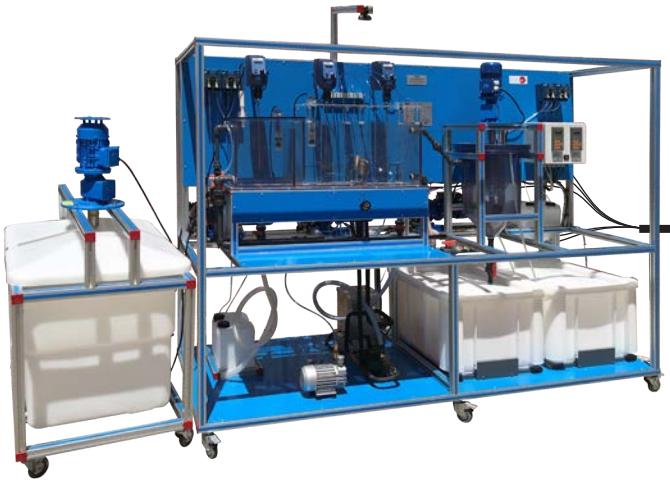
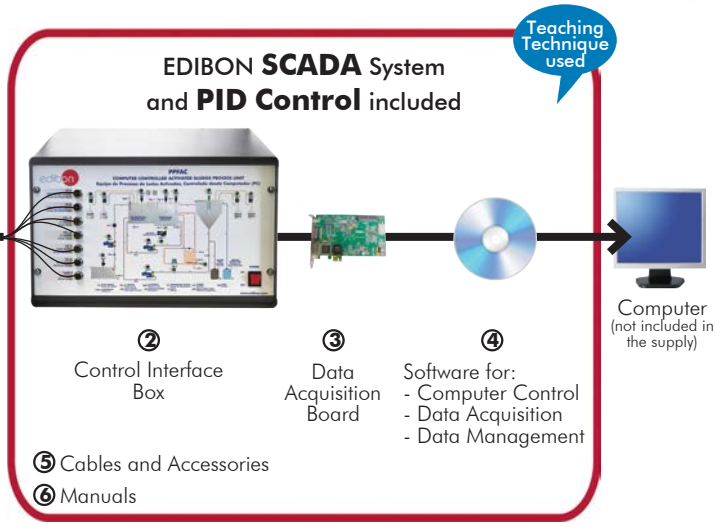
edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Activated Sludge Process Unit,** with SCADA and PID Control

PPFAC





① Unit: PPFAC. Computer Controlled Activated Sludge Process Unit

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

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
↳13.-ENVIRONMENT

For more information about Key Features, click here

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

Wastewaters undergo many treatment processes before being considered drinking water. Biological treatment is the removal of harmful organic substances suspended in water.

One of the biological treatment methods implies the use of activated sludge. In this process the wastewater is mixed with microorganisms under aerobic conditions to break down organic matter into carbon dioxide, water and other inorganic compounds. The activated sludge process has three basic components: a reactor where the microorganisms are kept in suspension, aerated and in contact with the wastewater, a liquid-solid separation system and a sludge recycling system to recycle the activated sludge.

GENERAL DESCRIPTION

The Computer Controlled Activated Sludge Process Unit, "PPFAC", has been designed to simulate the operation of a wastewater treatment plant, breaking down water organic components with aerobic microorganism cultures (activated sludge).

PPFAC detail

The unit is mounted on a metal frame and consists of two modules connected by a set of hoses (included).

The first module consists of a supply tank with raw water and dissolved organic matter. A computer controlled stirrer keeps the mixture under constant stirring.

The second module includes the water treatment tank where the activated sludge microorganisms are located, a clarifier and other elements required to carry out the wastewater treatment.

The raw water is impelled by a computer controlled pump from the supply tank to the water treatment tank, where it is mixed with the activated sludge that contains the microorganisms.

Air is supplied to the water treatment tank by a computer controlled compressor.

The tank is divided in two zones separated by a wall: one zone for the nitrification process (ammonium is oxidized to nitrate in the presence of oxygen) and the other zone is for the denitrification process (nitrate is reduced to molecular nitrogen without air). Raw water is mixed with the activated sludge by three computer controlled stirrers: two in the nitrification zone and one in the denitrification zone. There are two sensors in the tank that measure the oxygen concentration in the two zones, a pH sensor at the inlet of the tank and a temperature sensor in the nitrification zone.

The oxygen concentration, the pH and the temperature can be modified by computer:

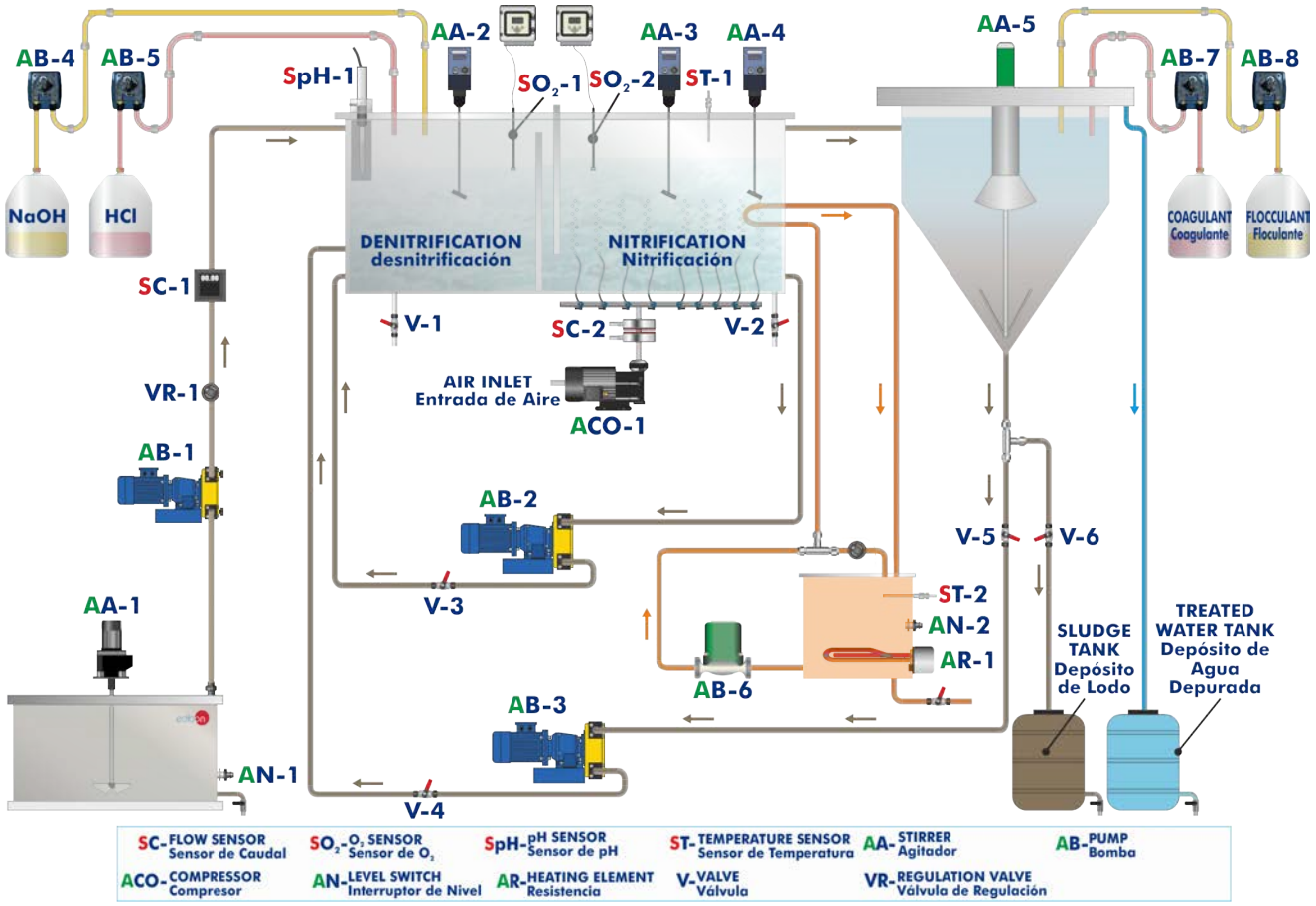
- The raw water pH value can be modified by adding acid and base with two variable speed peristaltic pumps. Thus, the pH value in activated sludge processes can be studied.
- The value of the oxygen concentration in the nitrification zone of the tank can be modified by controlling the air flow supplied by the compressor at the tank inlet.
- The temperature can be varied with a heat exchange circuit. A heating element heats water in a tank (with level switch and drain valve) and it is impelled by a pump through a circuit, which transfers its heat to the nitrification zone.

After leaving the tank, the mixture passes to the clarifier, where the activated sludge settles by sedimentation and is separated from the treated water. Part of that activated sludge returns to the water treatment tank driven by a computer controlled pump. In this clarifier, a coagulant (to reduce repulsive forces between particles) and a flocculant (to form larger flocs) can be added with two computer controlled peristaltic pumps with adjustable speed.

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.

15 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 PPFAC. 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.

Unit: PPFAC

Supply module:

Raw water tank: 250 l.
Computer controlled stirrer, range: 0 – 300 rpm.
Level switch.

Process module:

Raw water pump, maximum flow rate: 47 l/h, 4 bar.
Regulation valve for raw water.
Flow sensor to measure the raw water flow, range: 3 – 60 l/h.
Water treatment tank made of PMMA:
Denitrification zone, volume: 22 l.
Stirrer, range: 50 – 2200 rpm.
Line to connect the nitrification zone with the denitrification zone, using a computer controlled pump with a range of 0 – 47 l/h, 4 bar.
Nitrification zone, volume: 38 l.
Two stirrers, range: 0 – 2200 rpm.
Air diffuser.
Coil as a heat exchanger in the heating circuit.
Partition wall to prevent the denitrification zone from being aerated.
Clarifier made of PMMA, volume: 35 l.
Computer controlled stirrer, range: 0 – 30 rpm.
Tank for the coagulant, volume: 5 l.
Tank for the flocculant, volume: 5 l.
Two computer controlled peristaltic pumps.
Line to connect the clarifier with the water treatment tank, using a computer controlled pump with a range of 0 – 47 l/h, 4 bar.
Tank for the treated water, volume: 110 l.
Sludge collection tank, volume: 110 l.
Aeration system:
Computer controlled compressor.
Control valve to regulate the air flow rate.
Heating system:
Computer controlled heating element, power: 1500 W. PID control of the water temperature.
Level switch.
Computer controlled pump.
pH control system:
Two computer controlled peristaltic pumps.
Tank for the acid solution, volume: 5 l.
Tank for the basic solution, volume: 5 l.
Air flow sensor to measure the air flow in the aeration system, range: 50 – 600 l/h.
pH sensor, range: 0 – 14.
Two oxygen concentration sensors, range: 0 – 50 mgO_2/l.
Two "J" type temperature sensors, in the nitrification zone and the heating tank.
Webcam for viewing the treatment tank from the computer (PC).

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.

② PPFAC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

Control interface box with process diagram in the front panel 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.

PPFAC/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: 250 KS/s (kilo samples per second).

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 PPFAC/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 250 KS/s (kilo samples per second).

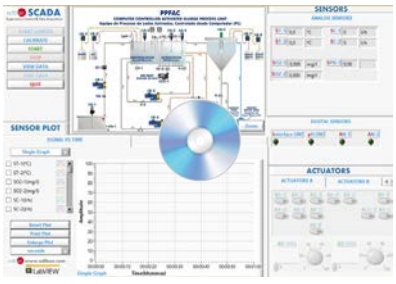
Calibration system for the sensors involved in the process.

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

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.



PPFAC/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: PPFAC + PPFAC/CIB + DAB + PPFAC/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.- Study of wastewater treatment with activated sludge.
2.- Study of the nitrification and denitrification processes.
3.- Study of the influence of the return sludge.
4.- Operation of the unit for steady working conditions.
5.- Study of the sludge age and its influence on the process.
6.- Study of results with a variation of the activated sludge mass flow.
7.- Study of results with a variation of the raw water volumetric load.
8.- Study of the internal recirculation return sludge rate influence on the pre-denitrification.
9.- Calculation of the pre-denitrification efficiency.
10.-Study of the pH value influence on the biological degradation.
11.-Study of the temperature value influence on the biological degradation.
12.-Study of the oxygen concentration value influence on the biological degradation.

Additional practical possibilities:

13.-Sensors calibration.

Other possibilities to be done with this Unit:

14.-Many students view results simultaneously.

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

15.-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.

16.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.
17.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
18.-This unit can be used for doing applied research.
19.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
20.-Control of the PPFAC unit process through the control interface box without the computer.
21.-Visualization of all the sensors values used in the PPFAC 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.
- Computer.

DIMENSIONS AND WEIGHTS

PPFAC:

Supply module:

-Dimensions: 1400 x 900 x 1000 mm approx.
(55.11 x 35.43 x 39.37 inches approx.)

-Weight: 50 Kg approx.
(110 pounds approx.)

Process module:

-Dimensions: 2500 x 900 x 1900 mm approx.
(98.42 x 35.43 x 74.80 inches approx.)

-Weight: 350 Kg approx.
(771 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.)

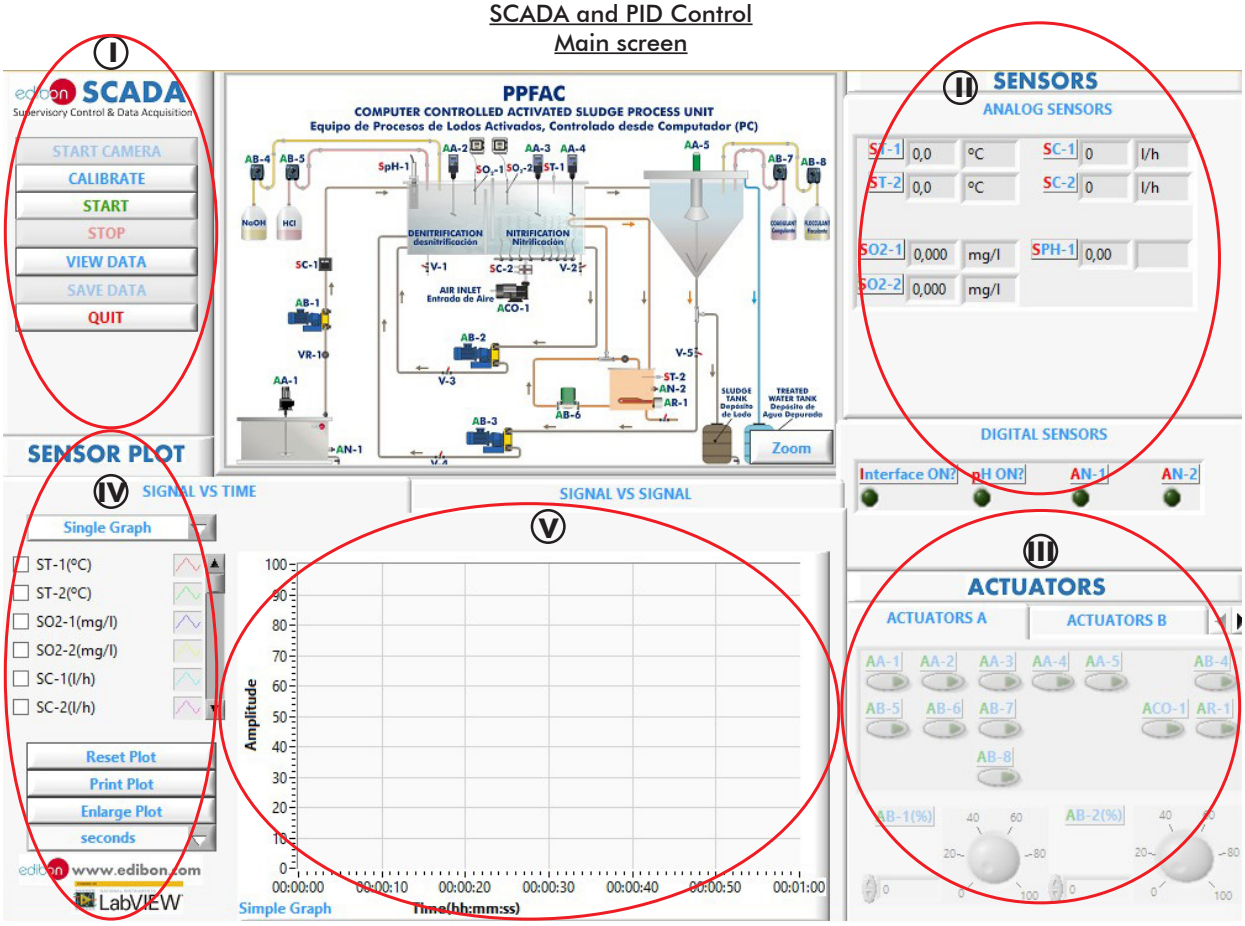
ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- Analytical equipment to determine the following parameters: BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), NO_3 (nitrate) and NH_4 (ammonium).

REQUIRED CONSUMABLES (Not included)

- Substances for the preparation of artificial wastewater: meat extract (or saccharose), urea, peptone, di-potassium hydrogen phosphate, calcium chloride di-hydrate, magnesium sulfate hepta-hydrate.
- Activated sludge (from a wastewater treatment plant).
- Hydrochloric acid.
- Caustic soda.
- Coagulant.
- Flocculant.

SCADA and PID Control
Main screen



Ⓘ Main software operation possibilities.

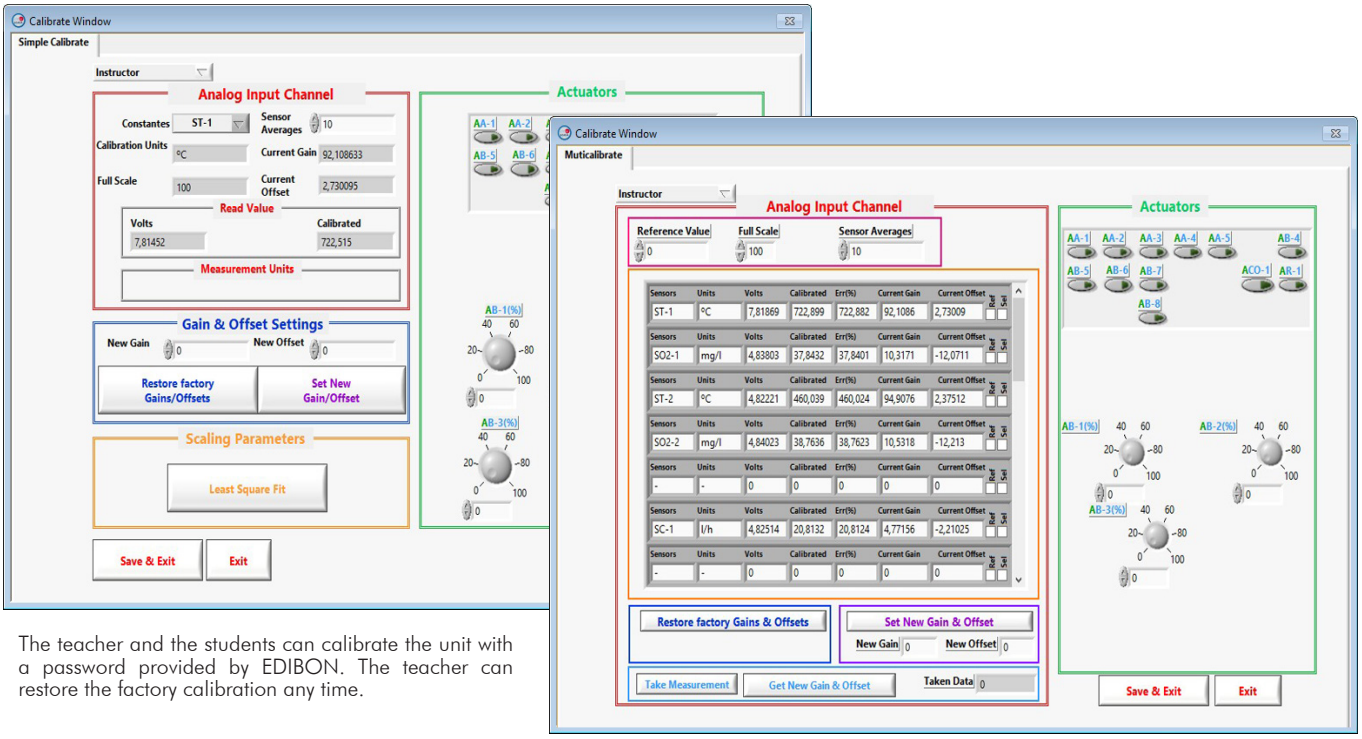
Ⓘ **Sensors displays, real time values, and extra output parameters. Sensors:** ST=Temperature sensor. SO_2=O_2 sensor. SC=Flow sensor. SpH=pH sensor.

Ⓘ **Actuators controls. Actuators:** ACO=Compressor. AN=Level switch. AR=Heating element. AB=Pump. AA=Stirrer.

Ⓘ Channel selection and other plot parameters.

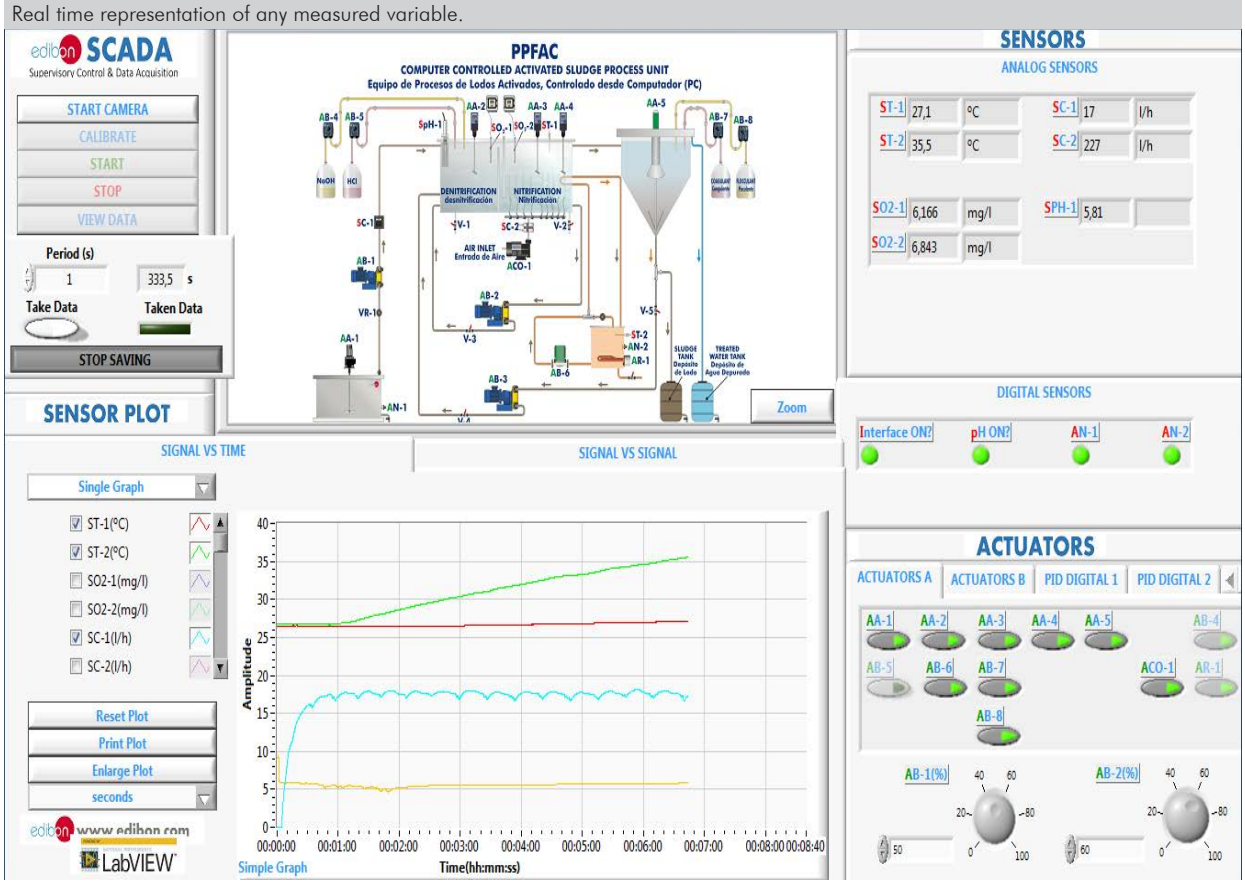
Ⓥ Real time graphics displays.

Software for Sensors Calibration
Example of screen

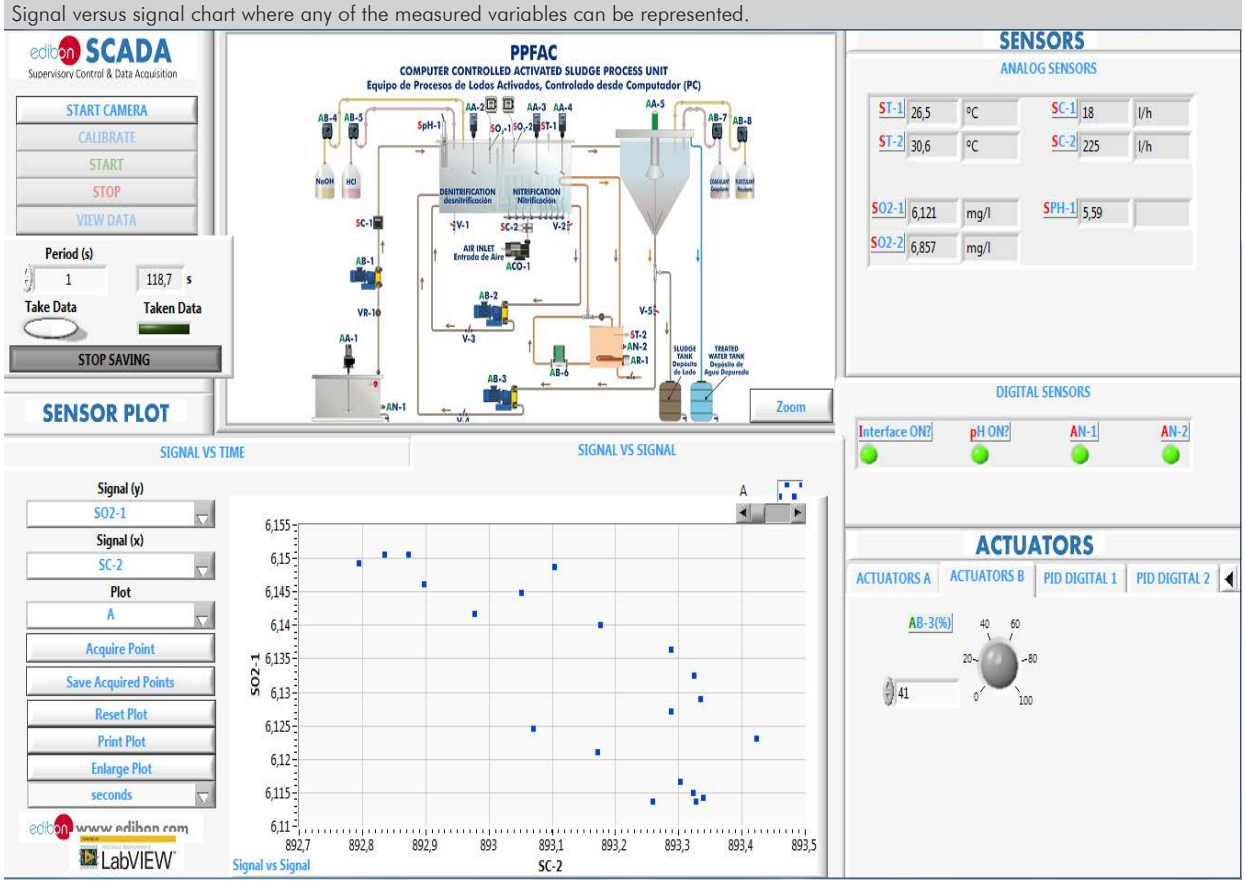


The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

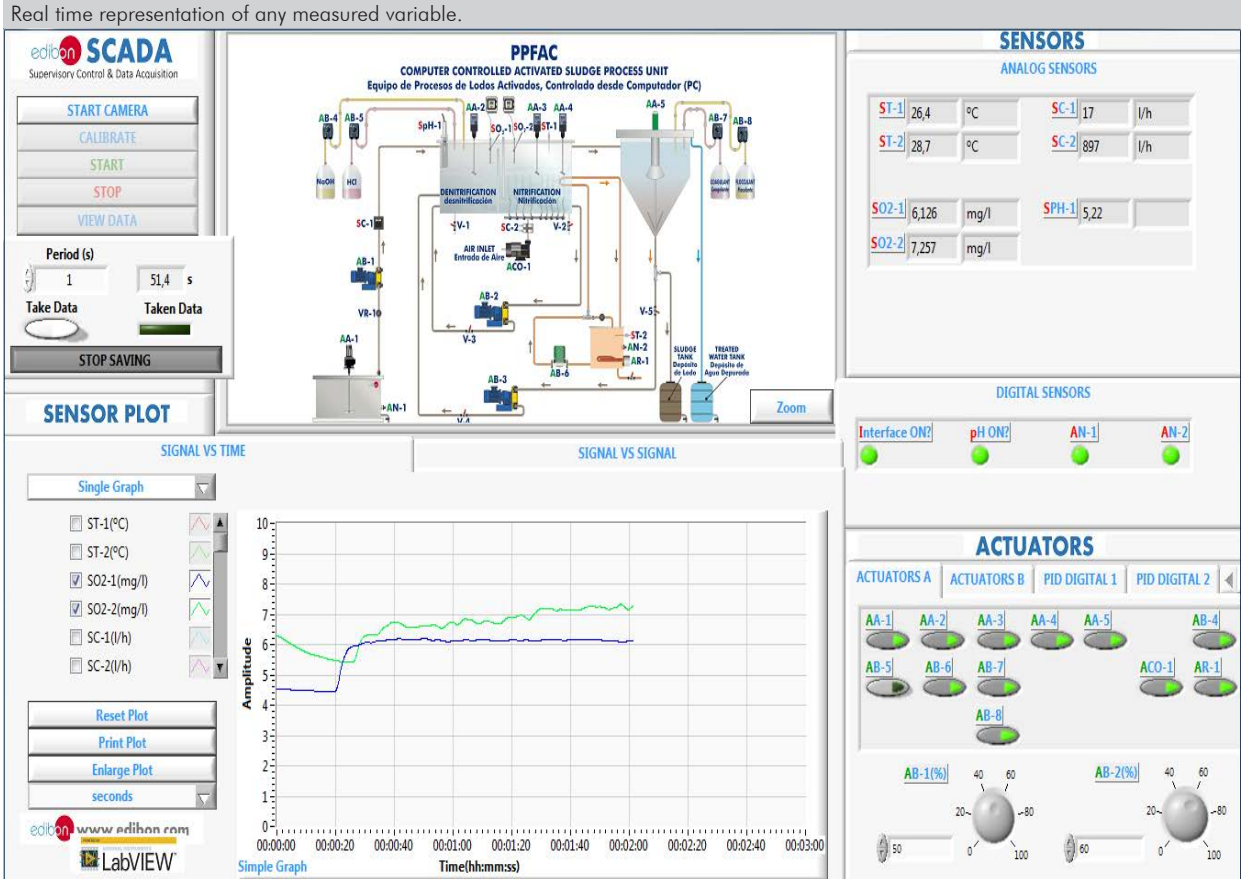
Real time representation of any measured variable.



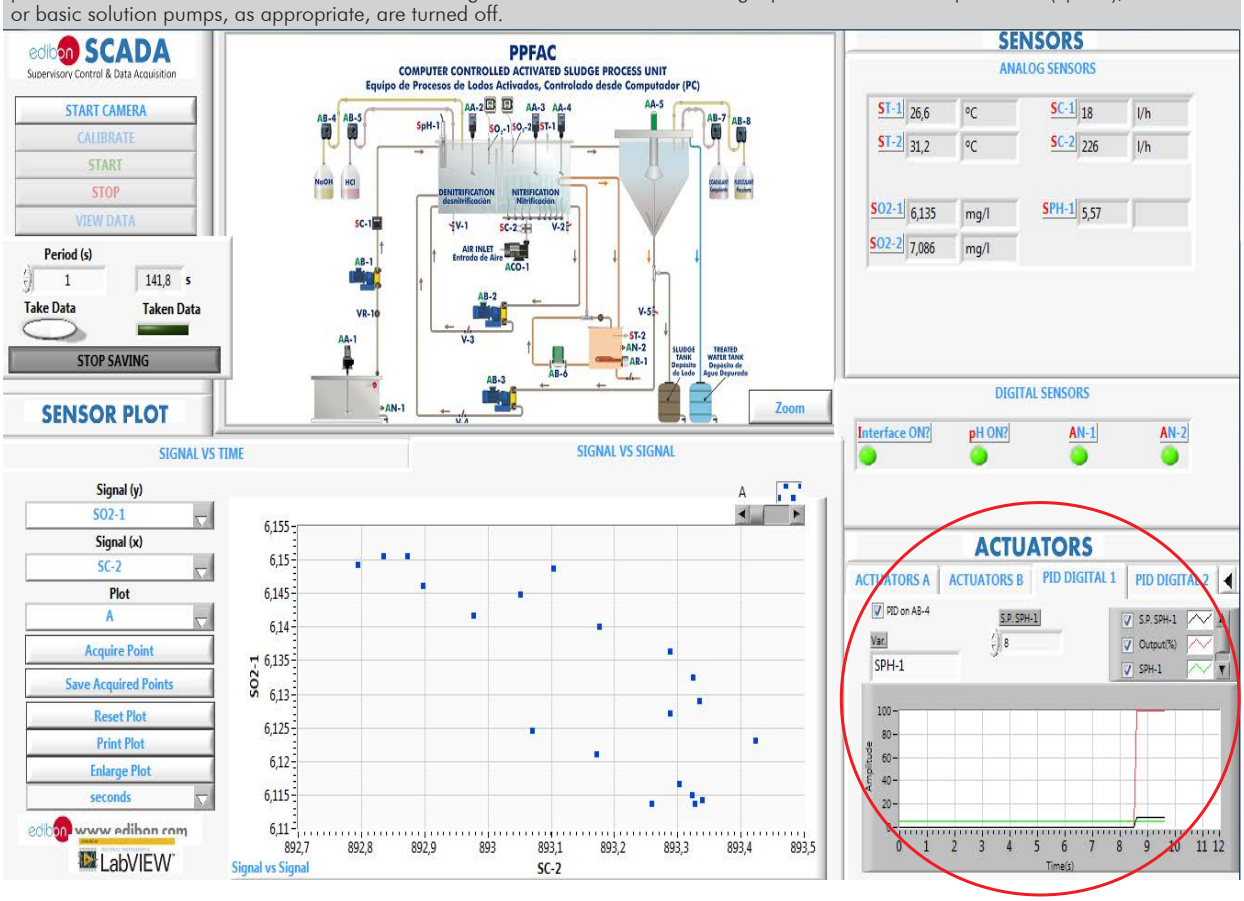
Signal versus signal chart where any of the measured variables can be represented.



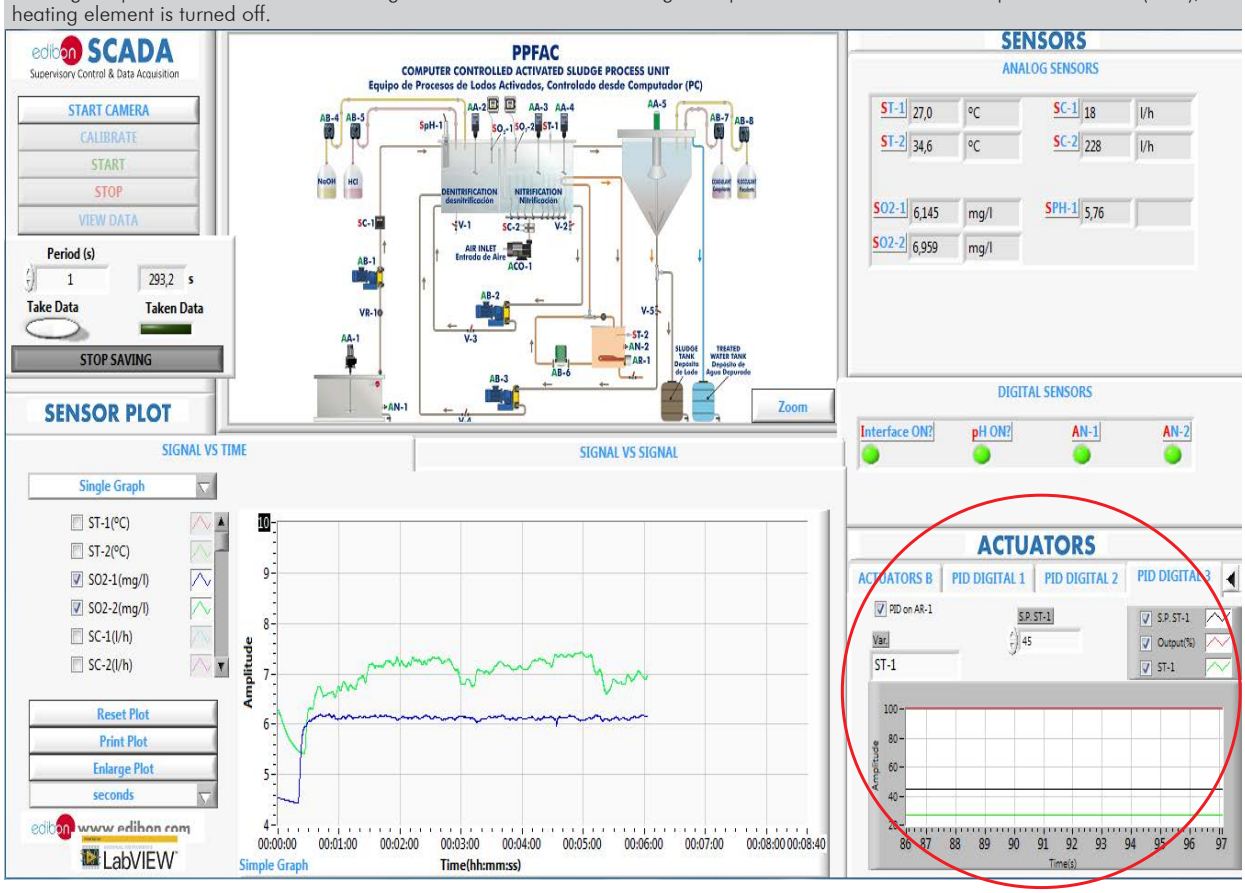
Real time representation of any measured variable.



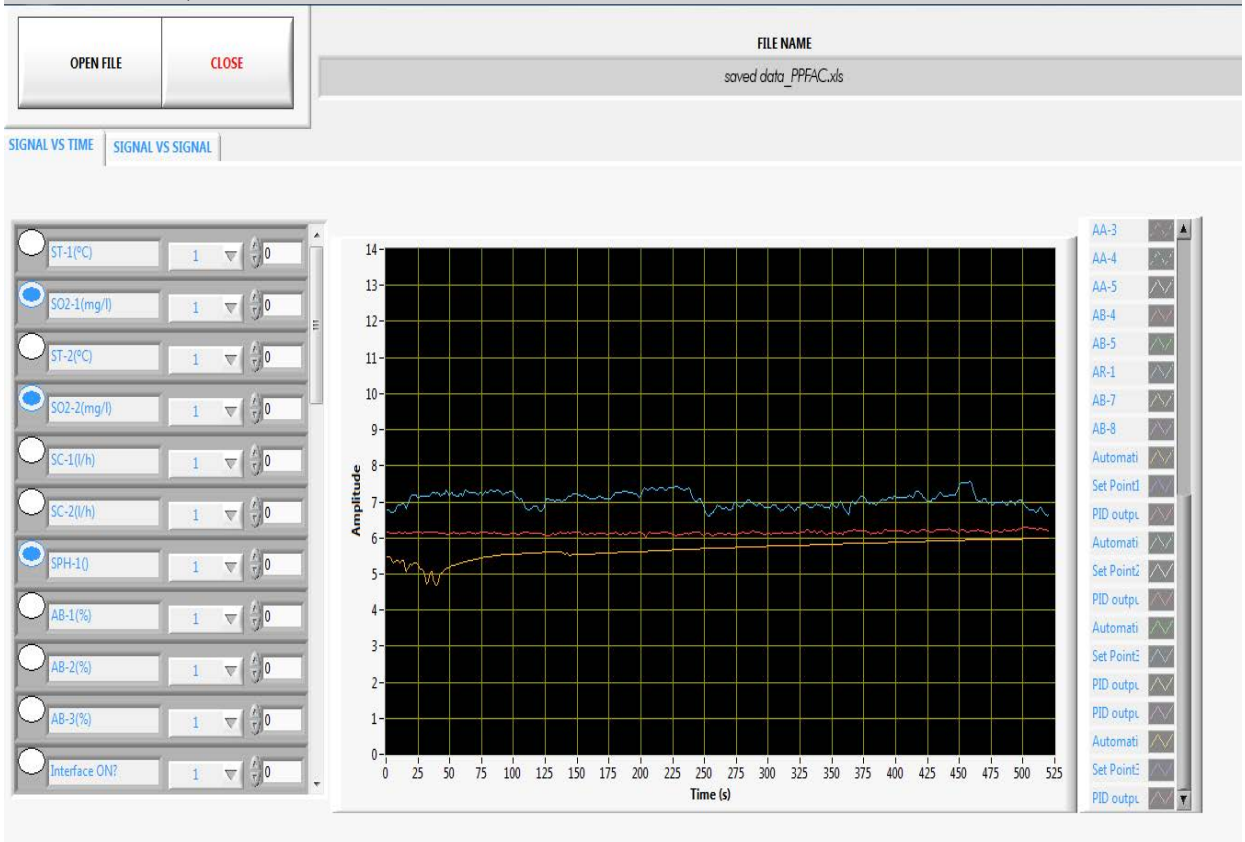
pH control in the water treatment tank is done through a PID control. When the target pH is reached at the pH sensor (SpH-1), the the acid or basic solution pumps, as appropriate, are turned off.



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.



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.

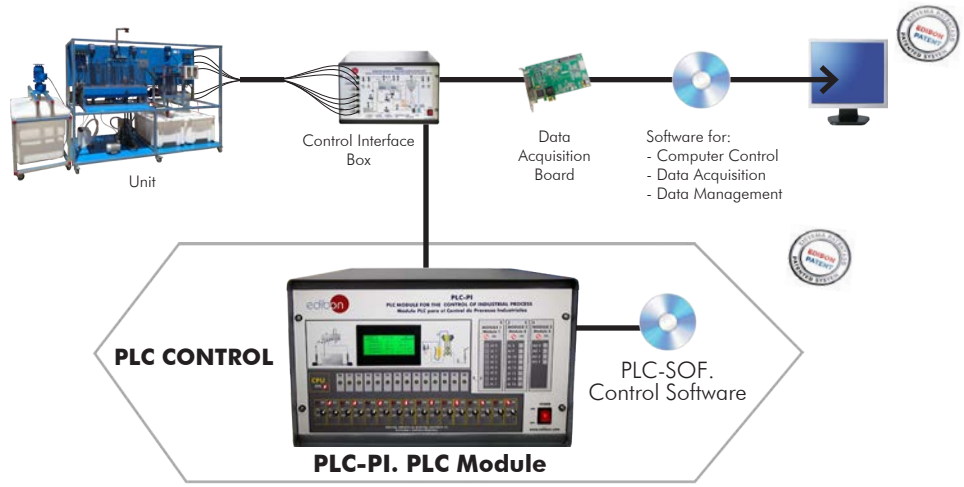
Communication RS232 wire to computer (PC).

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.).

-PPFAC/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 Activated Sludge Process Unit (PPFAC).



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 PPFAC/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.**

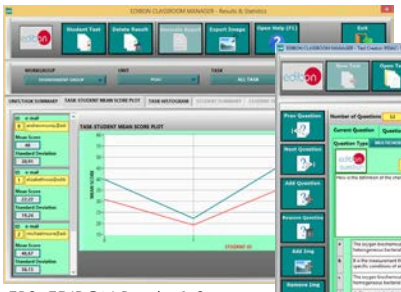
For more information see **ICAI** catalogue. Click on the following link:

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

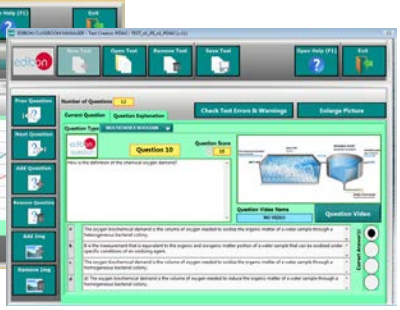
Instructor Software

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

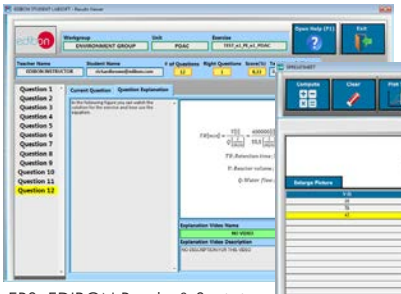


ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

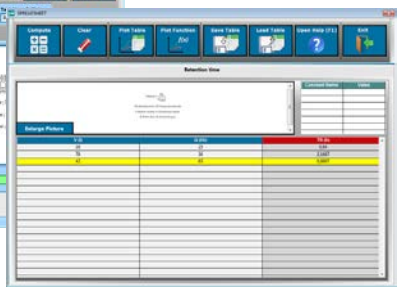
Student Software

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 PPFAC/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.**

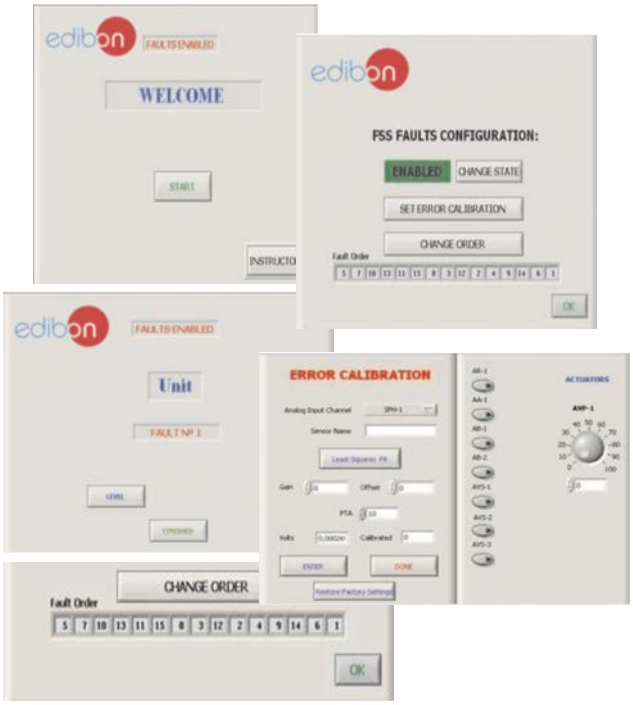
Faults in the controls execution:

- **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.

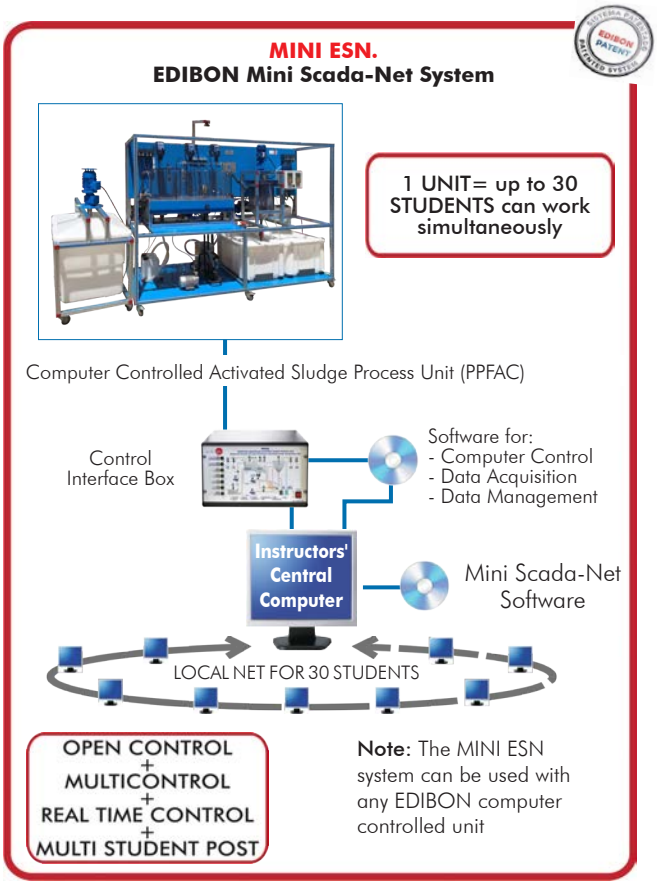
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

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.**



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

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: PPFAC. Computer Controlled Activated Sludge Process Unit.**

② **PPFAC/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

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

⑤ **Cables and Accessories**, for normal operation.

⑥ **Manuals.**

*IMPORTANT: Under PPFAC 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.
- PPFAC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑧ PPFAC/ICAI. Interactive Computer Aided Instruction Software.

⑨ PPFAC/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 PPFAC. 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.
Supply module:
Raw water tank: 250 l.
Computer controlled stirrer, range: 0 – 300 rpm.
Level switch.
Process module:
Raw water pump, maximum flow rate: 47 l/h, 4 bar.
Regulation valve for raw water.
Flow sensor to measure the raw water flow, range: 3 – 60 l/h.
Water treatment tank made of PMMA:
Denitrification zone, volume: 22 l.
Stirrer, range: 50 – 2200 rpm.
Line to connect the nitrification zone with the denitrification zone, using a computer controlled pump with a range of 0 – 47 l/h, 4 bar.
Nitrification zone, volume: 38 l.
Two stirrers, range: 0 – 2200 rpm.
Air diffuser.
Coil as a heat exchanger in the heating circuit.
Partition wall to prevent the denitrification zone from being aerated.
Clarifier made of PMMA, volume: 35 l.
Computer controlled stirrer, range: 0 – 30 rpm.
Tank for the coagulant, volume: 5 l.
Tank for the flocculant, volume: 5 l.
Two computer controlled peristaltic pumps.
Line to connect the clarifier with the water treatment tank, using a computer controlled pump with a range of 0 – 47 l/h, 4 bar.
Tank for the treated water, volume: 110 l.
Sludge collection tank, volume: 110 l.
Aeration system:
Computer controlled compressor.
Control valve to regulate the air flow rate.
Heating system:
Computer controlled heating element, power: 1500 W. PID control of the water temperature.
Level switch.
Computer controlled pump.
pH control system:
Two computer controlled peristaltic pumps.
Tank for the acid solution, volume: 5 l.
Tank for the basic solution, volume: 5 l.
Air flow sensor to measure the air flow in the aeration system, range: 50 – 600 l/h.
pH sensor, range: 0 – 14.
Two oxygen concentration sensors, range: 0 – 50 mgO_2/l.
Two "J" type temperature sensors, in the nitrification zone and the heating tank.
Webcam for viewing the treatment tank from the computer (PC).
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.

② PPFAC/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 PPFAC/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.- Study of wastewater treatment with activated sludge.

2.- Study of the nitrification and denitrification processes.

3.- Study of the influence of the return sludge.

4.- Operation of the unit for steady working conditions.

5.- Study of the sludge age and its influence on the process.

6.- Study of results with a variation of the activated sludge mass flow.

7.- Study of results with a variation of the raw water volumetric load.

8.- Study of the internal recirculation return sludge rate influence on the pre-denitrification.

9.- Calculation of the pre-denitrification efficiency.

10.-Study of the pH value influence on the biological degradation.

11.-Study of the temperature value influence on the biological degradation.

12.-Study of the oxygen concentration value influence on the biological degradation.

Additional practical possibilities:

13.-Sensors calibration.

Other possibilities to be done with this Unit:

14.-Many students view results simultaneously.

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

15.-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.

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

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

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

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

20.-Control of the PPFAC unit process through the control interface box without the computer.

21.-Visualization of all the sensors values used in the PPFAC 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.

-PPFAC/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 **PPFAC/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 PPFAC/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.

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.
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.

edibon INTERNATIONAL

C/ Julio Cervera, 10-12-14. Móstoles Tecnológico.
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.
Tel.: 34-91-6199363 Fax: 34-91-6198647
E-mail: edibon@edibon.com Web: **www.edibon.com**

Edition: ED01/20
Date: June/2020

REPRESENTATIVE: