



Computer Controlled Chemical Reactors Teaching Equipment

Instruction Manual

CEXC

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General Overview

The Armfield CEXC Computer Controlled Chemical Reactors Teaching Equipment demonstrates the characteristics of the important types of chemical reactors. Continuous stirred tank reactor (CSTR), tubular reactor with plug (PF) and laminar flow (LF), and stirred tank reactor (batch reactor). Other types of reactor are demonstrated using separate equipment: CEU, packed bed chemical and enzymic reactors; and CEP MkII, continuous stirred tank reactors in series.

The reactors available for use with CEXC are as follows:

- CEB MkIII Transparent Batch reactor
- CEM MkII CSTR
- CET MkII Tubular reactor
- CEY Plug Flow Reactor
- CEZ Laminar Flow Reactor

There is a mounting position on CEXC for three of them, and an independent stand for the other two. Reactors are interchangeable. CEXC is in effect the bench providing the services required by each of the reactors such as dual peristaltic pumps for feed delivery, a hot water circulator or chiller (optional) for constant temperature operation, and sensors – temperature and conductivity. CEXC is operated with the built in IFD5 interface to allow computer controlled and data logging. The CEXC with the CEM MkII is shown below:



CEXC fitted with CEM MkII Continuous Stirred Tank Reactor

Equipment Diagrams



Figure 1: CEXC Computer Controlled Service Unit

Important Safety Information

Introduction

All practical work areas and laboratories should be covered by local safety regulations **which must be followed at all times**.

It is the responsibility of the owner to ensure that all users are made aware of relevant local regulations, and that the apparatus is operated in accordance with those regulations. If requested then Armfield can supply a typical set of standard laboratory safety rules, but these are guidelines only and should be modified as required. Supervision of users should be provided whenever appropriate.

Your **CEX Reactor Bench** has been designed to be safe in use when installed, operated and maintained in accordance with the instructions in this manual. As with any piece of sophisticated equipment, dangers exist if the equipment is misused, mishandled or badly maintained.

Water Borne Hazards

The equipment described in this instruction manual involves the use of water, which under certain conditions can create a health hazard due to infection by harmful micro-organisms.

For example, the microscopic bacterium called *Legionella pneumophila* will feed on any scale, rust, algae or sludge in water and will breed rapidly if the temperature of water is between 20 and 45°C. Any water containing this bacterium which is sprayed or splashed creating air-borne droplets can produce a form of pneumonia called Legionnaires Disease which is potentially fatal.

Legionella is not the only harmful micro-organism which can infect water, but it serves as a useful example of the need for cleanliness.

Under the COSHH regulations, the following precautions must be observed:

- Any water contained within the product must not be allowed to stagnate, ie. the water must be changed regularly.
- Any rust, sludge, scale or algae on which micro-organisms can feed must be removed regularly, i.e. the equipment must be cleaned regularly.
- Where practicable the water should be maintained at a temperature below 20°C. If this is not practicable then the water should be disinfected if it is safe and appropriate to do so. Note that other hazards may exist in the handling of biocides used to disinfect the water.
- A scheme should be prepared for preventing or controlling the risk incorporating all of the actions listed above.

Further details on preventing infection are contained in the publication "The Control of Legionellosis including Legionnaires Disease" - Health and Safety Series booklet HS (G) 70.

Electrical Safety

The equipment described in this Instruction Manual operates from a mains voltage electrical supply. It must be connected to a supply of the same frequency and voltage as marked on the equipment or the mains lead. If in doubt, consult a qualified electrician or contact Armfield.

The equipment must not be operated with any of the panels removed.

To give increased operator protection, the unit incorporates a Residual Current Device (RCD), alternatively called an Earth Leakage Circuit Breaker, as an integral part of this equipment. If through misuse or accident the equipment becomes electrically dangerous, the RCD will switch off the electrical supply and reduce the severity of any electric shock received by an operator to a level which, under normal circumstances, will not cause injury to that person.

At least once each month, check that the RCD is operating correctly by pressing the TEST button. The circuit breaker **MUST** trip when the button is pressed. Failure to trip means that the operator is not protected and the equipment must be checked and repaired by a competent electrician before it is used.

Hot Surfaces and Liquids

The unit incorporates a pumped electric water heater, and is capable of producing temperatures that could cause skin burns.

Before disconnecting any of the pipes or tubing:

- Stop all the pumps.
- Leave time for the water to cool
- Check that the temperature is at a safe level

Do not touch any surfaces close to 'Hot Surfaces' warning labels, or any of the interconnecting tubing, whilst the equipment is in use.

Chemical Safety

Details of the chemicals intended for use with this equipment are given in the Operational Procedures section. Chemicals purchased by the user are normally supplied with a COSHH data sheet which provides information on safe handling, health and safety and other issues. It is important that these guidelines are adhered to.

- It is the user's responsibility to handle chemicals safely.
- Prepare chemicals and operate the equipment in well ventilated areas.
- Only use chemicals specified in the equipment manuals and in the concentrations recommended.
- Follow local regulations regarding chemical storage and disposal.

Description

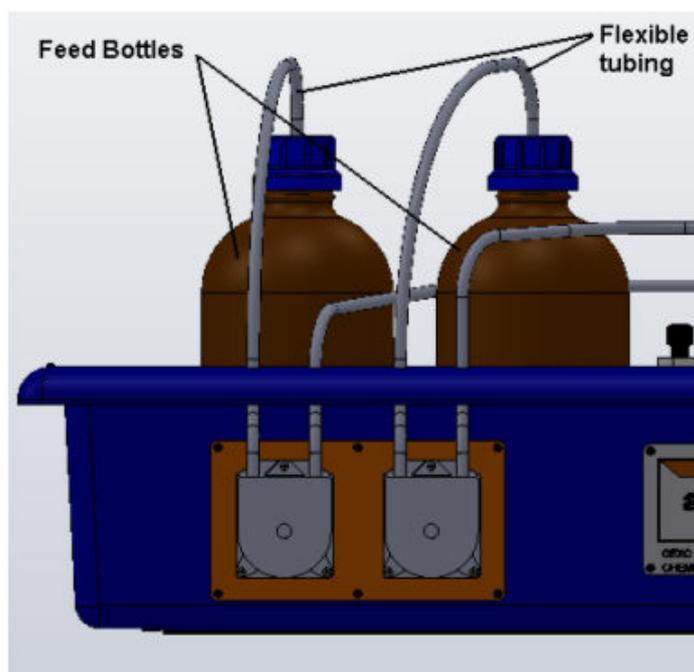
Where necessary, refer to the drawings in the [Equipment Diagrams](#) section.

Overview

The CEXC Computer Controlled Chemical Reactors Service Unit consists of a moulded ABS plinth which is used as a mounting for the Chemical reactors to be used. It also provides the ancillary services for the reactor.

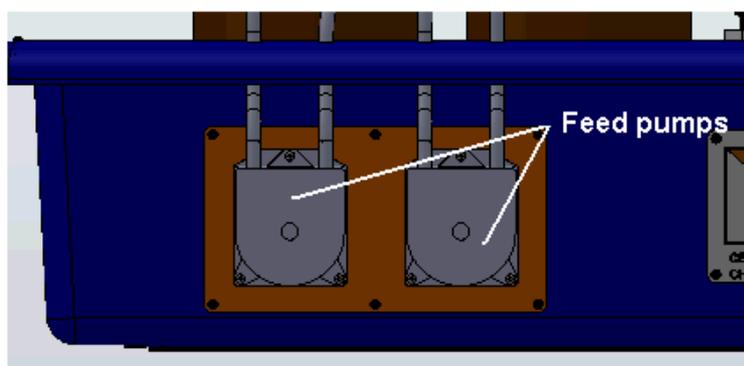
Chemical storage bottles

The reagent bottles consist of two glass bottles which are fitted into the molded channel. Flexible silicone tubing is used to connect the reagent bottles to the pumps.



Feed pumps

Two variable throughput peristaltic pumps are used to pump the reagents from the reagent bottles to the fitted reactor. The pumps are mounted on the front of the plinth.



The speed of each pump is individually controlled using the Armfield software via the USB connector. They can be also calibrated by the user and the data logged for subsequent calculations.

Stirrer

The optional CEM MkII and CEB MkIII reactors are equipped with agitators driven by an electric motor. The stirrer is also computer controlled using the Armfield software. The speed can be varied using the up/down arrows or by typing in a value between 0-100%.

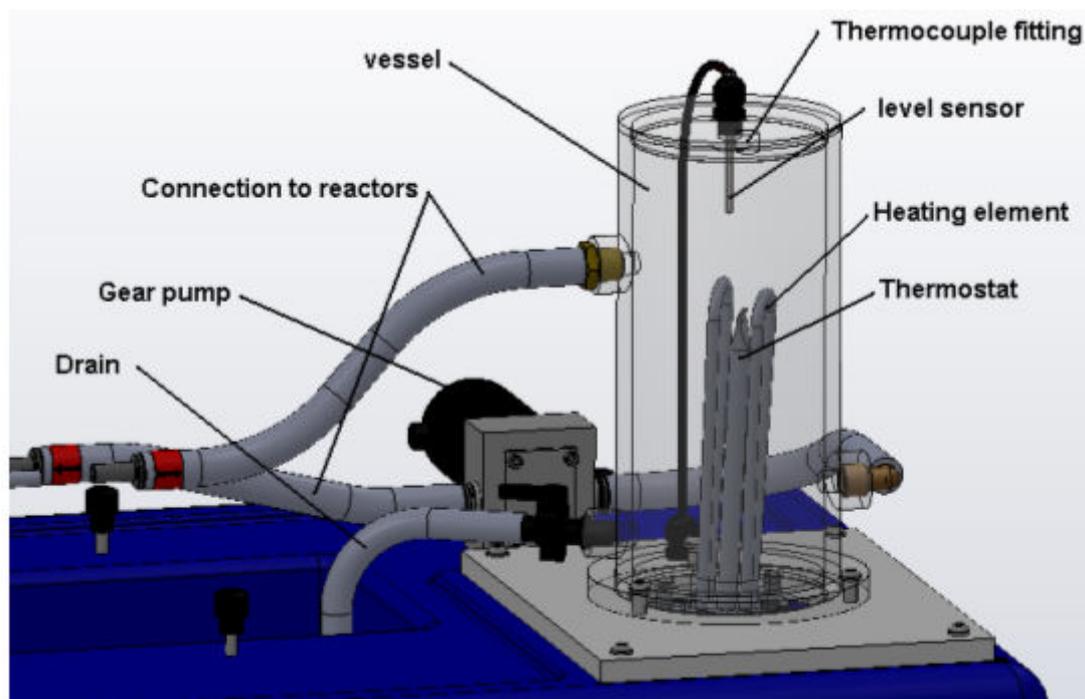
Hot water circulator

A clear, acrylic, self-contained hot water circulator is positioned on the plinth at the front right hand side. (See diagram below).

This vessel incorporates an electrical element for heating water. A thermostat and level detector are incorporated in the vessel to prevent the heater from operating if the water is too hot or the level in the vessel is too low. These safety devices are fixed and cannot be used for experimental purposes.

The lid accommodates an adjustable gland for a variable-height thermocouple sensor T2 supplied with this unit. The thermocouple is used to measure the fluid temperature inside the vessel.

Flexible tubes are used to connect the circulator to each reactor. Water, heated by an electrical heating element in the circulator, is circulated by a gear pump located at the back of the plinth behind the vessel.



Temperature control of the reactor

Temperature control of the reactor contents is achieved by circulation of heated or chilled water through a submerged coil or a jacket on the appropriate reactor. The hot water circulator is integrated with the CEXC service unit. The optional chilled water circulator (CW-17) is designed to stand on the bench alongside the CEXC and can be supplied as an accessory if required.

Operation of the heater is controlled by a PID controller in the PC software. The PID controller maintains the required Hot Water Temperature to obtain a steady Reactor

Temperature T1. Any offset in the required Reactor temperature T1 on CEB-MKII or CEM-MKII can be corrected by adjusting the set point of the Hot Water Temperature T2 in the PID controller. The Set Point temperature, Proportional Band, Integral, Derivative and Cycle times are all set to default values when the software is loaded but all of these may be adjusted by the user if required. Default settings for the PID controller are listed below:

CEB-MKIII	T2	Hot water temperature from circulator
	P	10 %
	I	100 secs
	D	0 secs
	Cycle time	10 secs
CEM-MKII	T2	Hot water temperature from circulator
	P	1 %
	I	0 secs
	D	0 secs
	Cycle time	10 secs
CET-MKII	T1	Reactor temperature (Hot water inside jacket)
	P	1 %
	I	0 secs
	D	0 secs
	Cycle time	10 secs

PID control of temperature is not required on CEY or CEZ

It is possible to run the reactors at temperatures below ambient by disconnecting the hot water circulator and connecting the flexible hoses from the chilled water circulating accessory CW-17 (if supplied). The required chilled water temperature is set using the thermostat on the chiller unit. Refer to the Instruction Manual supplied with CW-17 for further details about the chilled water circulator.

Conductivity measurement of the reactor contents

A conductivity probe is supplied to be used individually with any of the reactors. The conductivity is displayed on the software in units of milliSiemens/cm. During a chemical reaction, the conductivity of the reacting solution changes as more of the reactants are converted. This data can be logged and used to determine the degree of conversion and the rate of conversion.

Reactor attachment

Three of the five chemical reactors are mounted on identical PVC base plates which are designed to stand on the plinth in the space provided and to be secured to the base by thumbnuts. CEY and CEZ are supplied with separate stands. Full details for each of the reactors are given in the appropriate reactor manual.

Mains plate at rear of the plinth

In order to use the unit all the circuit breakers and the RCD should be in the ON (up) position.

Installation

Advisory

Before operating the equipment, it must be unpacked, assembled and installed as described in the steps that follow. Safe use of the equipment depends on following the correct installation procedure.

Electrical Supply

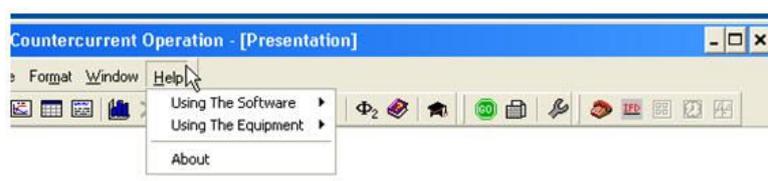
	CEXC-A	CEXC-B	CEXC-G
Green/yellow lead	Earth (Ground)	Earth (Ground)	Earth (Ground)
Brown lead	Live (Hot)	Live (Hot)	Live (Hot)
Blue lead	Neutral	Neutral	Neutral
Fuse rating	13A	15A	13A
Voltage	220-240V	110-120V	220V
Frequency	50Hz	60Hz	60Hz

Installing the PC Software

Before operating any of the accessories with the CEXC it will be necessary to install the software from the CD-ROM supplied with CEXC onto an appropriate PC (PC not supplied).

For instructions on how to install and run the software insert the CD-ROM into the optical drive on the PC (PC not supplied) then choose 'Help' from the menu.

After installing and running the software for the appropriate accessory on the PC, instructions on how to operate the software can be obtained by choosing the 'Help' tab in the top right hand corner of the screen as shown below:



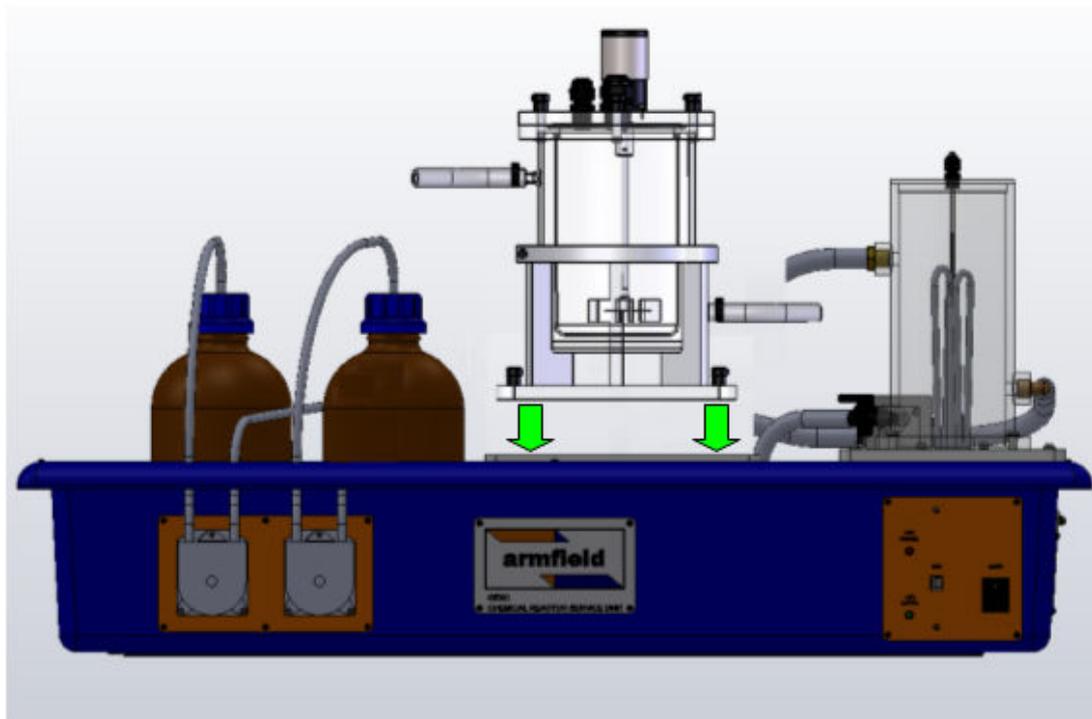
Note that when operating the software for the first time it will be necessary to enable the USB virtual COM port by choosing the Red telephone icon (Start COM session).



Full instructions about enabling the port are included in the Help menus.

Installing the Equipment

Mounting the Reactor Unit onto the CEXC

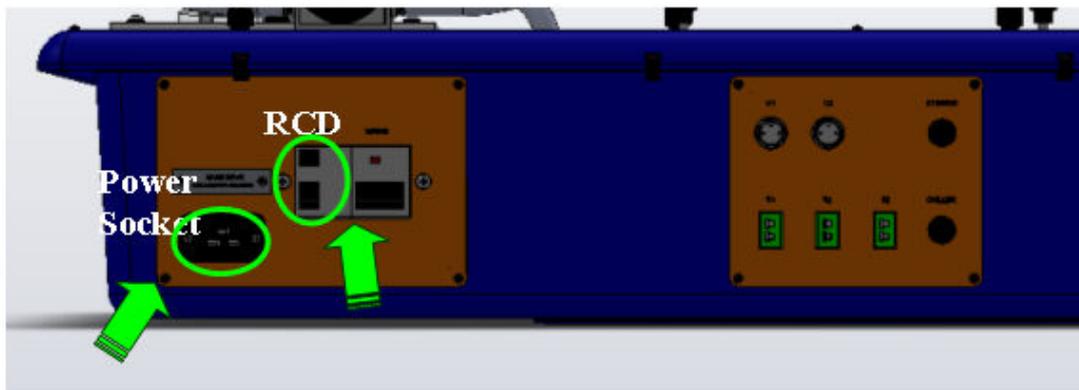


- Fit the Reactor Unit (e.g. CEB-MkIII) assembly to the CEXC using the 4 locating studs and black thumbnuts.
- Fit the reagent bottles into the moulded channel on the CEXC. Fit tubing on the left hand side of each of the two feed pumps into the bottles through the hole in the cap.
- Connect the remaining two pipes from the feed pumps to the connectors on the base or top of the reactor. The feed bottles provided with CEXC are not required with all reactor units.
- Connect the conductivity probe, temperature sensors and the stirrer plugs to the sockets located on the rear of the CEXC.
- Plug the temperature sensor and conductivity sensor supplied with CEXC into the appropriate sockets at the rear of the service unit then insert the sensors through the appropriate glands in the lid of the reactor. Check that the sensors are fully immersed then tighten the glands.
- If the reactor has a stirrer connect the stirrer plug to the socket located on the rear of the CEXC.

Connection to the electrical supply

- Check that the voltage specified on the equipment matches the supply voltage.

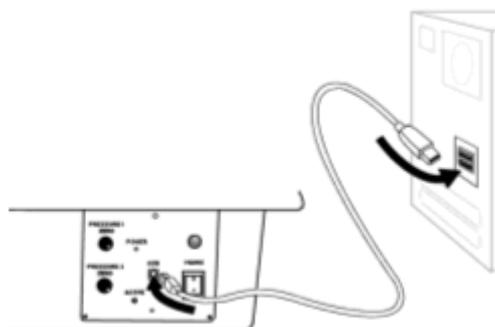
NOTE: This unit must be earthed.



- Connect the power socket at the rear of the plinth to a suitable mains electricity supply.
- Ensure that circuit breakers and RCD are ON (up)
- The on/off switch for the apparatus is located on the orange panel on the front of the plinth. Switch on the apparatus

Connection to the Data Logger

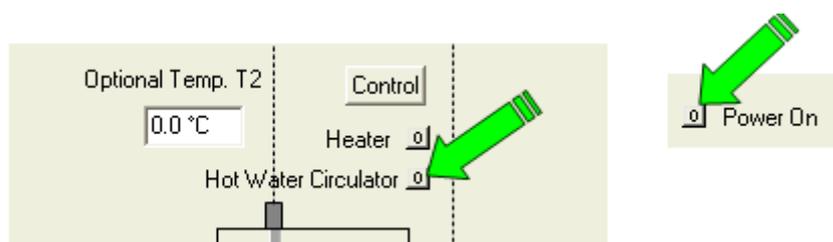
- Connect CEXC to a PC using the USB cable supplied.



- Run the software for the appropriate reactor.

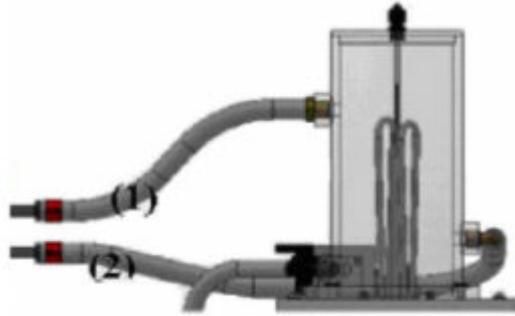
Priming HWC Vessel

- Turn on the mains switch
- Fill HWC vessel with water up to the low level electrode (20 mm from top)



- Click Hot Water Circulator button and click Power On. Level of water in the vessel will decrease as reactor coil is filled. Keep filling the HWC vessel until the level in the vessel is stable and over the low level electrode.

Connecting the HWC to Reactor Unit



- Connect return pipe of the HWC (1) to the connection for the top of the coil or tank depending on the reactor unit used.
- Connect the supply pipe of the HWC (2) to the connection for the bottom of the coil or tank depending on the reactor unit used.

Connecting the Reactor Unit to the Chiller

- The chiller unit is used when operating temperatures at or below ambient are required.
- The feed and return hoses for the chiller are connected to the jacket of the reactor through the connections at the top and at the bottom of the reactor vessel. (See CW-17 manual)
- When working with Chiller there is no computer control as PID temperature controller is needed since CW-17 operates with a Thermostat.
- Reactor Unit (e.g. CEB MKIII) software in Isothermal Operation will be used with 'Control' mode OFF. Variables will be monitored but the working temperature will be established by the thermostat.

Electrical Wiring Diagram

Click on the relevant link to invoke the Wiring Diagram:

[Wiring Diagram CDM33265J](#)

Printed Versions of this Instruction Manual

Please note, all wiring diagrams are appended at the rear of this manual. If viewing this Instruction Manual via Help Text in Armfield Software refer to the printed version of the manual for these diagrams.

Operation

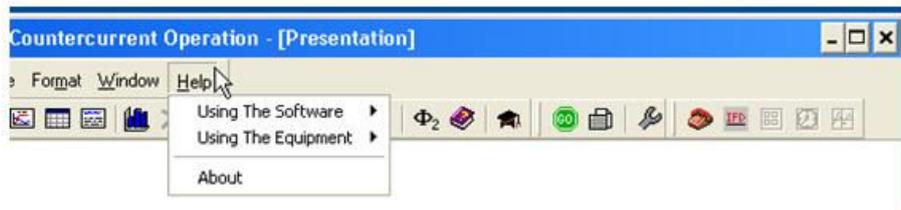
Where necessary, refer to the drawings in the [Equipment Diagrams](#) section.

The apparatus must be set up in accordance with the Installation section. Additionally, ensure you have read the Important Safety Information at the beginning of this manual.

Operating the PC Software

Each of the accessories associated with CEXC has dedicated PC software that is installed from the CD-ROM supplied with CEXC.

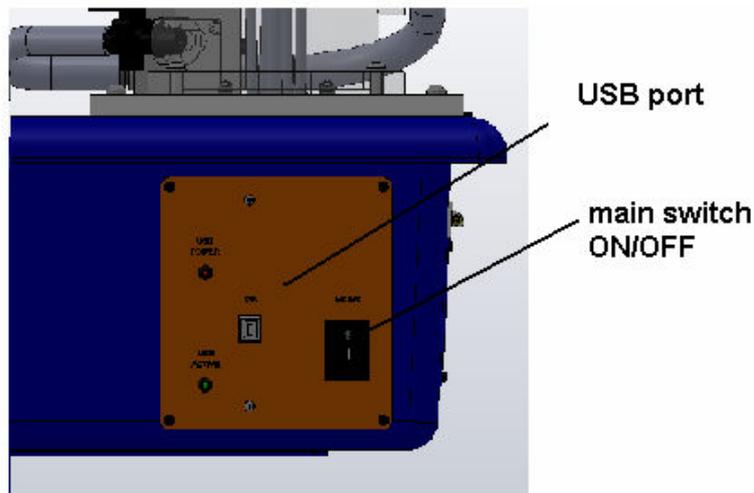
Details about operating the software can be obtained by choosing the 'Help' tab in the top right hand corner of the screen as shown below:



Operating the Equipment

Switching-on the unit

The unit is switched on using the switch on the front of the unit. The circuit breakers and RCD device located at the rear of the unit should be turned on beforehand. Both the temperature controller and conductivity display should illuminate.



Ensure the installation procedure has been followed (Refer to the Installation Section).

Check the USB connection is made between the CEXC unit and the PC, and, the CEXC in conjunction with the reactor software, is installed and running on the PC. Check the circuit breakers and RCD device at the rear left of the unit are in the on (up) position. Turn the unit on by pressing the ON/OFF switch on the unit. This will enable the software to display the sensor readings from the service unit.

Operation of Remote Controller/Data Logger and Software

For full details see Operating the Software.

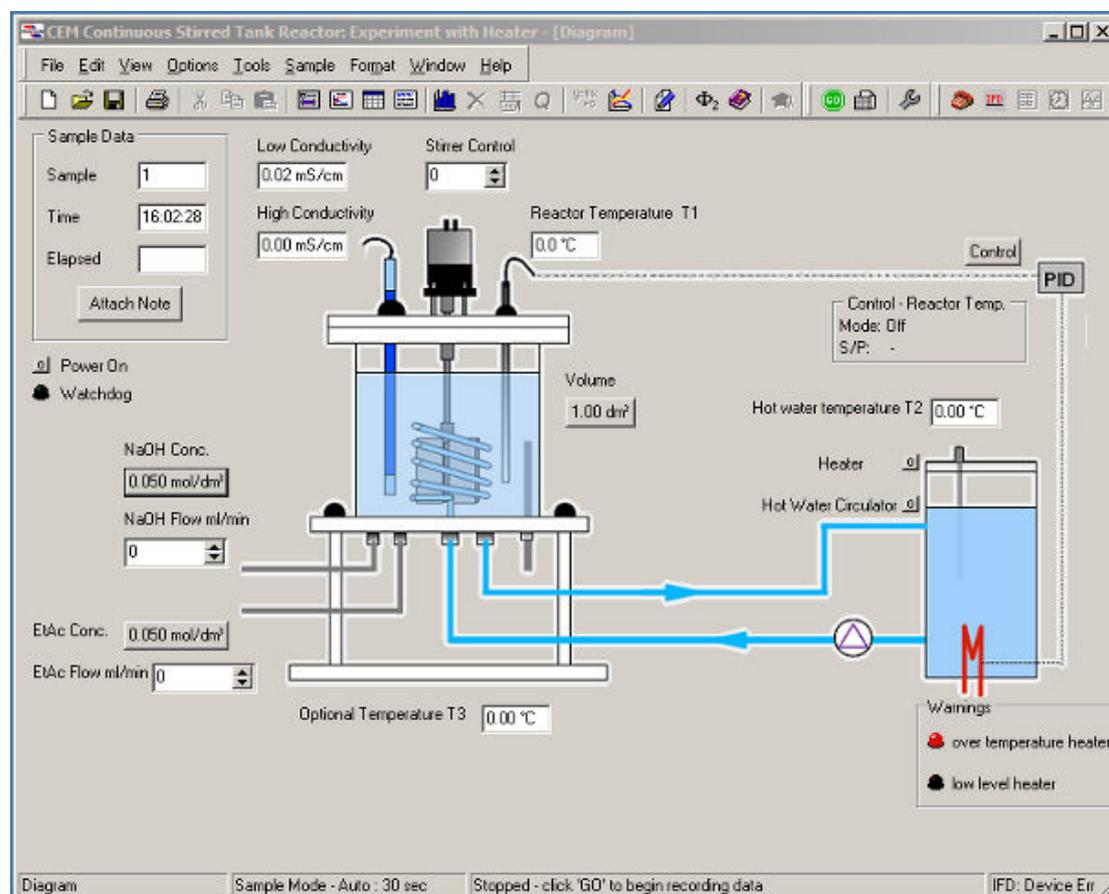
The Armfield CEXC service Unit is controlled using the CEXC software supplied, which allows real-time monitoring and data logging of all sensor outputs and control of the peristaltic pumps, hot water circulator and stirrer if reactor requires. Recorded results can be displayed in tabular and graph format. The software runs on a Windows™ PC which connects to the CEXC using a USB interface.

Installation of the software is described in the Installation section, and the software must be installed before connecting the PC to the CEXC. The software may then be run from the Start menu (Start > Programs > Armfield Chemical Reactor Software > CET/CEM/CEB/CEY/CEZ). Operation of the software is described in a walkthrough presentation within the reactor software, and also in the online Help Text accessible via the software Help menu. Operation and setting of specific controls is also provided within the experiments described in this manual.

Mimic Diagram

The equipment is operated and monitored from the Mimic Diagram screen in the software. This shows all the sensor outputs, and includes controls for the speed of the pumps, PID temperature controller and the stirrer when reactor requires.

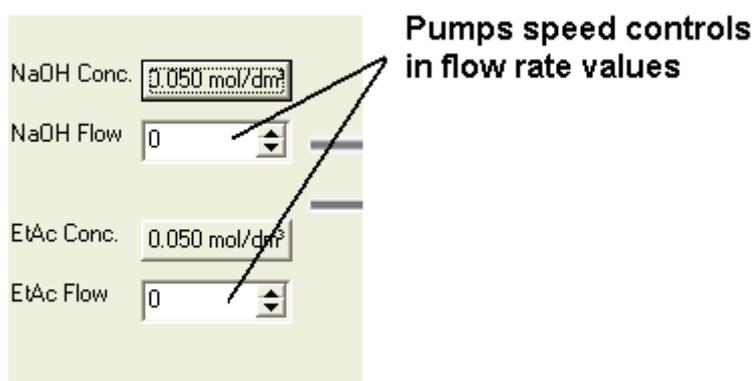
Example of display on CEM MkII software:



Controlling the feed pumps

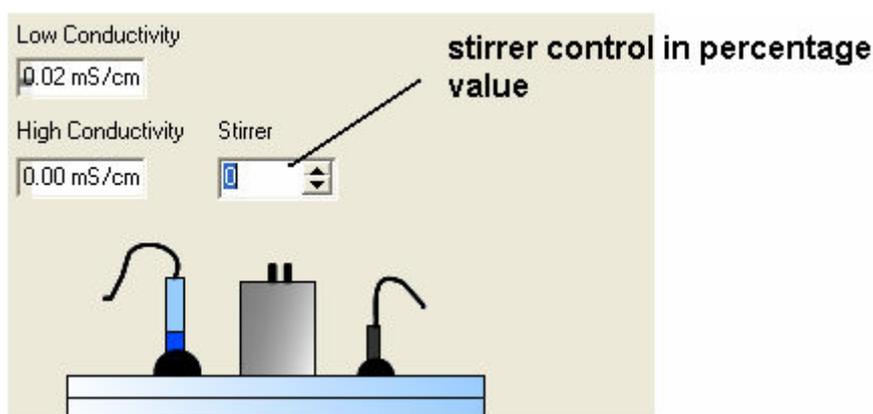
Feed pumps are controlled from the mimic diagram screen in the CEXC software supplied with each reactor. The pump settings are displayed as flow rate values and a value in millilitres per minute. The required settings may be typed directly into the flowrate display box, or adjusted up or down using the arrow keys attached to the boxes.

Example of display on CEM MkII software:



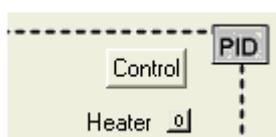
Operating the stirrer (CEM MkII and CEB MkIII)

Operation is similar to the two feed pumps. Speed is adjusted using the rotary switch when the selector switch is set to manual.



Operating the heating element

The heater is controlled via the PID control window from the mimic diagram screen of the reactor chosen in the CEXC software, and the switch is displayed onscreen only to give an indication. The switch will display a '0' when the heating element is off and a '1' when the heating element is on.



Priming the vessel

Remove the lid from the hot water vessel. Fill the vessel by pouring clean (preferably demineralised) water until the level is approximately 20mm from the top.

Check that the low-level indication in the software is not activated.

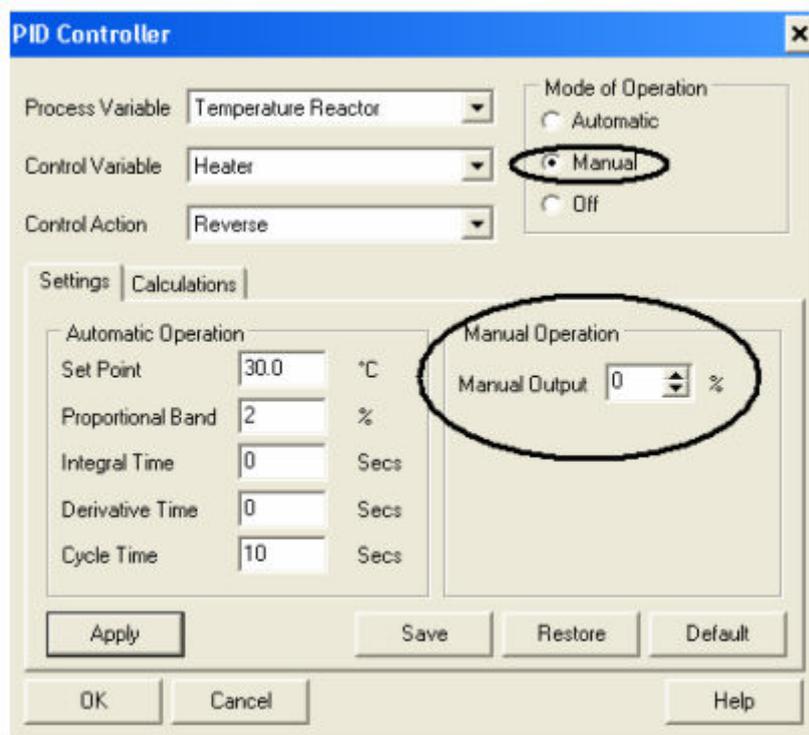


Setting the hot water temperature

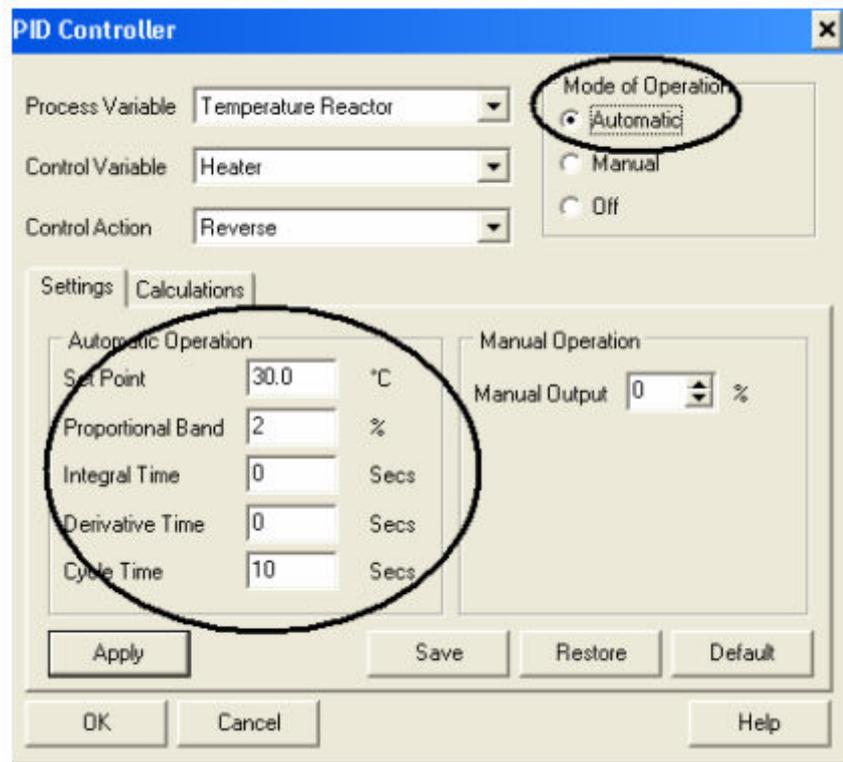
Two modes are available for controlling the hot water temperature, a manual (or open loop) control mode to provide constant heater power and an auto (or closed loop) temperature control mode. Both modes are accessed via the software.

To access the heater control mode click the software 'control' button close to the appropriate sensor.

In manual mode, the heater is set to be on for a fixed proportion of time, operator selectable from 0% to 100%. This mode is useful when assessing energy balances or settling times.



In auto mode, the power to the heaters is modulated in accordance with a PID algorithm to achieve a stable temperature at one of the sensors (usually the hot water inlet to the heat exchanger). Advanced users may change the P, I and D parameters to perform process control investigations.



For experiments with reactor where a constant temperature has to be maintained, the best mode is the Automatic, and the settings for each reactor are shown in Operational Procedure in each Manual.

Using the teaching software

If using the CEXC service unit, a USB port at the front of the unit provides a connection to a compatible PC via connection. By using the appropriate Windows™ based Armfield software, any of the sensors outputs provided with the service unit may then be displayed in real time or logged for display in table or graphical format. The operation of the Windows™ based software is described in detail in the Help Text included with the CEXC software choosing the working reactor. The individual Teaching Exercises are included with each printed reactor manual, and are also described in the software Help Text.

Equipment Specifications

Overall Dimensions

Height - 0.60m

Width - 1.00m

Depth - 0.50m

Miscellaneous

Peristaltic pump flow rate: 0 - 150 ml/min per pump

Feed bottles capacity: 2.5 L per bottles

Environmental Conditions

This equipment has been designed for operation in the following environmental conditions. Operation outside of these conditions may result reduced performance, damage to the equipment or hazard to the operator.

- a. Indoor use;
- b. Altitude up to 2000m;
- c. Temperature 5°C to 40°C;
- d. Maximum relative humidity 80% for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40°C;
- e. Mains supply voltage fluctuations up to $\pm 10\%$ of the nominal voltage;
- f. Transient over-voltages typically present on the MAINS supply;

Note: The normal level of transient over-voltages is impulse withstand (over-voltage) category II of IEC 60364-4-443;

- g. Pollution degree 2.

Normally only nonconductive pollution occurs.

Temporary conductivity caused by condensation is to be expected.

Typical of an office or laboratory environment.

Routine Maintenance

Responsibility

To preserve the life and efficient operation of the equipment it is important that the equipment is properly maintained. Regular maintenance of the equipment is the responsibility of the end user and must be performed by qualified personnel who understand the operation of the equipment.

General

The equipment should be disconnected from the electrical supply when not in use.

After use the feed tanks, reactor vessel, sump tray and pipework should be washed through with water to remove chemical residues and then drained.

RCD Test

Test the RCD by pressing the TEST button at least once a month. If the RCD button does not trip when the Test button is pressed then the equipment must not be used and should be checked by a competent electrician.

Temperature sensors Calibration

The temperature sensors are calibrated before delivery and should not require re-calibration. However, should calibration become necessary follow the below procedure. This should only be done once the unit has fully warmed up.

Connect CEXC service unit to a PC and start up the Armfield software corresponding to the reactor in use. Open the corresponding mimic diagram screen where T1, T2 and T3 windows are displayed.

The temperature conditioning circuit (which provides the reading from the thermocouples supplied with the CEXC service unit) is located on a printed circuit board inside the plinth on the right-hand side. However, should re-calibration become necessary the appropriate calibration potentiometers can be located using the diagram given in [Accessing the electrical circuits inside the plinth.](#)

Ensure the equipment has been connected to the electrical supply and switched on for at least 20 minutes. Start up the Armfield software for the specific reactor. To access the PCB remove the panel on the right hand side of the plinth by removing the four fixing screws.

If a thermocouple calibrator is available:

Connect Thermocouple calibrator simulator to T1 input socket, located at the rear of the plinth. Set to 25°C and adjust VR1 (T1 ZERO) and VR2 (T1 SPAN) on the PCB to give 25°C displayed on PC. Check accuracy at 15° and 40°C.

Repeat the same procedure for T2 by adjusting VR3 (T2 ZERO) and VR4 (T2 SPAN) on the PCB to give 25°C displayed on PC, and VR5 (T3 ZERO) and VR6 (T3 SPAN) for T3 (if an extra thermocouple is used).

If a thermocouple calibrator is not available:

Temperature sensor T1, T2 and T3 should be dipped into crushed ice, and then adjust the ZEROS to give 0°C, then sensors should be dipped into boiling water and then adjust the SPANS to 100°C.

When the conditioning circuit has been re-calibrated, replace the front panel of the electrical console and re-install the sensors in the appropriate place on the CEXC service unit.

Calibration of the conductivity sensor

The conductivity conditioning circuit (which provides the reading from the conductivity probe supplied with the CEXC service unit) is located on the printed circuit board shown above inside the electrical console. This circuit is calibrated before despatch and should not require re-calibration. However, should re-calibration become necessary the appropriate calibration potentiometers can be located using the diagram in [Accessing the electrical circuits inside the plinth](#).

Ensure the equipment has been connected to the electrical supply and switched on for at least 20 minutes. To access the PCB remove the cover plate on the right hand side of the plinth by unscrewing the four fixing screws. It is not necessary to detach the PCB from the plinth.

Disconnect the conductivity probe from the socket at the left-hand side of the electrical console. Connect an AC Voltmeter (Range AC mV) to pins 1 and 2 of the vacant socket and adjust potentiometer VR10 on the PCB to give a reading of 50 mV (RMS) on the Voltmeter (probe excitation voltage).

Disconnect the Voltmeter then reconnect the probe to the appropriate socket having removed the probe from the appropriate reactor fitted to the CEXC.

High conductivity Calibration

Fill a small beaker with a Conductivity standard solution (e.g. 0.1M KCl giving a conductivity of 12.88 mS at 25°C) and measure the temperature of the standard solution using a suitable thermometer. From the table supplied determine the actual conductivity of the solution at the measured temperature.

Immerse the probe into the Conductivity standard solution in the beaker then adjust potentiometer VR7 to give a reading of the standard solution in the 'High conductivity' window on the software to match the conductivity.

Low conductivity Calibration

Fill a small beaker with a Conductivity standard solution (e.g. 0.01M KCl giving a conductivity of 1.41mS at 25°C) and measure the temperature of the standard solution using a suitable thermometer. From the table supplied determine the actual conductivity of the solution at the measured temperature.

Immerse the probe into the Conductivity standard solution in the beaker then adjust potentiometer VR8 to give a reading of the Standard solution in the 'Low conductivity' window on the software.

When the conditioning circuit has been re-calibrated replace the panel and re-install the probe in the appropriate reactor on the CEXC service unit.

12.88 mS/cm at 25°C 0.1 M KCl

°C	mS/cm	°C	mS/cm
5	8.22	20	11.67
10	9.33	21	11.91
15	10.48	22	12.15
16	10.72	23	12.39
17	10.95	24	12.64
18	11.19	25	12.88
19	11.43	26	13.13

1.413 mS/cm at 25°C 0.01 M KCl

°C	mS/cm	°C	mS/cm
5	0.896	20	1.278
10	1.02	21	1.305
15	1.147	22	1.332
16	1.173	23	1.359
17	1.199	24	1.386
18	1.225	25	1.413
19	1.251	26	1.441

When the conditioning circuit has been re-calibrated replace the front panel of the electrical console and re-install the probe in the appropriate reactor on the CEX service unit.

Accessing the electrical circuits inside the plinth

Maintenance of the CEXC service unit does not require access to the electrical circuits or components located inside the moulded plinth. However, in the event of an electrical problem, it may be necessary for a competent electrician to gain access to the inside of the mouldings as follows:

Ensure that the equipment is disconnected from the electrical supply (not just switched off).

Drain any liquids contained in the reagent vessels or reactors.

Unscrew the channel drain valve located in the recess at the left hand end of the moulded plinth.

Disconnect the electrical connections between the top and bottom plinth sections by disconnecting the appropriate connectors.

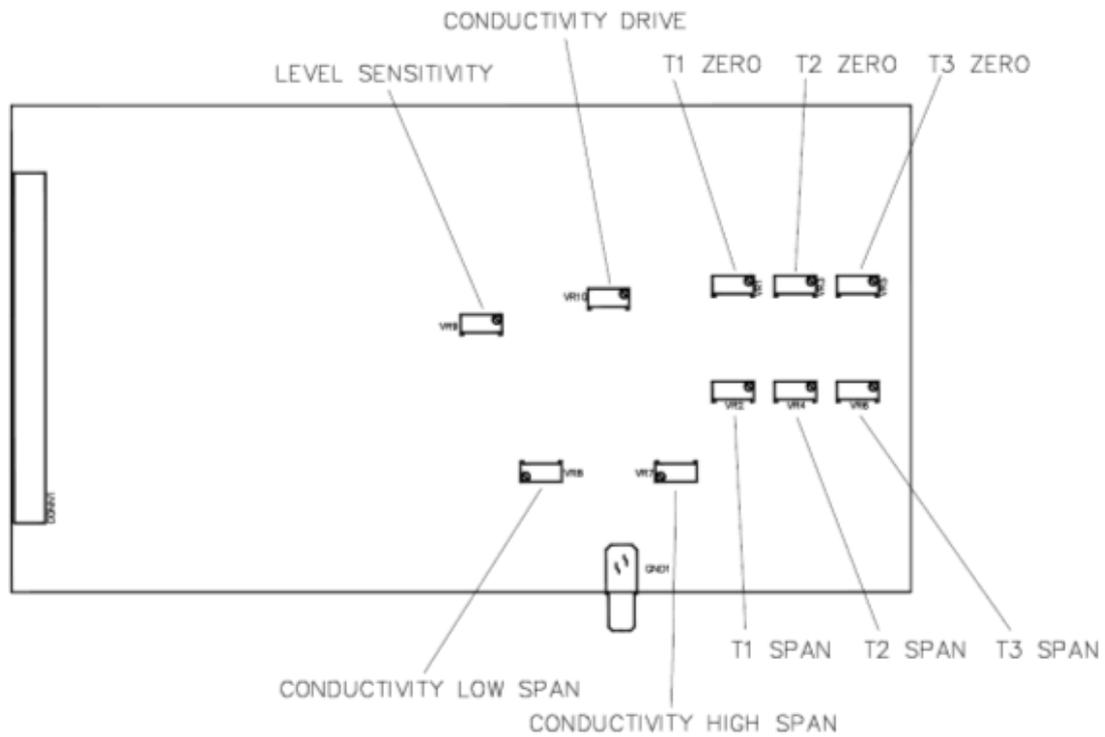
Unscrew the six fixings around the periphery of the plinth top.

Carefully lift the top moulded section away from the bottom moulded section and place the top section in a suitable location.

The electrical circuits inside the bottom moulded plinth section are accessible.

A circuit diagram showing the mains and DC electrical circuits inside the plinth is included at the rear of this manual to assist in fault finding.

Should it be necessary to remove the cover plate at the right hand side of the plinth by unscrewing the four fixings then the PCB connections diagram below shows the location and function of the electrical connectors on the PCB to aid re-assembly.



Re-assembly of the top and bottom moulded plinth sections is the inverse of the above instructions.

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