edibon

Engineering and Technical Teaching Equipment

Chemical Reactors

QR

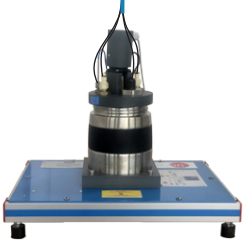
www.edibon.com
↳PRODUCTS
↳11.-CHEMICAL ENGINEERING

QUS.
Service Unit
for QR

Electric console

Required elements (at least one)
(Not included):

QRCA. Continuous Stirred Tank Reactor for QR



QRD. Batch Reactor for QR

QRL. Laminar Flow Reactor for QR

QRP. Plug Flow Reactor for QR

QRT. Tubular Flow Reactor for QR

QRS. Stirred Tank Reactors in Series for QR

LRQA CERTIFIED ISO 9001
Certificate of Approval of the Quality Management System

CE
European Union Certificate
(total safety)

UL CSA
UL and CSA Regulations
(All our products are manufactured according to current UL and CSA regulations)

LRQA CERTIFIED ISO 14001
Certificate of Approval of the Environmental Management System

worlddidac MEMBER
Worlddidac Association Certificate of Membership

INTRODUCTION

A chemical reactor is a device where a change in composition occurs due to a chemical reaction. It is therefore any vessel where a chemical reaction occurs. In a chemical reaction, chemical bonds between atoms are broken and new bonds are formed. Two types of substances are involved in this process: those that we initially have and know as reactants and those that are obtained after the chemical reaction, called products.

Depending on the requirements, different types of reactors are used.

The problem of reactor engineering is to make the most appropriate design with a methodology independent of the size and reaction being carried out, and to design to maximise the conversion and selectivity of that reaction at the lowest possible cost.

GENERAL DESCRIPTION

The Chemical Reactors, "QR", has been designed by EDIBON for the study and comparison of different types of chemical reactors.

The minimum supply consists of two main elements: the Service Unit for QR, "QUS", and at least one of the required elements described below.

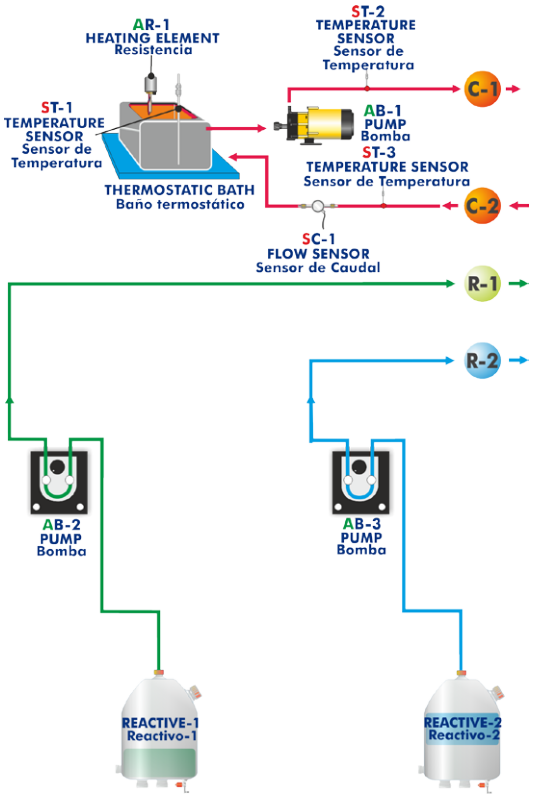
The Service Unit for QR, "QUS", provides the necessary elements for the operation of the different reactor modules. It performs the following functions:

- Reagent supply: consisting of two 1 liter pyrex containers each located at the back, two dosing pumps and all the necessary connections.
- Temperature control: consisting of a thermostatic bath and an impulsion pump.
- Quick and easy to perform reactor exchange and positioning system.

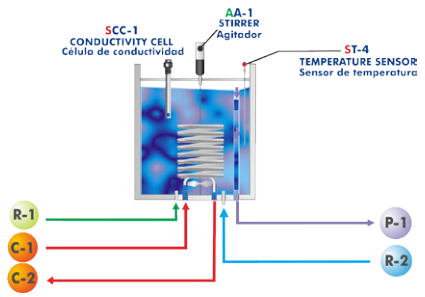
Required elements (at least one) (Not included):

- QRCA. Continuous Stirred Tank Reactor for QR.
- QRT. Tubular Flow Reactor for QR.
- QRD. Batch Reactor for QR.
- QRS. Stirred Tank Reactors in Series for QR.
- QRL. Laminar Flow Reactor for QR.
- QRP. Plug Flow Reactor for QR.

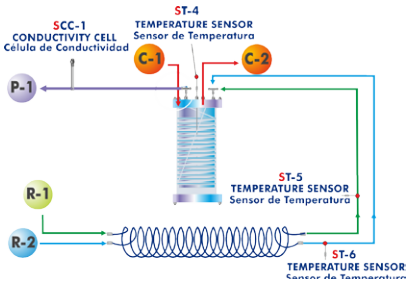
QUS
SERVICE UNIT FOR QR
Unidad de Servicio para QR



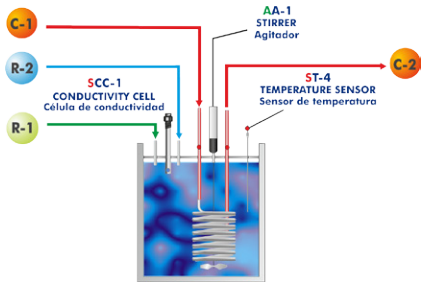
QRCA
CONTINUOUS STIRRED TANK REACTOR FOR QR
Reactor Continuo de Tanque Agitado para QR



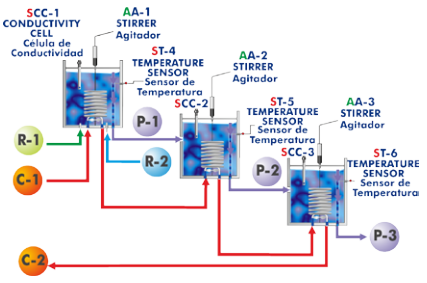
QRT
TUBULAR FLOW REACTOR FOR QR
Reactor de Flujo Tubular para QR



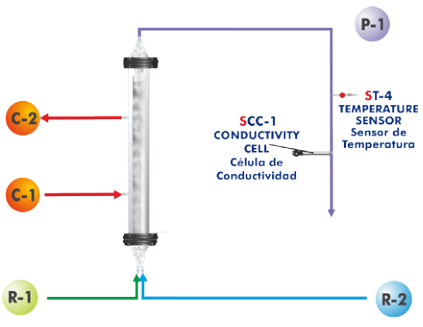
QRD
BATCH REACTOR FOR QRC
Reactor Discontinuo para QR



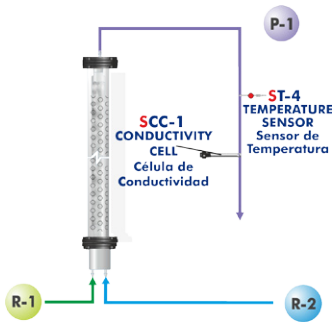
QRS
STIRRED TANK REACTORS IN SERIES FOR QR
Reactores de Tanque Agitado en Serie para QR



QRL
LAMINAR FLOW REACTOR FOR QR
Reactor de Flujo Laminar para QR



QRP
PLUG FLOW REACTOR FOR QR
Reactor de Flujo Pistón para QR



QUS. Service Unit for QR:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This unit is common for the required elements (at least one) (Not included).

Accommodation and exchange system of the reactors, quick and easy to handle.

It supplies all the services for the operation of each reactor.

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

The "QUS" unit mainly consists of:

- Two peristaltic dosing pumps, with variable speed. Flow rate up to 3 l/h (unit standard disposition). With another disposition, they could reach a flow rate up to 10 l/h.
- Thermostatic bath, capacity: 6 l. Temperature control of hot water in order to maintain the reactor temperature.
- Pump of 3 l/min, to impel the thermostatization water from the bath to the reactor.
- Two tanks for the reagents, capacity: 1 l each one, made of Pyrex glass.
- The control of the reaction is carried out by a conductivity sensor, which allows the reaction evolution parameterization in real time.
- Three "J" type temperature sensors, one to know the thermostatic bath temperature in a continuous way and two sensors to know the water temperature of the thermostatic bath water inlet and outlet.
- Quick connectors with shutoff valve that enable an easy coupling of the Service Unit to the chosen reactor.

Electronic console:

- Metallic box.
- Temperature sensors connections.
- Digital display for temperature sensors.
- Selector for temperature sensors.
- Peristaltic pumps controllers and switches.
- Water pump switch.
- Stirrer switches.
- Heating element controller.
- Main switch.

Cables and accessories, for normal operation.

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

QUS detail

<u>Required elements (at least one)</u> (Not included):

- QRCA. Continuous Stirred Tank Reactor for QR.
- QRT. Tubular Flow Reactor for QR.
- QRD. Batch Reactor for QR.
- QRS. Stirred Tank Reactors in Series for QR.
- QRL. Laminar Flow Reactor for QR.
- QRP. Plug Flow Reactor for QR.

Required elements (at least one) (Not included):

QRCA. Continuous Stirred Tank Reactor for QR

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

Designed to demonstrate the behaviour of a reactor used for homogeneous reactions liquid-liquid.

Reactor body made of borosilicate glass, with a maximum capacity of 2 l, specially designed to work in continuous. It also allows batch operation.

Adjustable volume, range: 0.4 – 1.5 l.

Stainless steel heat transfer coil (5 loops of 60 mm of diameter) and a baffle (removable).

Stirrer.

Reactor lip with connectors for the appropriate sensors.

Temperature sensor "J" type to control the temperature into the reactor.

Conductivity cell to control the reaction. Measurement range up to 20 mS.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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

QRCA

QRT. Tubular Flow Reactor for QR

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

Reactor composed by a continuous tube where the reagents are introduced through the coil end and the products are obtained through the inverse end. Into it, a continuous reagent mix is produced, so the composition will be different at each point. This type of reactors are industrially used for homogeneous reactions liquid-liquid, generally in isothermal conditions.

With this small scale reactor the behaviour of this type of reactors used at industrial level can be observed.

Tubular flow reactor, volume: 0.4 l. Coil shaped. Placed into an acrylic vessel through which the cooling or heating medium circulates. Coil length: 20 m.

Electric pre-heater of 12 loops, and loop diameter of 70 mm approx, for the two reagents feed lines. It is placed before the mix and the currents inlet to the reactor.

Temperature controlled by water jacketed.

Two temperature sensors "J" type to know the reagents outlet temperature from the pre-heater.

Conductivity cell to control the reaction. Measurement range up to 20 mS.

Reactor lip with connectors for the appropriate sensors.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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

QRT

Required elements (at least one) (Not included):

QRD. Batch Reactor for QR

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

Designed for the kinetic study of homogeneous reactions liquid-liquid, both in adiabatic conditions and in isothermal conditions.

The reactor body is an isolated vessel with a stainless steel external casing, working volume: 1 l.

Heat transfer coil made of stainless steel and reactor of 5 loops of 60 mm of diameter. The baffle tube internal diameter is of 6 mm and the external one is of 8 mm.

Stirrer.

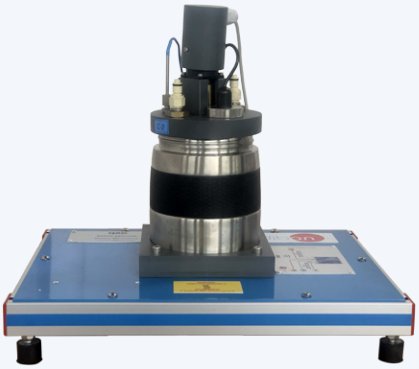
Temperature sensor "J" type to control the temperature into the reactor.

Conductivity cell to control the reaction. Measurement range up to 20 mS.

Reactor lip with connectors for the appropriate sensors.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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



QRD

QRS. Stirred Tank Reactors in Series for QR

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

These stirred reactors in series are used to increase the reagents conversion referred to an only reactor and so obtain product with higher purity.

Three continuous stirred tank reactors connected in series.

The three reactors have different height to let product from the first reactor go to the second one and so on.

Reactors body made of pyrex glass, volume: 2 l.

Each reactor is fitted with a conductivity cell. Measurement range up to 20 mS.

Each reactor has a stirrer.

The two reagent vessels and the two variable speed dosing pumps (at the Service Unit for QR, "QUS") feed reagents into the first reactor in line.

A dead-time residence coil can also be attached to the exit of the last reactor in the series.

Three temperature sensors "J" type, one in each reactor.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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

QRS

Required elements (at least one) (Not included):

QRL. Laminar Flow Reactor for QR

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

Designed to demonstrate the flow pattern characterisation and the steady state conversion in a tubular reactor.

Working volume: 400 ml.

Laminar flow reactor constituted by a glass column of 400 ml and 1000 mm long, including two diffusers packed with glass balls of 3 mm.

At the bottom of the column a premixer provides a complete mixing of the reagents entering the reactor and improves the flow distribution.

The reactor refrigeration jacket keeps its contents at a constant temperature to keep the laminar flow conditions.

Temperature sensor "J" type.

Conductivity cell to control the reaction. Measurement range up to 20 mS.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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

QRL

QRP. Plug Flow Reactor for QR

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

All elements of this unit are chemically resistant.

Designed to demonstrate the flow pattern characterisation and the steady state conversion in a tubular reactor with axial dispersion.

Working volume: 1 l.

Plug reactor constituted by a glass column of 1 l and 1100 mm long, packed with 3 mm diameter glass balls.

At the bottom of the column a premixer provides a complete mixing of the reagents entering the reactor and improves the flow distribution.

The unit uses a six ways injection valve, which allows either the feeding of reagents in a continuous way or the possibility to carry out pulse and step changes to characterization of the flow pattern.

Temperature sensor "J" type.

Conductivity cell to control the reaction. Measurement range up to 20 mS.

Quick connectors with shutoff valve that enable an easy coupling of the reactor to the Service Unit for QR, "QUS".

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

QRP

Practices to be done with the Continuous Stirred Tank Reactor for QR (QRCA):

1.- Determination of the ionic conductivities.
2.- Batch operation. Obtaining of the reaction order respect to ethylacetate. Initial velocity method.
3.- Batch operation. Obtaining of the reaction order respect to sodium hydroxide. Initial velocity method.
4.- Batch operation. Velocity Constant Computation. Constant sodium hydroxide initial concentration.
5.- Batch operation. Velocity Constant Computation. Constant ethylacetate initial concentration.
6.- Velocity equation formulation.
7.- Batch operation. Variation of the kinetic constant with temperature. Arrhenius Equation.
8.- Batch operation. Theoretical and experimental conversion comparative. Deviation from ideality.
9.- Batch operation. Mixture effects.
10.-Continuous operation.
11.-Continuous operation. Mixture effects.
12.-Conductivity measurement system: conductimeter.
13.-Variation of conversion with residence time.
14.-Residence time distribution.
15.-Determination of the reaction rate constant.

Practices to be done with the Tubular Flow Reactor for QR (QRT):

16.-Analysis of reagents and products.
17.-Ionic conductivities determination.
18.-Theoretical conversion of the tubular reactor.
19.-Experimental determination of the conversion of the tubular reactor.
20.-Dependence of the residence time.
21.-Determination of the reaction order.
22.-Dependence of the speed constant and the conversion with the temperature.
23.-Conductivity measurement system: conductimeter.
24.-Complete emptying of the unit.
25.-Determination of the reaction rate constant.

Practices to be done with the Batch Reactor for QR (QRD):

26.-Determination of the ionic conductivities.
27.-Batch operation. Calculation of the order of the reaction referred to the ethyl-acetate. Initial velocity method.
28.-Batch operation. Determination of the order of the reaction referred to the sodium hydroxide. Initial velocity method.
29.-Batch operation. Determination of the speed constant, the initial concentration of the sodium hydroxide is constant.
30.-Batch operation. Determination of the speed constant, the initial concentration of the ethyl acetate is constant.
31.-Formulation of the speed equation.
32.-Batch operation. Variation of the kinetic constant when the temperature is not constant: Arrhenius equation.
33.-Batch operation. Comparison of the theoretical and the experimental conversion: Deviation from the ideality.
34.-Calculation of the heat transference coefficient of the coil.
35.-Calculation of the hydrolysis reaction enthalpy.
36.-Batch operation. Mixture effects.
37.-Conductivity measurement system: conductimeter.

Practices to be done with the Stirred Tank Reactors in Series for QR (QRS):

38.-Investigation of dynamic behaviour of stirred tank reactors in series.
39.-Determination of the ionic conductivities.
40.-Influence of flow rate.
41.-Work with just one reactor in continuous.
42.-Work with just one reactor in continuous with mixture effects.
43.-Work with three reactors in continuous.
44.-Effect of step input change.
48.-Response to an impulse change.
46.-Investigation of time constant using dead time coil.

Practices to be done with the Laminar Flow Reactor for QR (QRL):

47.-Determination of the residence time distribution of the reactor.
48.-Effect of flow rate and feed concentration on the determination of flow pattern.
49.-Steady state conversion for a reaction with laminar flow.
50.-Effect of flow rate and feed concentration on the steady state conversion.
51.-Demonstration of the flow pattern in the reactor and comparison with the theoretical model.
52.-Effect of the temperature on the laminar flow characterisation.
53.-Determination of the steady state conversion of a second order reaction.
54.-Flow pattern characterisation in a laminar flow reactor.
55.-Conductivity measurement system: conductimeter.

Practices to be done with the Plug Flow Reactor for QR (QRP):

56.-Determination of the residence time distribution of the reactor.
57.-Effect of flow rate and feed concentration on the determination of flow pattern.
58.-Study of the reactor response to different perturbations: step and pulse change.
59.-Effect of flow rate and feed concentration on the steady state conversion.
60.-Demonstration of the flow pattern in the reactor and comparison with the theoretical model.
61.-Determination of the steady state conversion of a second order reaction.
62.-Understanding the principles of tracer techniques in flow pattern characterisation.
63.-Conductivity measurement system: conductimeter.

REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.

REQUIRED ELEMENTS (Not included)

Required (at least one):

- QRCA. Continuous Stirred Tank Reactor for QR.
- QRT. Tubular Flow Reactor for QR.
- QRD. Batch Reactor for QR.
- QRS. Stirred Tank Reactors in Series for QR.
- QRL. Laminar Flow Reactor for QR.
- QRP. Plug Flow Reactor for QR.

DIMENSIONS AND WEIGHTS

QR:

QUS. Service Unit for QR:

-Dimensions: 800 x 800 x 1000 mm approx.
(31.49 x 31.49 x 39.37 inches approx.)

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

QRCA. Unit:

-Dimensions: 330 x 330 x 500 mm approx.
(12.99 x 12.99 x 19.68 inches approx.)

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

QRT. Unit:

-Dimensions: 330 x 350 x 500 mm approx.
(12.99 x 13.78 x 19.68 inches approx.)

-Weight: 15 kg approx.
(33 pounds approx.)

QRD. Unit:

-Dimensions: 330 x 330 x 500 mm approx.
(12.99 x 12.99 x 19.68 inches approx.)

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

QRS. Unit:

-Dimensions: 950 x 450 x 600 mm approx.
(37.40 x 17.71 x 23.62 inches approx.)

-Weight: 35 kg approx.
(77 pounds approx.)

QRL. Unit:

-Dimensions: 330 x 330 x 1490 mm approx.
(12.99 x 12.99 x 58.66 inches approx.)

-Weight: 25 kg approx.
(55 pounds approx.)

QRP. Unit:

-Dimensions: 330 x 330 x 1350 mm approx.
(12.99 x 12.99 x 53.15 inches approx.)

-Weight: 25 kg approx.
(55 pounds approx.)

Electronic console:

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

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

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

-Laboratory materials as: burettes, test tubes, glasses, balance and a 1 l glass flask.

RECOMMENDED CONSUMABLES (Not included)

-Chemical reagents: ethyl acetate, sodium acetate and sodium hydroxide.

SIMILAR UNITS AVAILABLE

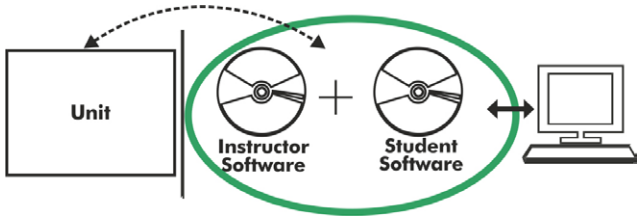
Offered in this catalog:

- QR. Chemical Reactors.

Offered in other catalogs:

- QRC. Computer Controlled Chemical Reactors.
- QRQC. Computer Controlled Chemical Reactors Training System.

QR/ICAI. Interactive Computer Aided Instruction Software System:



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

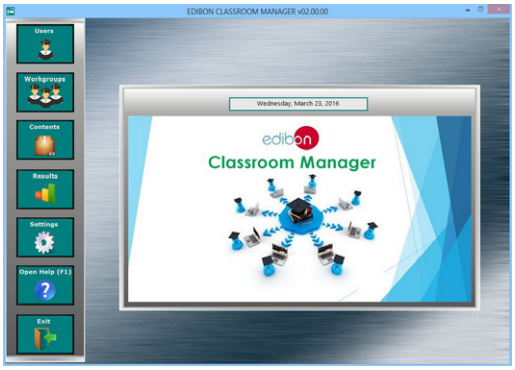
Instructor Software

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

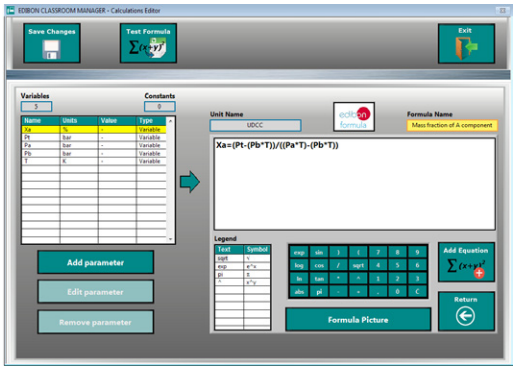
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

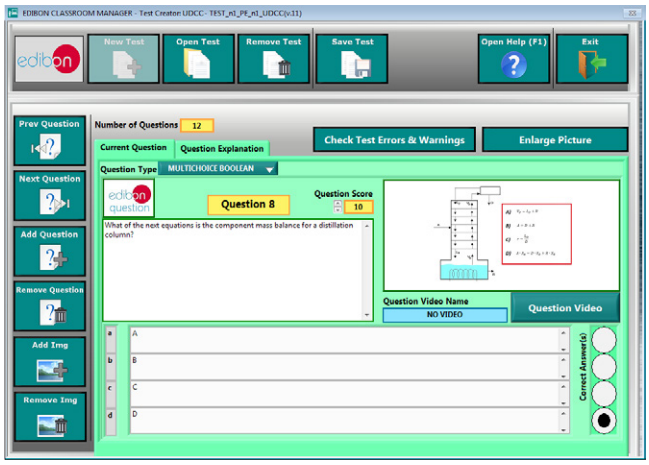
- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation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



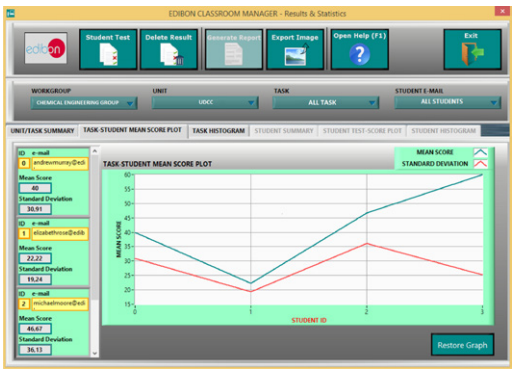
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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



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

Optional

Student Software

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

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

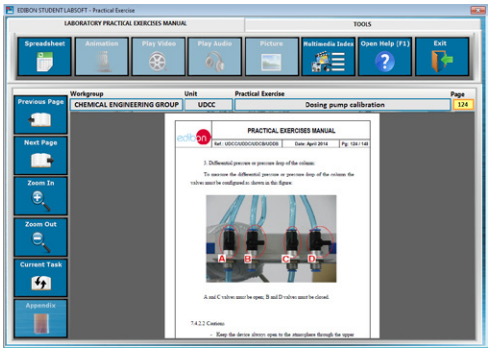
Innovative features:

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

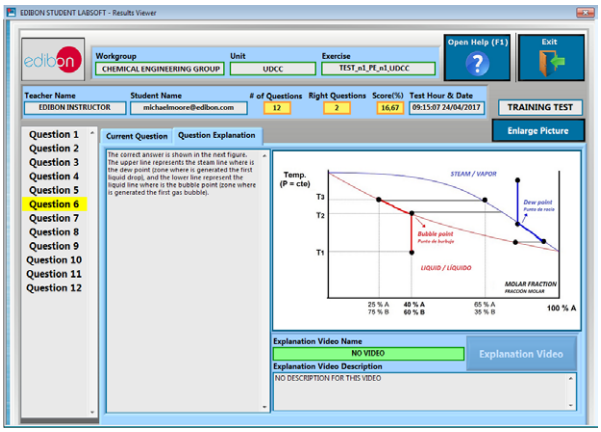
For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/interactive-computer-aided-instruction-software

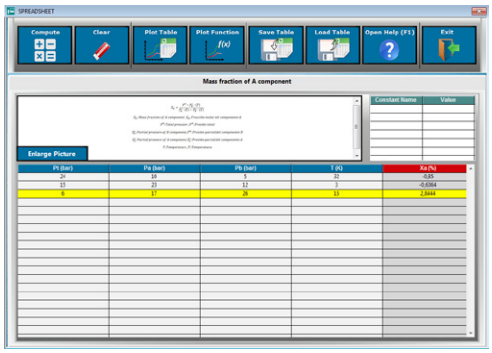
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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

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