control.

14.-Repetition of the previous practical exercises for different compounds.

Additional practical possibilities:

15.-Calibration of the pumps.

16.-Sensors calibration.

Other possibilities to be done with this Unit:

17.-Many students view results simultaneously.

   To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

18.-Open Control, Multicontrol and Real Time Control.

   This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

19.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.

20.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

21.-This unit can be used for doing applied research.

22.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

23.-Control of the UELLC unit process through the control interface box without the computer.

24.-Visualization of all the sensors values used in the UELLC unit process.

- By using PLC-PI additional 19 more exercises can be done.

- Several other exercises can be done and designed by the user.

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module front panel.

Digital inputs (X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.

Analog inputs block: 16 Analog inputs.

Analog outputs block: 4 Analog outputs.

Touch screen.

Panasonic PLC:

High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.

Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-UELLC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **UELLC/ICAI. Interactive Computer Aided Instruction Software.**

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.

- 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.

- 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.

⑨ **UELLC/FSS. Faults Simulation System.**

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them.

There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:
- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:
- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:
- Several on/off faults can be included.

<u>c) Multipost Expansions options</u>

⑩ **MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:
- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

This system is used with a Computer Controlled Unit.
- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

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

REPRESENTATIVE: