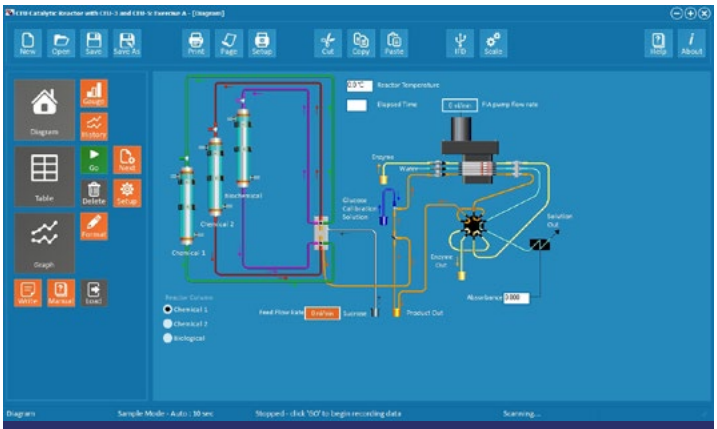
CE SERIES

Catalytic Reactors - CEU

NOW WITH DATA LOGGING SYSTEM INCLUDED

The CEU utilises the sugar inversion reaction (sucrose -> glucose + fructose) to study the performance of packed bed chemical and biological catalytic reactors.

A colorimetric assay is used to determine the degree of conversion using an optical sensor. Assays may be automated using optional flow injection analysis.



CEU process flow sheet with optional third reactor and FIA system

CEU: Unit shown with the optional enzymic reactor and flow injection analysis (FIA) system

Demonstration / Instructional capabilities

The CEU unit introduces students to the fundamentals of packed bed catalytic reactors. It is a benchtop unit available with either two or three reactor columns. Using two columns with a chemical catalyst allows a different particle size exchange resin to be used in order to study the effect of particle size on reactor kinetics. It is possible to use a third column to investigate biological catalysis, using the enzyme invertase, and compare this with chemical catalysis.

An optional flow injection analysis (FIA) module is available. This module is positioned on the CEU plinth and provides an easy online measurement of product yield, eliminating the need for manual assays. The module is also useful for teaching the FIA technique and demonstrating the advantages of this measurement method in continuous processes.

Experimental content

- Understanding the principles of packed bed catalytic reactors
- Mass balancing
- Examination of steady and unsteady state catalysis
- Comparison of chemical and biological (enzymic) catalysis
- Flow characterisation in a packed bed
- Understanding the principles of flow injection analysis (FIA)

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Issue: 4
URL: http://www.armfield.co.uk/ceu
Applications
ChE ME CE IP

Detailed capabilities

CEU

The basic CEU comprises a vacuum formed plinth with two packed bed reactor columns with provision to mount a third. It includes a hot water circulation system complete with temperature controller to maintain the desired reaction temperature.

The recommended reaction is the inversion of sucrose to form glucose and fructose. This is a safe and environmentally friendly reaction.

An optical absorbance sensor is provided to monitor the status of the reaction. With the basic system, samples are taken manually and inserted into the absorbance sensor using sample tubes.

A variable speed peristaltic feed pump controls the flow rate through the reactors.

Valves are provided to change the feed and product flow from one column to the other quickly and easily. This allows the student to investigate different reaction systems without having to dismantle the equipment and repack the columns.

CEU-3 Flow Injection Analysis

The FIA module is a self-contained sub-assembly which is located on the CEU plinth. The module contains a multichannel pump and a multi port valve. The absorbance sensor from the CEU is repositioned on this module to allow online measurements to be taken.

The FIA pump supplies a proportion of the product to the multi port FIA valve. The pump also delivers assay reagent and the carrier liquid to facilitate the assay procedure. The FIA valve mixes the reagent and product in the correct ratios before the mixture is delivered to the optical sensor where the product yield is measured.

CEU-5 Third Reaction Column

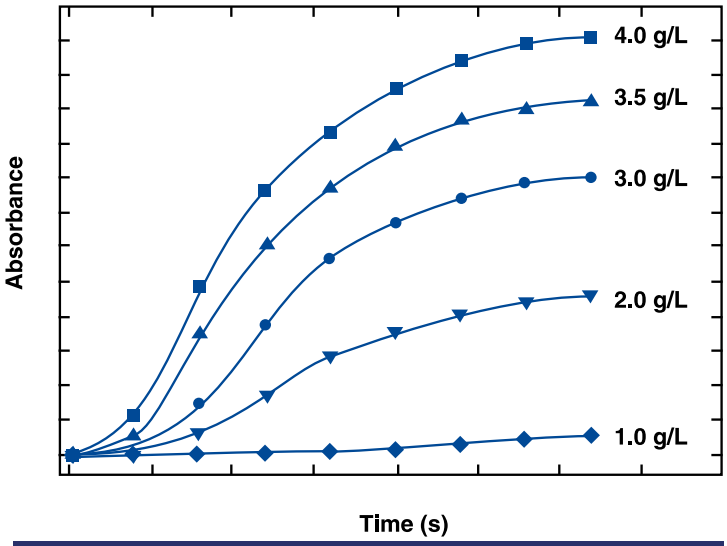
An additional reactor may be specified which uses the same sucrose inversion reaction but an alternative biological, enzymic catalyst. This allows comparison between chemical and biological catalysts.

Note: Regular recharging of the biological reactor column is required due to the less stable nature of this type of catalyst.

CEU-DTA-ALITE

Educational software and data logging supplied as standard

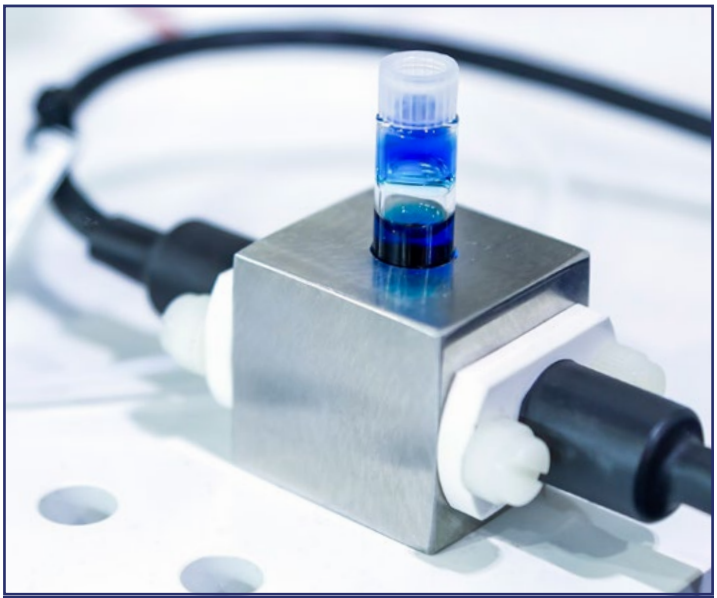
The sensor outputs are available for data logging and analysis. The armSOFT data logger interfaces between the CEU and the user's computer using a USB port. The associated software includes graph plotting, full instructions on setting up the equipment and performing the investigations, related theory and full help texts. It requires a computer running Windows 7 (not supplied) with a USB port.



Calibration curves for the optical sensor

Reactor input / Output selector valve

HWC Tank



Optical flow cell

Requirements

Scale

1Ph | PC | USB

Electricity Requirements:

CEU-A:	220-240V / 1ph / 50Hz / 5A
CEU-B:	120V / 1ph / 60Hz / 10A
CEU-G:	220-240V / 1ph / 60Hz / 5A

Software:

Requires the user to have a PC running Windows 7 or above with a USB port.

Consumables:

500ml of 2M Hydrochloric acid
500ml of 2M Calcium chloride
3kg Amberlite
10g Glucose
38g Sucrose
1kg Liquid Glucose (oxidase)
250mg Invertase
30g of Sodium alginate

Detailed capabilities

Teaching exercises are included to familiarise students with the following topics:

- Determination of steady state and unsteady state kinetics of a packed bed catalytic reactor
- Performance comparison of a chemical catalyst (protonated cationic exchange resin) with a biological catalyst (immobilised enzyme)
- Effect of catalyst particle size on the Thiele modulus and the effectiveness factor (quantification of the competitive effects that occur between reaction kinetics and mass transfer inside the catalytic particle)
- Effect of flow rate, temperature and feed concentration on steady state conversion
- Tracer studies to characterise fluid flow within the reactors
- Demonstration of the flow injection analysis (FIA) technique
- Examination of the reproducibility and sensitivity of the FIA analysis method as a function of the flow rate and sample concentration

Overall dimensions

Length	1.00m
Width	0.50m
Height	0.60m
Packed and crated shipping specifications	
Volume	0.44m^3
Gross weight	36kg

The complete CE range

CEK MKII - Fluid Mixing Studies
CEL MKII - Fixed and Fluidised Bed Apparatus
CEN MKII - Solids Handling Study Bench
CEQ - Corrosion Studies Kit
CERa MKII - Gaseous Diffusion Coefficient Apparatus
CERb - Liquid Diffusion Coefficient Apparatus
CES - Wetted Wall Gas Absorption Column
CEU - Catalytic Reactors
CEXC - Computer Controlled Chemical Reactor Teaching Equipment + 5 reactor types
CEP MKII - Stirred Tank Reactors In Series

Ordering specification

- A benchtop unit comprising a vacuum-formed ABS plastic plinth with integral electrical console on to which is mounted the packed bed reactor columns, feed pump, optical sensor and optional flow injection analysis (FIA) system
- The unit is supplied as standard with two reactor columns for chemical catalysis
- An optional third column can be added to the system for biological (enzymic) catalysis
- A heated water supply to the column jackets enables automatic control of reaction temperature to a set point value
- Feed flow rate 0-15 ml/min
- The optional FIA pump can be adjusted to give flow rates up to 2.5 ml/min
- All electrical circuits are fitted with appropriate protection devices
- The console has two digital meters. The first, associated with the controller, shows the temperature of water supplied to the column jackets and the second shows the optical sensor reading which provides a measurement of product concentration. Corresponding signals are routed to the I/O port for connection to a PC

Optional accessories

CEU-3:	Flow injection analysis accessory
CEU-5:	Third reaction column

Ordering codes

CEU-A:	220-240V / 1ph / 50Hz / 10A
CEU-B:	120V / 1ph / 60Hz / 15A
CEU-G:	220-240V / 1ph / 60Hz / 10A

Knowledge base

> 28 years expertise in research & development technology
> 50 years providing engaging engineering teaching equipment

Benefit from our experience, just call or email to discuss your laboratory needs, latest project or application.

An ISO 9001:2015 Company

CE Products CE certified

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Aftercare

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Commissioning
Training
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