Chemical Engineering

Advancing Chemical Engineering Education

Armfield's chemical and process engineering equipment bridges the gap between theory and practice, giving students hands-on experience of core engineering principles.

Armfield enables universities to deliver engaging, industry-relevant teaching that prepares students for real-world engineering challenges.

This brochure outlines our solutions alongside their place within the curriculum, including alignment with Bloom's Taxonomy, key theories, and fundamental laws. Covering areas such as evaporation, mass transfer, filtration, biochemical engineering, drying, and industrial processes, our systems support progressive learning from basic understanding to practical application.





ENGINEERING EDUCATION TEACHING & RESEARCH

For more than six decades, we have worked in close partnership with universities worldwide to support the teaching of Chemical and Process Engineering. Our aim has always been to translate fundamental theory into meaningful, hands-on learning experiences that align clearly with course syllabi and the practical skills students need for their future careers.

Chemical and Process Engineering demands more than theoretical understanding alone. Students must see how real systems behave — from transport phenomena and reaction engineering to separation processes and process control.

At Armfield, we design educational equipment that bridges this gap, combining sound engineering fundamentals with practical experimentation.

Our product development is driven by collaboration with academic teams to ensure our systems support taught modules and clearly defined learning outcomes.

The result is equipment that enables progressive learning, from introductory concepts through to advanced analysis and independent investigation, using robust platforms that reflect industrial practice.

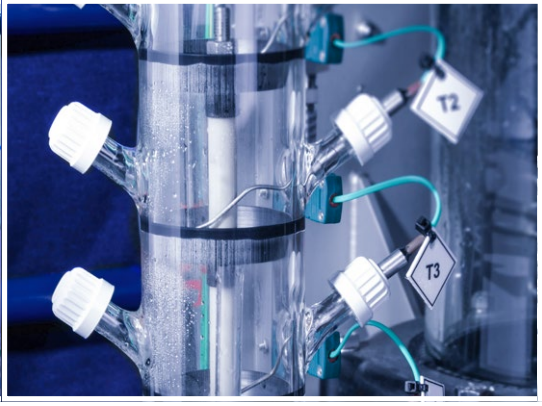
This booklet presents a comprehensive portfolio spanning the core areas of Chemical and Process Engineering. Each system is designed to form part of a coherent teaching strategy, supporting multiple cohorts, learning levels, and long-term laboratory use.

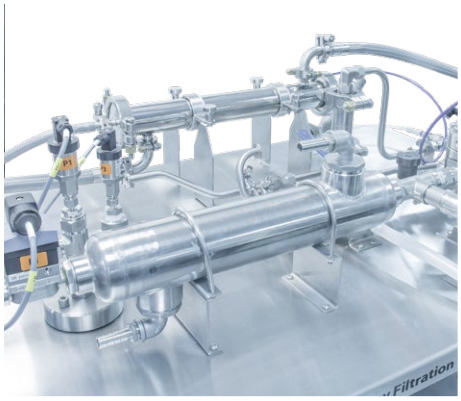
Education continues to evolve, and so do we. Whether you are reviewing existing laboratories, developing new programmes, or seeking bespoke solutions to meet specific teaching needs, we would be pleased to work with you.

Please contact us to discuss how we can support your requirements.

Andy Macpherson
Managing Director of Armfield Ltd







Filtration & Membrane Separation Systems
Thermal Separation, Distillation & Evaporation Systems
Mass Transfer, Extraction, Absorption & Adsorption Processes
Drying, Dewatering & Particle Processing Systems
Water, Environmental & Utility Process Engineering
Biochemical Engineering & Bioprocess Systems
Reaction Engineering, Crystallisation & Bench-Top Process Studies
Materials, Corrosion & Degradation Studies
Process Control, Instrumentation & Automation
Advanced Fluid Mechanics
Thermodynamics - Heat Transfer / Heat Exchange

Contents

Cross Flow Membrane Filtration **FT17**	6
Modular Cross Flow Filtration **FT18-MkII**	7
Filtration Unit **UOP12**	8
Distillation Columns **UOP3BM / UOP3CC**	10
Rising Film Evaporator **FT22**	11
Solid/Liquid Extraction Unit **UOP4-MkII**	12
Liquid/Liquid Extraction Unit **UOP5-MkII**	13
Gas Absorption Column **UOP7-MkIII**	14
Fixed Bed Adsorption Unit **UOP15-MkII**	15
Anaerobic Digester **W8**	16
Aerobic Digester **W11**	17
Computer Controlled Water Cooling Tower **UOP6-MKII**	18
3-Phase Horizontal Separator **UOP30**	19
Essentials of Process Control Range **PCT60-64**	20/21
Computer Controlled Tray Dryer **UOP8-MKIIe**	23
Spray Dryer **FT30-MKIII**	24
Fluidised Bed Dryer **FT31**	25
Flocculation Test Unit **W1-MKII**	26
Ion Exchange Unit **W9-MKII**	27
Aeration Unit **W10-MKII**	28
Crystallisation Unit **UOP14-MKII**	29
Chemical Reactors Teaching Equipment **CEXC**	30
Catalytic Reactor Unit **CEU**	32
Fluid Mixing Studies **CEK-MKII**	33
Fluid Mixing Studies **CEL-MKII**	34
Stirred Tank Reactors in Series **CEP-MKII**	35
Corrosion Studies Kit **CEQ**	36
Gaseous Diffusion Coefficient Apparatus **CERa-MKII**	37
Liquid Diffusion Coefficient Apparatus **CERb**	38
Temperature Measurement and Calibration **TH1**	39
Pressure, Measurement and Calibration **TH2**	39
Saturation Pressure (Marcet Boiler) **TH3**	39
Expansion Processes of a Perfect Gas **TH5**	39
Vapour Compression Refrigeration Unit **RA1-MKII**	39
Multi-Pump Test Rig **C3-MKII**	40
Fluid Machines Range **FM50-53**	41
Fluid Friction Measurement **C6-MKII**	42
Heat Transfer **HT10X** / Heat Exchange **HT30X**	43

UNIVERSITYS AND LEARNING FACILITIES

With over 150 years of experience, Armfield is a trusted global supplier of high quality equipment. Founded in 1875 in Ringwood, England, our commitment to quality, innovation and service has driven us from our roots in engineering machinery to become a world leader in two distinct fields: **Engineering Education** and **Industrial Food Technology.**

Armfield has supplied and partnered with over 3,000 universities, education centres and research hubs worldwide since 1958, providing equipment that covers all major engineering disciplines. In 1992, our Pilot-scale Food Division was launched, developing and supplying equipment for many of the world's leading corporations across the food, beverage and pharmaceutical industries. A selection of our valued customers is shown below.

TEXAS A&M UNIVERSITY
UNIVERSITY OF OXFORD
UNIVERSITY OF CAMBRIDGE
ROLLS ROYCE
VILLANOVA UNIVERSITY IGNITE CHANGE. GO NOVA.
UNSW SYDNEY
gsk GlaxoSmithKline
UCD DUBLIN
STANFORD UNIVERSITY
المراعي Almarai
Unilever
DIAGEO
TATE & LYLE
جامعة الشارقة UNIVERSITY OF SHARJAH
RMA Royal Military Academy Brussels
UNITED STATES AIR FORCE ACADEMY
Ethiopian የኢትዮጵያ Aviation University PIONEER OF AVIATION EXCELLENCE
Universidad de los Andes
UNIVERSIDAD DE CHILE
جامعة خليفة Khalifa University
Coca-Cola
PEPSICO
pepsi
Lay's
Tropicana
QUAKER



SHEFFIELD UNI
THEY UNDERSTAND

Dr. Midiana Rosado Hau School of Engineering

From Lecture Theory to Measurable Engineering Phenomena

Dr. Midiana Rosado from the University of Sheffield works in the Fluid Mechanics Laboratory, where students from several engineering programs gain hands-on experience with aerodynamics and flow measurement.

In collaboration with Armfield, the lab recently introduced a new wing profile experiment that aerospace engineering students will use during the semester.

Using the wind tunnels and a water manometer system, students are able to measure pressure distribution around the wing and directly observe how aerodynamic forces develop.

Over the years, the University of Sheffield has worked closely with Armfield to set up a variety of practical experiments, including demonstrations of Bernoulli's principle, measurements of drag coefficients, and analysis of wake velocities behind different shapes. According to Dr. Rosado, these experiments help students move beyond theory and truly understand how fluid mechanics and aerodynamics behave in real systems.

"The students find the equipment extremely useful," she explains. "It allows them to visualise and measure the phenomena they learn about in lectures."

Looking ahead, the collaboration will continue to expand. The laboratory plans to introduce additional flow measurement equipment and develop new experimental activities together with Armfield.

For Dr. Rosado and her students, the partnership is about more than equipment—it's about creating engaging learning experiences that help future engineers understand the real behaviour of fluids and aerodynamic systems

NOTTINGHAM UNI
ARMFIELD ROCKS!

Professor John Turner Director of Education & Student Experience

Engineering Education Designed Around Real Learning

I have been contracted by Armfield Engineering Limited for the past year, and throughout this time I've been consistently impressed by their willingness to engage deeply with the realities of modern chemical engineering education. Rather than simply producing equipment and hoping it fits somewhere within a curriculum, Armfield has shown a genuine commitment to understanding how their rigs are used in practice and how they can better support student learning across multiple academic levels.

One clear example is the distillation column: originally suited mainly to higher-year teaching, Armfield embraced the idea of making small procedural and physical adjustments that will now allow the same rig to be used from first-year fundamentals through to final-year research projects. This shift has transformed a single-purpose piece of equipment into a multi-stage learning platform with far broader relevance.

Throughout our collaboration, Armfield has shown a strong interest in aligning their equipment with the structure and expectations of modern curricula. By exploring how different rigs map to learning outcomes, sustainability themes (UNSDGs), and practical teaching needs, they have demonstrated a thoughtful and forward-looking approach. Their willingness to develop supporting academic materials and ensure clear links between theory and practice has been particularly valuable for educators and students alike.

Working with Armfield has shown me a company that listens, adapts, and genuinely wants to enhance engineering education. Their focus on versatility, curriculum alignment, and practical relevance has made the collaboration both productive and rewarding.

Cross Flow Membrane Filtration FT17

The Armfield FT17 Cross-Flow Filtration Unit is a laboratory-scale teaching system designed to demonstrate membrane separation principles such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

Students can investigate the influence of operating parameters-pressure, temperature, and cross-flow velocity-on filtration performance, while gaining hands-on experience in process control, instrumentation, and data analysis. Its small-scale design makes it ideal for practical learning in food technology and chemical engineering laboratories.



Relevant Curriculum Modules

- Transport Phenomena (Mass transfer fundamentals)
- Separation Processes (Membrane filtration operations)
- Food Technology
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- **Darcy's Law** - Describes flow through porous membranes
- **Osmotic Pressure Law** - Critical for reverse osmosis and nanofiltration
- **Fick's Law of Diffusion** - Explains solute transport across membranes
- **Bernoulli's Principle** - Governs pressure & velocity relationships in fluid flow
- **Hagen–Poiseuille Equation** - For laminar flow in channels affecting cross-flow velocity

Learning Outcomes

Remember & Understand

Students demonstrate knowledge of membrane filtration fundamentals by explaining transmembrane pressure, permeate flux, and the operational differences between microfiltration, ultrafiltration, nanofiltration, and reverse osmosis. They interpret pressure, flow, and temperature measurements and relate observations to basic mass transfer and membrane separation theory.

- IChemE outcomes: Knowledge and understanding; awareness of engineering practice, safety, and hygiene.

Apply & Analyse

Students apply heat and mass balance principles to experimental data, analysing the effects of steam pressure, system pressure, and operating conditions on evaporation rate and thermal efficiency. They evaluate trends, calculate performance metrics, and compare experimental results with theoretical expectations.

- IChemE outcomes: Analysis; investigation; experimental data handling and technical reporting.

Evaluate & Create

Students evaluate alternative operating strategies to optimise evaporation performance and product quality, justify operating conditions using technical evidence, and design or adapt experimental methodologies for specific process objectives.

- IChemE outcomes: Design; evaluation; independent investigation; professional engineering judgement.

Technical specifications

Vessel volume	1l
Maximum Operating Pressure	40 bar
Retentate control temperature range	5-60°C
Filter size	90mm

Requirements	Dimensions		Scale
1Ph PC USB	Length	0.700	
	Width	0.600	
	Height	0.600	

- **Electrical Supply:** Single phase (see Ordering codes)
- FT17-50 requires a Windows PC with USB interface



Ceramic membrane filtration accessory

FT17-50 Enhanced Unit

The Armfield FT17-50 offers advanced computer control, data logging, and diafiltration. It features an electronic pressure sensor (0-40 bar), thermocouple for retentate temperature, feed pump speed controller for adjustable cross-flow velocity, and an electronic mass balance for permeate mass measurement. Diafiltration is supported via a peristaltic pump and high-level sensor.

Accessories

FT17-5 – Ceramic membrane filtration accessory.
Includes a 15 kDa ceramic membrane, ideal for demanding processes requiring durability, chemical resistance, and high pressure/temperature tolerance.

FT17-15 – Temperature control accessory (requires FT17-50).
Enables feed/return tank temperature control between 5 °C and 60 °C for precise filtration conditions.

FT17-CONSUM – Polymer membrane set.
Contains four membranes for reverse osmosis, nanofiltration, and microfiltration, allowing quick replacements and rapid mode changes to maximize lab efficiency.

Ordering codes

FT17-A	220-240V/1ph/50Hz
FT17-G	220-240V/1ph/60Hz
FT17-50-A	220-240V/1ph/50Hz
FT17-50-G	220-240V/1ph/60Hz
FT17-5	Ceramic membrane filtration accessory
FT17-15	Temperature control accessory (requires FT17-50)
FT17-CONSUM	Set of additional polymer membranes

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Modular Cross Flow Filtration FT18-MkII

The Armfield FT18-MkII is a pilot-scale cross-flow membrane filtration unit designed for teaching, research, and process development across the full range of membrane operations, from microfiltration (MF) and ultrafiltration (UF) to nanofiltration (NF) and reverse osmosis (RO).

It allows students and researchers to understand how pressure-driven separation works, how membrane performance is characterised, and how operating parameters influence flux, fouling, and selectivity.



FT18-60 (HMI)
Integrated Touchscreen

Relevant Curriculum Areas

- Transport Phenomena (Mass transfer fundamentals)
- Separation Processes (Membrane filtration operations)
- Food Technology
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Darcy's Law *(Filtration Flux Through a Porous Medium)*
- Hagen–Poiseuille Law *(Laminar Flow in Tubes or Pores)*
- Bernoulli's Principle *(Energy Conservation in Flowing Fluids)*
- Fick's Laws of Diffusion *(Mass Transfer Driving Concentration Polarisation)*
- Osmotic Pressure & Osmotic Flow *(Key for NF/RO)*
- Combined Resistance-in-Series Model *(Widely Used in Membrane Teaching)*
- Shear Stress and Hydrodynamics *(Extension of Hagen–Poiseuille & Boundary-Layer Theory)*
- Gel-Layer / Cake Filtration Model

Learning Outcomes

Remember & Understand

Students demonstrate understanding of crossflow membrane filtration concepts, including transmembrane pressure, flux, fouling, concentration polarisation, and the operational differences between MF, UF, NF, and RO. They explain the role of pressure, flow, temperature, and membrane configuration in governing separation performance.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of safety, materials, and laboratory practice.

Apply & Analyse

Students apply mass transfer and fluid mechanics principles to pilot-scale data, analysing the influence of crossflow velocity, TMP, membrane type, and operating mode on permeate flux and rejection. They perform mass balances, interpret logged process data, and assess fouling behaviour and cleaning strategies.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and reporting.

Evaluate & Create

Students evaluate alternative membrane modules and operating strategies for defined separation objectives, justify design and operating decisions using quantitative evidence, and design experimental programmes addressing optimisation, scale-up relevance, and process robustness.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements

1Ph	PC	USB

Scale

Length	0.720
Width	1.000
Height	1.500

- **Electrical Supply:** Three phase (see Ordering codes)
- **Water supply:** Mains water 10 l/min at 2 bar or equivalent flow recirculation chiller for lower temperatures
- **Air supply:** 6 bar with minimal air consumption (FT18-50-1 option only)



Ceramic Filter Module (FT18-5)



Hollow Fibre Filter Module (FT18-7)



Spiral Wound Filter Module (FT18-6)



Tubular Filter Module (FT18-8)

FT18-MKII-50 & FT18-MKII-50-1 Enhanced Units

The FT18-MKII-50 incorporates full electronic sensing and PC or touchscreen control via the ArmBUS software platform. Pressures, retentate temperature, retentate flow rate, and permeate mass are continuously measured using electronic transmitters and a high-precision mass balance.

The software displays a real-time process flow diagram and automatically calculates key operating parameters such as transmembrane pressure (TMP), flux, and cross-flow velocity. The FT18-MKII-50-1 adds an automated backpulsing/backflushing module, compatible with the ceramic and hollow fibre membrane modules.

Accessories & Filtration Modules

FT18-20 – 30 L Stainless Steel Feed/Retentate Vessel

FT18-60 – Integrated Touchscreen (HMI) Control Module

Technical specifications

Max flow rate	1400 l/hr
Max operating pressure	50 bar (See filter module options)
Pressure sensors	0-60 bar
Mass balance range	0-6kg
Minimum test volume without FT18-20	15L

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Filtration Unit UOP12

The Armfield UOP12 Filtration Unit is a benchtop solid–liquid separation system designed to teach the fundamentals of batch filtration and continuous tangential flow microfiltration.

The standard configuration features a transparent acrylic plate-and-frame filter press, enabling direct visualisation of slurry flow, cake formation, and filtrate clarity. An optional hollow-fibre microfiltration module (UOP12-10) extends the unit to continuous membrane processes, allowing students to explore protein transmission, flux behaviour, fouling, and shear-dependent filtration performance.

The UOP12 supports both constant pressure and constant flow operation and includes integrated instrumentation for pressure, temperature, optical absorbance, and flow rate measurement.



Relevant Curriculum Modules

- Transport Phenomena (Mass transfer fundamentals)
- Separation Processes (Solid-liquid filtration operations)
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Darcy's Law *(Filtration Flux Through a Porous Medium)*
- Hagen–Poiseuille Law *(Laminar Flow in Tubes or Pores)*
- Bernoulli's Principle *(Energy Conservation in Flowing Fluids)*
- Fick's Laws of Diffusion *(Mass Transfer and Concentration Polarisation)*
- Osmotic Pressure & Osmotic Flow
- Combined Resistance-in-Series Model
- Shear Stress and Hydrodynamics
- Gel-Layer / Cake Filtration Model
- Diafiltration & Mass-Balance Principles *(UOP12-10 protein separation)*

Learning Outcomes

Remember & Understand

Students demonstrate understanding of solid–liquid separation principles by explaining filtration mechanisms, Darcy's Law, filter media and cake formation, and the distinction between constant-pressure and constant-flow operation. They interpret pressure, flow, temperature, and optical absorbance measurements in relation to filtration behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply mass balance and transport concepts to experimental data, analysing filtration performance through determination of medium and cake resistances, effects of body aid, cake washing efficiency, and filtration mode. For tangential flow operation, students analyse membrane flux, pressure drop, fouling behaviour, and transmission characteristics.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative filtration and operating strategies, justify process and operating decisions using quantitative and economic evidence, and design experimental programmes addressing optimisation, scale-up, and process selection between batch and continuous filtration approaches.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	UOP12-10	Scale
1Ph PC USB COLD COMP. AIR	Length:	1.100	1.100	
	Width:	0.500	0.500	
	Height:	0.600	0.750	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Plate and frame filter:**
  Optional mains water supply 3 l/min at 2 bar,
  Optional pressurised air supply at 2 bar.

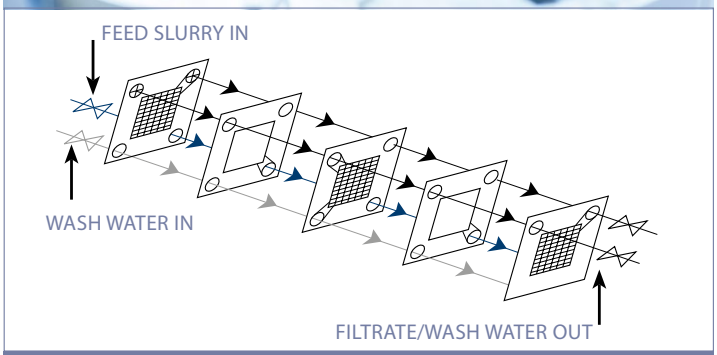
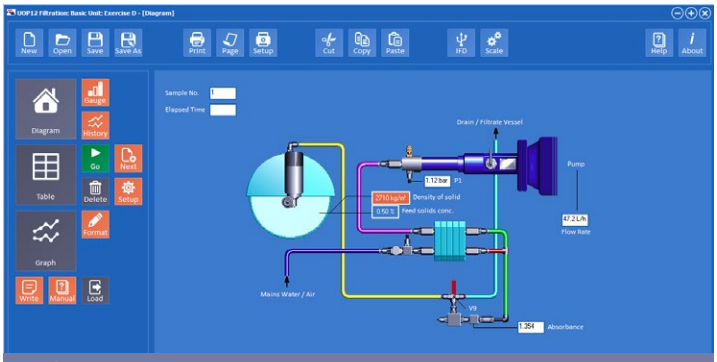


Diagram of flow path through the plate and frame filter

UOP12-10 – Tangential Flow Hollow Fibre Filtration Module

A hollow-fibre microfiltration accessory enabling continuous tangential flow filtration using a 0.2 µm polysulfide cartridge (110 cm^2 area). Supports investigation of membrane fouling, trans cartridge pressure drop, flux, and protein transmission.

Includes prefilter, tubular heat exchanger, and full sensor integration for pressure, temperature, and permeate absorbance measurement.



Software

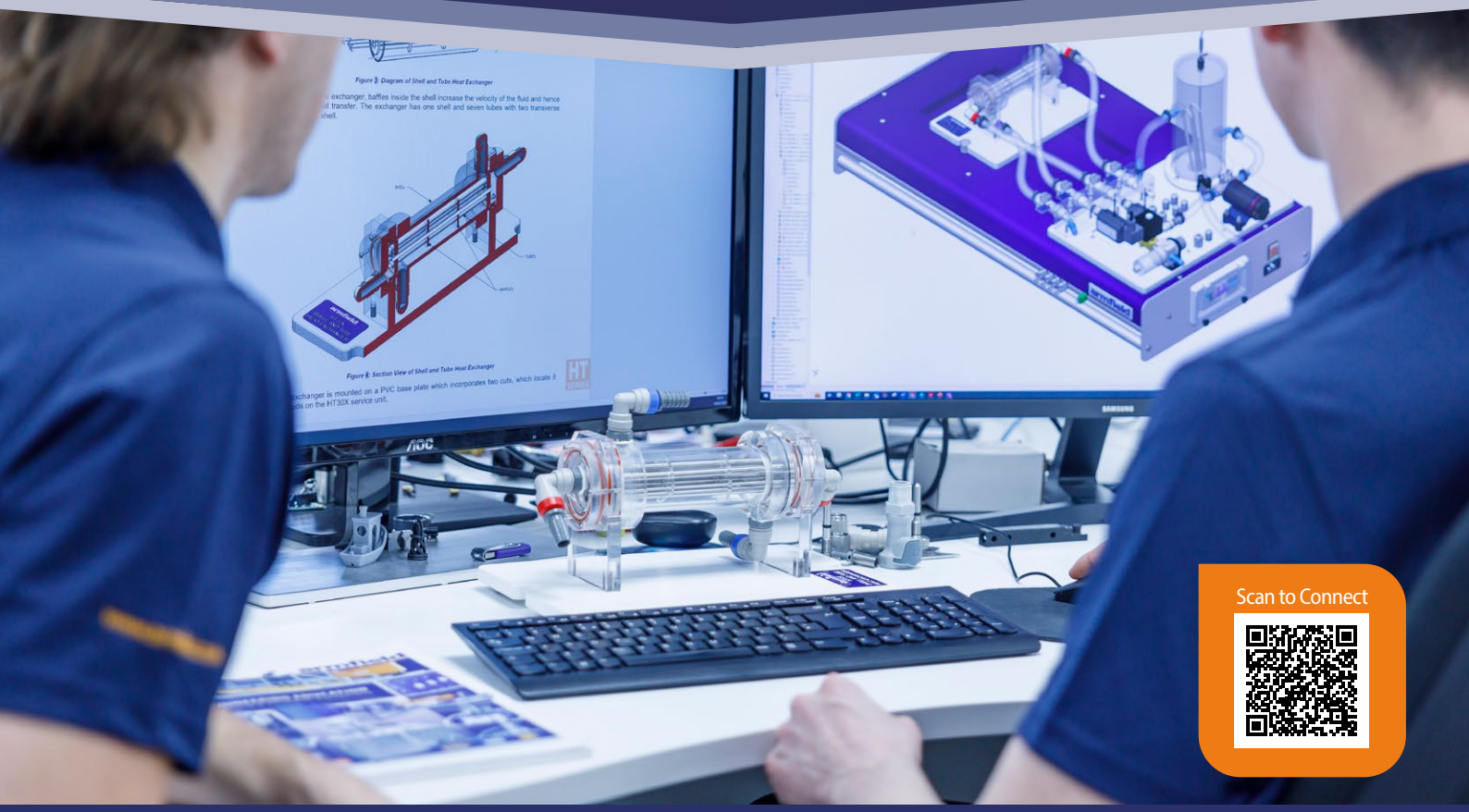
The UOP12 software extends well beyond basic inverter control by integrating experiment setup, automated operation, and real-time data acquisition in a single platform. Built-in graphing functions provide live visualisation of key process variables during operation, ensuring repeatable testing, higher data quality, and efficient analysis.

Direct export to Microsoft Excel for immediate post-processing and reporting.

Ordering codes

- **UOP12-A:** 220-240V / 1ph / 50Hz, 10 amp
- **UOP12-B:** 120V / 1ph / 60Hz, 15 amp
- **UOP12-G:** 220-240V / 1ph / 60Hz, 10 amp

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved



EXPERT INSTALLATION **COMMISSIONING** TRAINING

Supporting You from Day One

Armfield ensures your systems are fully operational from day one. Training is typically delivered during installation, with additional sessions available at Armfield's UK headquarters.

THANK YOU **FOR CHOOSING** ARMFIELD LTD

Time to Service Your Armfield Equipment

Keep your equipment running at peak performance with our professional maintenance services, call or scan to arrange a quote.

Why Schedule Maintenance?

Extend the lifespan of your equipment.

Prevent costly repairs.

Ensure optimal efficiency and safety.

Creative Ideas Bespoke Design

Do you need new accessories, or bespoke designs? We specialise in creating tailored solutions worldwide.

Ask for details.

Refurb: Update / Renew

We refurbish old equipment, replacing pipes, consumables, and seals to restore optimal performance.

Contact Us Customer Service Team

Our Customer Service team is ready to help with product information, technical support, and training enquiries.

sales@armfield.com

www.armfield.com
info@armfieldinc.com
Call Now +44 (0)1425 478781

Distillation Columns UOP3BM

The Armfield UOP3CC is a comprehensive continuous distillation system designed for advanced teaching, research, and process familiarisation in chemical and process engineering, like the UOP3BM it is designed for use in ATEX environments. It provides a full industrial-style distillation workflow on a safe laboratory scale, enabling investigation of separation efficiency, hydrodynamics, heat and mass transfer behaviour, and process control strategies using real distillation equipment.

The standard 50 mm diameter sieve-plate glass column incorporates eight plates arranged in two sections, complete with temperature measurement points and sampling ports for detailed tray-by-tray analysis. A packed column can also be substituted for studies in mass transfer performance and comparison of separation mechanisms.

The unit supports batch and continuous operation, atmospheric and vacuum distillation, and the study of azeotropic and immiscible mixtures. A stainless-steel reboiler, a coil-in-shell condenser, an optional decanter for phase separation, a reflux solenoid valve with adjustable timers, feed preheating arrangements, and extensive instrumentation make the UOP3CC a highly versatile platform. Computer connectivity via ArmSOFT software enables real-time data logging and external PID/PLC control.



UOP3 - UOP3CC safe area console

Relevant Curriculum Areas

- Transport Phenomena *(Heat & mass transfer fundamentals)*
- Separation Processes *(Distillation operations)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories or Laws

- Raoult's Law *(Vapour–Liquid Equilibrium in Ideal Mixtures)*
- Dalton's Law *(Partial Pressures in Vapour Phases)*
- Relative Volatility & Separation Efficiency
- Fenske, Underwood & Gilliland Correlations *(Distillation Design Relationships)*
- Enthalpy Balances & Heat Duties (Reboiler and Condenser Performance)
- McCabe–Thiele Method *(Graphical Design & Operating Line Analysis)*
- Hydrodynamics of Trays & Packed Columns *(Flooding, Weeping, Pressure Drop)*
- Azeotropic Behaviour & Phase Separation Principles
- Vacuum Distillation Theory *(Boiling Point Depression Under Reduced Pressure)*

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate knowledge of separation fundamentals by explaining vapour–liquid equilibrium, staged mass transfer, reflux, and energy balances, and by interpreting temperature and composition profiles.

- **IChemE outcomes:** Knowledge and understanding; awareness of engineering practice and laboratory safety.

Apply & Analyse

Students apply theory to experimental data, performing mass and energy balances, McCabe–Thiele analysis, efficiency and pressure-drop calculations, and comparative analysis of operating conditions.

- **IChemE outcomes:** Analysis; investigation; data handling and technical communication.

Evaluate & Create

Students evaluate alternative operating and control strategies, justify decisions using technical evidence, and develop original experimental or process optimisation studies, including control strategy implementation.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement.

Suggested Reboiler Charges

- Methylcyclohexane/Toluene
- Methanol/Water
- Methanol/Ethanol
- Ethanol/Water

UOP3BM Batch Unit

The UOP3BM is a self-contained batch distillation system featuring a glass sieve-plate or packed column, stainless-steel reboiler, condenser, decanter, and full instrumentation for temperature, reflux control, pressure drop, and vacuum operation.

It provides a safe, ATEX-rated platform for teaching practical distillation behaviour, tray efficiency, reflux strategies, and batch separation dynamics using real industrial hardware.



Requirements	Unit	Console	Scale
1Ph PC USB COLD SAFE VENTING	Length:	0.850	0.520
	Width:	0.800	0.400
	Height:	2.250	0.300

- Electrical Supply: Single phase (see Ordering codes)
- **Cold water supply:** 15 litres/minute at 2.0bar pressure (min.)
- Unit must be placed/located on a solvent-resistant floor in an area with Zone 2 Hazardous area classification or in a well ventilated environment with two metres of clear space on either side of the unit.
- **Venting:** Exhaust line to fume cupboard or to safe discharge area

Ordering codes

- **UOP3BM-A:** 220-240V / 1ph / 50Hz / 13 amp
- **UOP3BM-B:** 120V / 1ph / 60Hz / 25 amp
- **UOP3BM-G:** 220V / 1ph / 60Hz / 13 amp
- **UOP3CC-A:** 220-240V / 1ph / 50Hz / 13 amp
- **UOP3CC-B:** 120V / 1ph / 60Hz / 25 amp
- **UOP3CC-G:** 220V / 1ph / 60Hz / 13 amp

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Rising Film Evaporator FT22

The Armfield FT22 Rising Film Evaporator is a pilot-scale thermal processing unit designed for teaching, research, and process investigation of evaporation under atmospheric or vacuum conditions.

It enables users to study heat transfer, phase change, concentration behaviour, and process efficiency using a full industrial-style rising film configuration incorporating a steam-jacketed evaporator tube, cyclone separator, condenser, vacuum system, and CIP functionality.



Relevant Curriculum Modules

- Transport Phenomena *(Heat transfer fundamentals)*
- Separation Processes *(Evaporation operations)*
- Food Technology
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Heat Transfer Fundamentals *(Conduction, Convection, Condensation)*
- Latent Heat of Vaporisation & Enthalpy Balances
- Boiling Point Elevation & Phase Equilibrium
- Clausius–Clapeyron Relationship
- Overall Heat Transfer Coefficient (U) Relationships
- Evaporation Rate Relationships ($Q = U \cdot A \cdot \Delta T$)
- Vacuum Evaporation Principles *(Pressure–Temperature Dependence)*
- Mass & Energy Balances for Evaporators

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate knowledge of evaporation fundamentals by explaining boiling point-pressure relationships, latent heat, heat transfer mechanisms, and the role of vacuum in thermal processing. They interpret temperature, pressure, and flow measurements and relate observations to basic heat and mass transfer theory.

- **IChemE outcomes:** Knowledge and understanding; awareness of engineering practice, safety, and hygiene.

Apply & Analyse

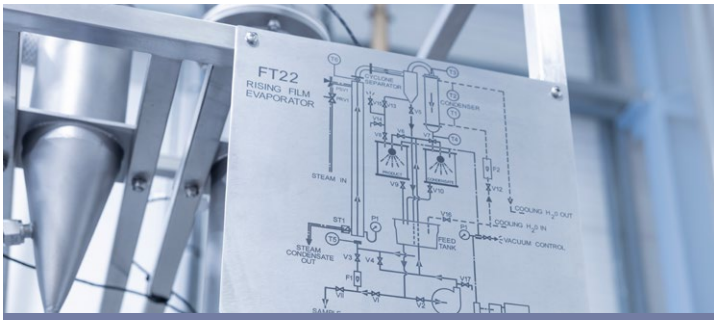
Students apply heat and mass balance principles to experimental data, analysing the effects of steam pressure, system pressure, and operating conditions on evaporation rate and thermal efficiency. They evaluate trends, calculate performance metrics, and compare experimental results with theoretical expectations.

- **IChemE outcomes:** Analysis; investigation; experimental data handling and technical reporting.

Evaluate & Create

Students evaluate alternative operating strategies to optimise evaporation performance and product quality, justify operating conditions using technical evidence, and design or adapt experimental methodologies for specific process objectives.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement.



Optional Accessories

UOP10: Steam Generator	Provides an adequate supply of steam as the heat transfer medium

Technical specifications

Product flow range	1l
Evaporator tube length	1.360 m
Heat transfer area	0.06 m^2
Condenser area	0.17 m^2

Requirements	Unit	Scale
1Ph, STEAM, DRAIN	Length: 0.780 Width: 0.650 Height: 2.600	

- Electrical Supply: Single phase (see Ordering codes)
- **Cold water supply:** 10 litres/minute

Ordering codes

- **FT22-A:** 220-240V/1ph/50Hz, (3kW)
- **FT22-B:** 120V/1ph/60Hz, (3kW)
- **FT22-G:** 220-240V/60Hz, (3kW)

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Solid/Liquid Extraction Unit UOP4-MkII

The Armfield UOP4-MKIII Solid–Liquid Extraction Unit is a laboratory-scale system designed to teach batch and continuous solid–liquid extraction (leaching) processes representative of industrial practice.

The unit incorporates a multi-stage, counter-current rotary extraction cell with automated solids feed, inter-stage solvent circulation, and independent temperature control at each stage.

An integrated batch extraction vessel enables fixed-bed, open-loop and closed-loop operation. Extensive instrumentation, including temperature and conductivity measurement at each stage with data logging, allows real-time monitoring of extraction performance, concentration profiles, and process dynamics.

Relevant Curriculum Modules

- Transport Phenomena *(Mass transfer fundamentals)*
- Separation Processes *(Solid–liquid extraction and leaching)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Solid–Liquid Equilibrium and Solubility
- Fick's Laws of Diffusion *(Intraparticle and film mass transfer)*
- Mass Transfer Coefficients and Rate-Limiting Steps
- Counter-Current and Multi-Stage Extraction Theory
- Residence Time and Throughput Effects
- Mass Balance Principles
- Process Economics and Stage Efficiency

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of solid–liquid extraction principles by explaining leaching mechanisms, solubility, diffusion, and the distinction between batch and continuous operation. They interpret temperature and conductivity measurements to describe concentration changes across extraction stages.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply mass transfer and mass balance concepts to experimental data, analysing the influence of solvent temperature, flow rate, number of stages, and solids throughput on extraction efficiency. They compare batch and counter-current continuous performance and quantify stagewise concentration profiles and overall recovery.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative extraction strategies, justify process configurations using quantitative and economic criteria, and design experimental programmes addressing optimisation, scale-up relevance, and process efficiency. They demonstrate independent judgement in selecting operating conditions and number of stages for defined separation objectives.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit		Scale
1Ph	Length:	0.770		
	Width:	0.560		
	Height:	1.520		

- **Electrical Supply:** Single phase (see Ordering codes)
- **Cold water:** Typically 0.5 l/min



Software

The UOP4-MKII software enables real-time data acquisition, allowing users to observe flow rates, conductivity levels and view live on-screen graphing of key process variables.

All experimental data are logged automatically and can be exported directly to Microsoft Excel for efficient analysis and reporting.

Technical specifications

Solvent temperatures	Ambient to 50°C, individually controllable
Pump rate	0-13.5 l/hr
Feed rate	0-3 l/hr
Rotation speed	1 rev/15min (4 revs/hr)
Cell compartment:	0.16 l capacity

Ordering codes

- **FT22-A:** 220-240V/1ph/50Hz, (3kW)
- **FT22-B:** 120V/1ph/60Hz, (3kW)
- **FT22-G:** 220-240V/60Hz, (3kW)

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Liquid/Liquid Extraction Unit UOP5-MkII

The Armfield UOP5-MKII Liquid–Liquid Extraction Unit is a laboratory-scale packed column designed to teach the fundamentals of continuous counter-current liquid–liquid extraction using safe, immiscible solvent systems.

The unit allows operation with either the aqueous or organic phase as the continuous phase and provides clear visualisation of phase contact, dispersion, and interface behaviour.

Integrated temperature and conductivity measurement, combined with computer-based data logging, enables quantitative determination of solute concentration, extraction efficiency, and mass transfer performance.

Relevant Curriculum Modules

- Transport Phenomena *(Interphase mass transfer)*
- Separation Processes *(Liquid–liquid extraction)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Liquid–Liquid Equilibrium and Distribution Coefficient
- Fick's Laws of Diffusion *(Interphase mass transfer)*
- Two-Film Theory and Overall Mass Transfer Coefficient
- Packed Column Hydrodynamics
- Counter-Current Mass Transfer Theory
- Mass Balance Principles
- Phase Holdup and Interface Control

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of liquid–liquid extraction principles by explaining phase equilibrium, distribution coefficients, counter-current operation, and the role of interfacial area in mass transfer. They interpret temperature and conductivity measurements to describe solute transfer between phases.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply mass balance and mass transfer theory to experimental data, analysing the effects of aqueous and organic flow rates, phase continuity, and operating conditions on extraction efficiency. They calculate distribution coefficients, overall mass transfer coefficients, and compare experimental performance with theoretical expectations.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Evaluate & Create

Students evaluate alternative extraction configurations and operating strategies, justify phase selection and operating conditions using quantitative evidence, and design experimental programmes addressing optimisation, energy efficiency, and process selection versus distillation.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	AC1	Scale
1Ph	Length:	1.220	1.100
	Width:	0.760	0.500
	Height:	2.045	0.750

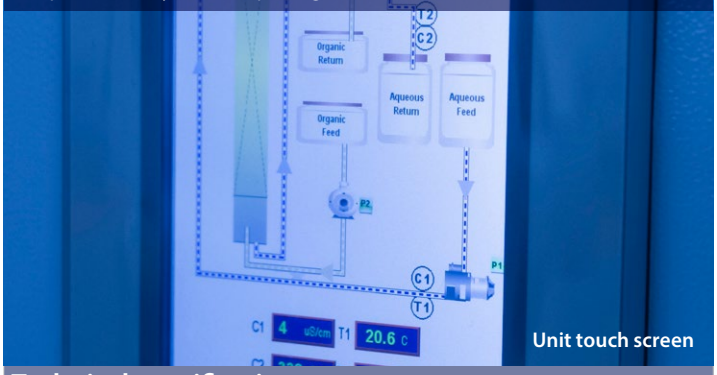
- **Electrical Supply:** Single phase (see Ordering codes)
- **Water Supply:** Initial fill with 20l of demineralised or deionised water
- **Compressed air:** Clean, dry compressed air 40 l/min at 3–10 bar
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software



Optional Accessories

Air compressor AC1 (If no compressed air supply is available)

The software enables active control, automatically logs all experimental data, and allows direct export to Microsoft Excel for efficient real-time data acquisition, analysis, and reporting.



Technical specifications

Maximum Pressure	6 Bar
Maximum Airflow	100 l/min at 1 Bar
Capacity	6l
Motor Power	820W
Noise	80 dBA typical at 1m

Ordering codes

UOP5-MkII:

- **UOP5-MkII-A** Supplied with European and UK mains leads
- **UOP5-MkII-B** Supplied with USA 115V mains lead
- **UOP5-MKII-G** Supplied with USA 230V mains lead

AC1:

- **AC1-A** 220-240V/1ph/50Hz
- **AC1-B** 120V/1ph/60Hz

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Gas Absorption Column UOP7-MkIII

The Armfield UOP7-MKIII Gas Absorption Column is a laboratory-scale packed column designed to teach the principles of gas–liquid mass transfer through absorption processes representative of industrial practice.

The unit operates with counter-current gas and liquid flow through random Raschig ring packing and supports both physical absorption into water and chemical absorption using dilute sodium hydroxide. Comprehensive electronic instrumentation enables measurement of gas and liquid flow rates, temperatures, pressure drop across column sections, and inlet/outlet CO_2 concentration, with integrated data logging for quantitative analysis.

Relevant Curriculum Modules

- Transport Phenomena *(Interphase mass transfer)*
- Separation Processes *(Gas absorption and stripping)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Gas–Liquid Equilibrium *(Henry's Law)*
- Two-Film Theory of Mass Transfer
- Overall Gas-Side and Liquid-Side Mass Transfer Coefficients
- Counter-Current Packed Column Theory
- Pressure Drop, Loading, and Flooding in Packed Columns
- Mass Balance Principles
- Chemical vs Physical Absorption

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of gas absorption fundamentals by explaining interphase mass transfer, gas–liquid equilibrium, and the role of packing in promoting contact area. They interpret flow, temperature, pressure drop, and CO_2 concentration measurements to describe absorption and stripping behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation

Apply & Analyse

Students apply mass balance and mass transfer theory to experimental data, analysing the effects of gas and liquid flow rates on absorption efficiency, pressure drop, loading, and flooding behaviour. They determine absorption rates, evaluate concentration profiles, and calculate overall mass transfer coefficients.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative absorption strategies, compare physical and chemical absorption performance, and justify operating conditions using quantitative and safety-based criteria. They design experimental programmes addressing optimisation, scale-up relevance, and process selection between absorption and alternative separation methods.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB COLD CO_2	Length: 1.017 Width: 0.667 Height: 2.876	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Water Supply:** 5 l/min at 2 bar
- **CO_2:** C20 l/min at 1 bar
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software

CO_2 Sensors supplied with unit



Software



4 software enables active control and all experimental data are logged automatically and can be exported directly to Microsoft Excel for efficient analysis and reporting real-time data acquisition.

Ordering codes

- **UOP7-MkII-A:** 220-240V / 1ph / 50Hz / 2A
- **UOP7-MkII-B:** 115V / 1ph / 60Hz / 4A
- **UOP7-MkII-G:** 220-240V / 1ph / 60Hz / 2A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Fixed Bed Adsorption Unit

UOP15-MkII



The Armfield UOP15 Fixed Bed Adsorption Unit is a laboratory-scale system designed to teach the principles of gas–solid separation through adsorption and desorption in a packed bed.

The unit demonstrates the removal of carbon dioxide from a binary gas mixture using activated carbon, with adsorption and regeneration behaviour monitored via axial temperature profiling and infrared CO_2 concentration measurement.

Precise control of gas flow rate, pressure, and column temperature allows detailed study of dynamic adsorption phenomena, including breakthrough and regeneration behaviour.

Relevant Curriculum Modules

- Transport Phenomena *(Interphase mass transfer)*
- Separation Processes *(Gas absorption and stripping)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Adsorption Equilibrium Isotherms *(e.g. Langmuir, Freundlich)*
- Fixed Bed Adsorption Theory
- Breakthrough Curve Analysis
- Mass Transfer Zone (MTZ) Concept
- Axial Dispersion and Solute Movement Theory
- Energy Effects in Adsorption *(Quasi-isothermal vs non-isothermal behaviour)*
- Mass Balance Principles

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of adsorption fundamentals by explaining the distinction between adsorption and absorption, the role of surface area and equilibrium in fixed beds, and the physical meaning of temperature and concentration profiles along the column.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation

Apply & Analyse

Students apply mass balance and mass transfer concepts to experimental data, analysing adsorption and desorption breakthrough curves, temperature fronts, and the influence of flow rate, concentration, pressure, and temperature on bed performance. They determine adsorption capacity and assess the development of mass transfer zones.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative operating and regeneration strategies, justify adsorption performance using quantitative evidence, and design experimental programmes addressing bed utilisation, regeneration efficiency, and scale-up relevance for industrial adsorption processes.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph | PC | USB | HE | CO_2	Length: 1.000 Width: 0.500 Height: 0.600	

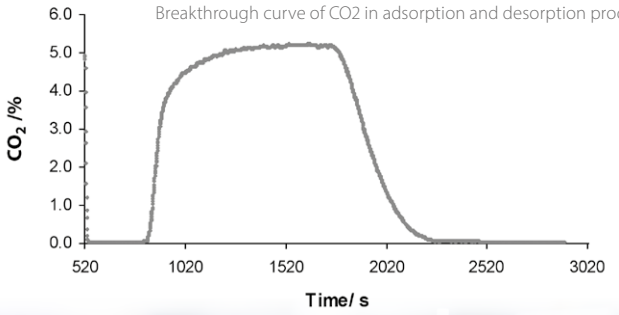
- **Electrical Supply:** Single phase (see Ordering codes)
- **Water Supply:** 5 l/min at 2 bar
- **Gases:**
  - CO_2 5 SLPM,1 bar max
  - Helium 1 SLPM,1 bar max
- **NOTE:** The equipment should be run in a ventilated room.
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software

Software

All sensors used on the unit are electronic and provide outputs for data logging and analysis. The data logger, provided with the unit, interfaces between the UOP15 unit and the user's computer using a USB port.

The associated software enables graph plotting and provides full instructions on setting up the equipment and performing the experiments.

Breakthrough curve of CO2 in adsorption and desorption processes





Technical specifications

Operation Pressure	6 Bar
Gas Flow Rates	0 < 5 SLPM (He)
	0 < 1 SLPM (CO_2)
Column Capacity	480 cm^3
Gases	CO_2, He
Relief valve pressure	20 psi
Column operating temperature	25 - 45°C

Ordering codes

- **UOP15-A:** 220-240V / 1ph / 50Hz, 10A
- **UOP15I-B:** 120V / 1ph / 60Hz, 15A
- **UOP15-G:** 220V / 1ph / 60Hz, 10A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Anaerobic Digester W8



The Armfield W8 Anaerobic Digester is a laboratory-scale biological reactor system designed to teach the principles of anaerobic biochemical reaction engineering and wastewater treatment.

The unit comprises two temperature-controlled, upward-flow packed bed reactors that may be operated in series or parallel, enabling demonstration of the multistage nature of anaerobic digestion, including acidogenesis and methanogenesis.

Continuous operation with controlled hydraulic loading, temperature, and feed composition allows detailed study of biokinetics, mass balances, process stability, and biogas production under steady-state and dynamic conditions.

Relevant Curriculum Modules

- Chemical Reaction Engineering
- Biological Chemical Reaction Engineering *(bioprocess and anaerobic kinetics)*
- Transport Phenomena *(reaction–diffusion and residence time effects)*
- Separation Processes (biogas generation and phase separation)
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Environmental & Water Engineering

Relevant Theories and Laws

- **Anaerobic Digestion Reaction Pathways** *(hydrolysis, acidogenesis, methanogenesis)*
- **Biological Reaction Kinetics** ***(substrate utilisation and microbial growth)***
- **Steady-State and Dynamic Reactor Behaviour**
- **Hydraulic Retention Time (HRT) and Organic Loading Rate (OLR)**
- **Carbon and COD Mass Balance Principles**
- **Temperature and pH Effects on Biochemical Reaction Rates**
- **Series and Parallel Reactor Behaviour**
- **Scale-up Principles for Biological Reactors**

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of anaerobic digestion fundamentals by explaining the stages of biological conversion, the role of temperature, pH, and residence time, and the relationship between substrate removal, COD reduction, and biogas production. They interpret basic measurements of flow, temperature, pH, gas volume, and composition in relation to process performance.

- **IChemE outcomes:** Knowledge and understanding of core chemical and biochemical engineering principles; awareness of laboratory practice, safety, and biological hazards.

Apply & Analyse

Students apply mass balance and reaction engineering principles to experimental data, analysing the effects of hydraulic loading, temperature, feed strength, and pH on reactor stability, COD removal efficiency, and methane yield. They distinguish between acidogenic and methanogenic behaviour and assess steady-state versus transient process response.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative operating strategies and reactor configurations, justify performance using quantitative biochemical and environmental criteria, and design experimental programmes addressing optimisation, process stability, and scale-up relevance for industrial anaerobic digestion and wastewater treatment systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph PC USB	Length: Width: Height:	1.000 0.500 0.760	
u **Electrical Supply:** Single phase (see Ordering codes)			



Includes PID control

Technical specifications

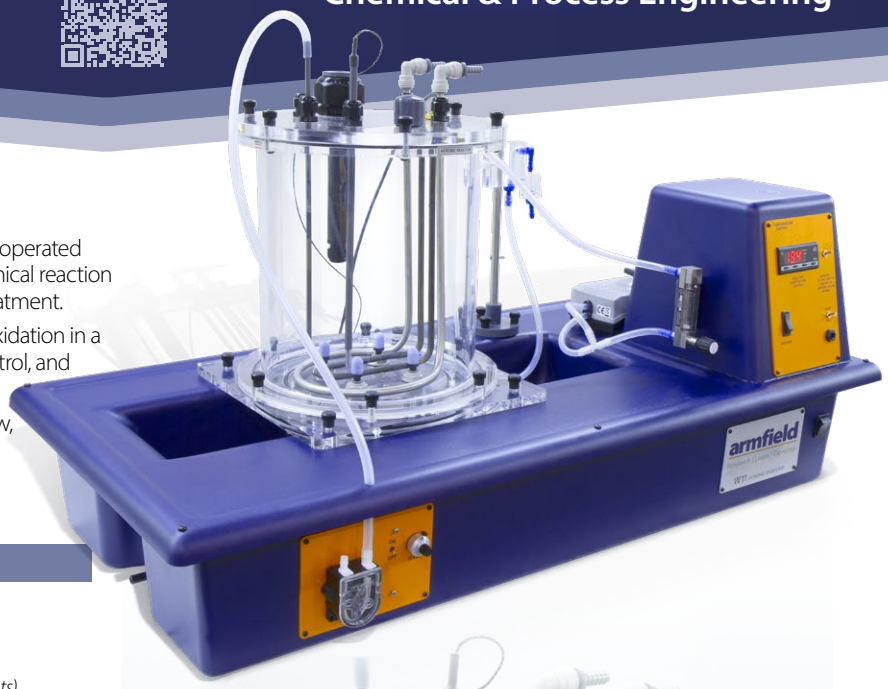
Reactor Vessel	2 x 5L (4.3L Packed sestion)
Reactor Packing	25mm diameter Bio-balls
Gas Collecting Vessel	2 x 5L
Heat Jacket	2
Temperature Sensor	2
Relief valve pressure	20 psi
Pumps (peristaltic pumps)	2 x 0-40mL, 4.0, 3.2 and 1.6mm tubes

Ordering codes

- **W8-A:** 220-240V / 1ph / 50Hz, 10A
- **W8-B:** 120V / 1ph / 60Hz, 15A
- **W8-G:** 220V / 1ph / 60Hz, 10A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Aerobic Digester W11



The Armfield W11 Aerobic Digester is a laboratory-scale, continuously operated biological reactor designed to teach the principles of aerobic biochemical reaction engineering and the activated sludge process used in wastewater treatment.

The unit enables controlled study of biomass growth and substrate oxidation in a completely mixed reactor, with continuous aeration, temperature control, and regulated hydraulic loading.

Integrated measurement of dissolved oxygen, pH, temperature, airflow, and biomass concentration allows detailed investigation of process performance, stability, and purification efficiency under steady-state and dynamic operating conditions.

Relevant Curriculum Modules

- Chemical Reaction Engineering
- Biological Chemical Reaction Engineering *(aerobic bioprocess kinetics)*
- Transport Phenomena *(gas–liquid mass transfer and mixing)*
- Separation Processes *(biomass retention and effluent clarification concepts)*
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Environmental & Water Engineering

Relevant Theories and Laws

- Activated Sludge Process Theory
- Biological Reaction Kinetics *(substrate utilisation and microbial growth)*
- Oxygen Transfer and Gas–Liquid Mass Transfer
- Hydraulic Retention Time (HRT) and Organic Loading Rate (OLR)
- COD and BOD Mass Balance Principles
- Completely Mixed Reactor Behaviour *(CSTR analogy)*
- Steady-State and Dynamic Process Response
- Scale-up Principles for Aerobic Treatment Systems

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of aerobic digestion fundamentals by explaining microbial oxidation of organic matter, the role of aeration and dissolved oxygen, and the significance of retention time and temperature in biological treatment. They interpret basic measurements of pH, DO, temperature, airflow, and COD/BOD in relation to reactor performance.

- **IChemE outcomes:** Knowledge and understanding of core chemical and biochemical engineering principles; awareness of laboratory practice, safety, and biological hazards.

Apply & Analyse

Students apply mass balance and reaction engineering principles to experimental data, analysing the effects of organic loading, hydraulic retention time, aeration rate, temperature, and biomass concentration on COD and BOD removal efficiency. They assess steady-state versus transient behaviour and quantify process stability and performance.

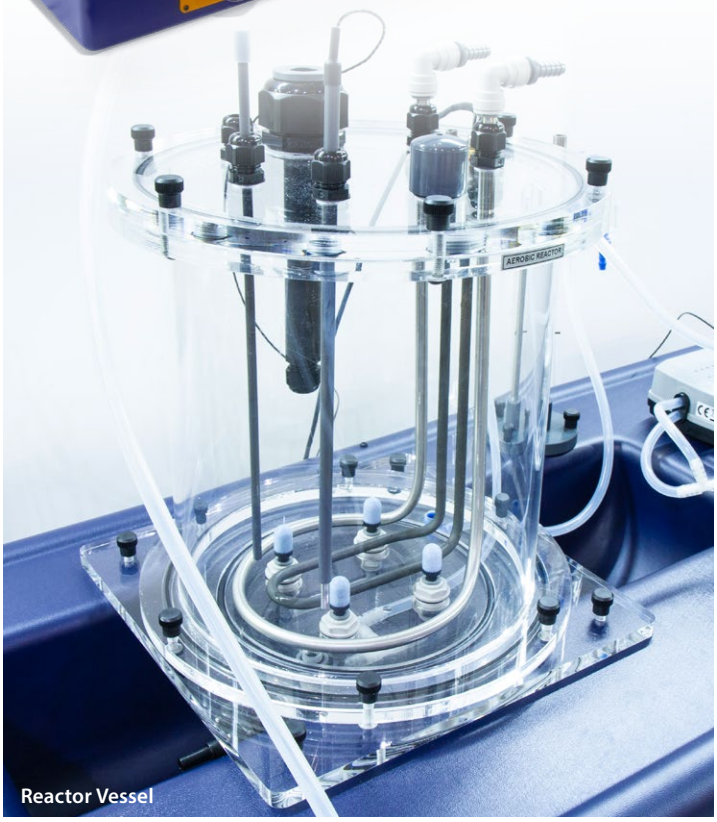
- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative operating strategies and reactor conditions, justify performance using quantitative biochemical and environmental criteria, and design experimental programmes addressing optimisation, scale-up relevance, and comparison with anaerobic or alternative biological treatment processes.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph PC USB	Length:	1.000	
	Width:	0.500	
	Height:	0.500	
u **Electrical Supply:** Single phase (see Ordering codes)			


Reactor Vessel

Technical specifications

Feed Pump	24V DC, peristaltic, 0-30rpm corresponding to 0-40 L/day
Air Compressor	120V/240V, 0-3.0 L/min (STP)
Reactor Vessel	10L maximum capacity
pH Meter Range	0.00 to 14.00
Do Meter Range	0-100% saturation, resolution: 2%
Reactor Heater	Toughened glass, electrical immersion 200W
Temperature Controller	3-term PID (temperature limit set at 35°C)

Optional accessories

- **CW17:** Chilled Water Circulating Unit

Ordering codes

- **W11-A:** 220-240V / 1ph / 50Hz, 10A
- **W11-B:** 120V / 1ph / 60Hz, 15A
- **W11-G:** 220V / 1ph / 60Hz, 10A
- **CW17:** (Optional)

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Computer Controlled Water Cooling Tower UOP6-MKII

The Armfield UOP6-MKII Computer-Controlled Water Cooling Tower is a laboratory-scale evaporative cooling system designed to teach the principles of simultaneous heat and mass transfer between air and water in direct contact.

The unit represents a forced-draught industrial cooling tower, allowing controlled investigation of evaporative cooling, humidity effects, and packing characteristics.

Computer control and real-time data acquisition enable precise manipulation of air flow rate, water flow rate, inlet water temperature, and thermal load, with direct measurement of temperatures, relative humidity, evaporation losses, and energy transfer under steady-state and dynamic conditions.

Relevant Curriculum Modules

- Transport Phenomena (heat and mass transfer)
- Separation Processes (evaporative cooling and phase change)
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Energy & Thermal Systems
- Environmental & Water Engineering

Relevant Theories and Laws

- Heat and Mass Transfer in Direct-Contact Equipment
- Psychrometric Relationships *(humidity, wet-bulb and dry-bulb concepts)*
- Evaporative Cooling Theory
- Energy and Mass Balance Principles
- Counter-Current Flow Behaviour
- Packing Characteristics and Interfacial Area Effects
- Cooling Tower Performance Parameters (range, approach, effectiveness)

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of evaporative cooling fundamentals by explaining the interaction between air and water, the role of humidity and latent heat, and the function of packing in promoting heat and mass transfer.

They interpret temperature and relative humidity measurements to describe cooling tower behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply heat and mass balance principles to experimental data, analysing the effects of air flow rate, water flow rate, inlet water temperature, packing height, and packing density on cooling performance and evaporation rate. They quantify energy transfer, water losses, and system efficiency under varying operating conditions.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative operating strategies and packing configurations, justify performance using quantitative thermal and mass-transfer criteria, and design experimental programmes addressing optimisation, scale-up relevance, and comparison with industrial cooling tower operation.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB COLD	Length: 0.850 Width: 0.630 Height: 0.990	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software
- Demineralised Water



UOP6-MKII-23 Packing Characteristics Accessory

The UOP6-MKII-23 is an optional Accessory for the UOP6-MKII Water Cooling Tower that extends the experiment from overall performance measurement to internal, stage-by-stage heat and mass-transfer analysis.

By replacing the standard tower with a four-section packed column incorporating intermediate air temperature, relative humidity, and water temperature measurements, enabling students to measure conditions within the packing

Additional educational value provided

- Direct measurement of temperature and humidity profiles through the packing height
- Construction of driving-force (enthalpy) diagrams for successive packing sections
- Determination of packing characteristic equations and comparison of spray vs packed tower operation
- Quantitative analysis of local heat and mass-transfer rates, not just overall tower effectiveness

The UOP6-MKII-23 upgrades the UOP6-MKII from a performance demonstration unit to a rigorous transport-phenomena teaching platform, suitable for higher-level analysis, design, and scale-up studies.

Ordering codes

- **UOP6-MKII-A:** 220-240V / 1ph / 50Hz, 10A
- **UOP6-MKII-B:** 120V / 1ph / 60Hz, 20A
- **UOP6-MKII-G:** 220V / 1ph / 60Hz, 10A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

3-Phase Horizontal Separator UOP30

The Armfield UOP6-MKII Computer-Controlled Water Cooling Tower is a laboratory-scale evaporative cooling system designed to teach the principles of simultaneous heat and mass transfer between air and water in direct contact.

The unit represents a forced-draught industrial cooling tower, allowing controlled investigation of evaporative cooling, humidity effects, and packing characteristics.

Computer control and real-time data acquisition enable precise manipulation of air flow rate, water flow rate, inlet water temperature, and thermal load, with direct measurement of temperatures, relative humidity, evaporation losses, and energy transfer under steady-state and dynamic conditions.

Relevant Curriculum Modules

- Transport Phenomena *(multiphase flow and momentum transfer)*
- Separation Processes *(gravity separation and coalescence)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Energy, Oil & Gas Engineering
- Environmental & Water Engineering

Relevant Theories and Laws

- Gravity Separation and Density Difference Principles
- Multiphase Flow Behaviour
- Droplet Settling Velocity *(Stokes' Law)*
- Residence Time Distribution
- Coalescence and Emulsion Theory
- Momentum Balance Principles
- Separator Design Concepts *(weir, bucket & interface control)*

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of three-phase separation fundamentals by explaining the role of density difference, residence time, droplet size, and coalescence in gravity separation. They interpret flow, level, temperature, and visual observations to describe separator operation and phase behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students Students apply mass and momentum balance concepts to experimental data, analysing the effects of flow rate, water cut, phase continuity, and separator configuration on separation efficiency and residence time. They calculate settling velocities, assess emulsion formation, and compare performance of different internal designs.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative separator configurations and operating strategies, justify design and operating decisions using quantitative performance metrics, and design experimental programmes addressing optimisation, scale-up relevance, and application to industrial oil, gas, and water separation systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB OIL COLD	Length: 1.250 Width: 0.650 Height: 2.000	

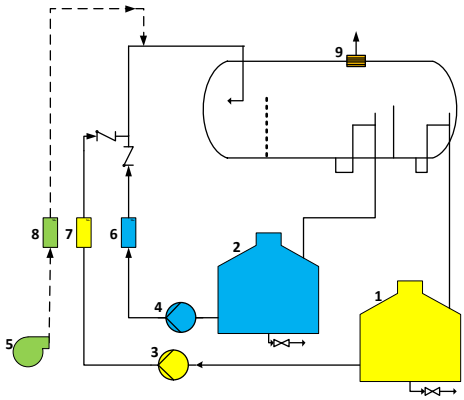
- **Electrical Supply:** Single phase (see Ordering codes)
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB
- **Oil:** Single origin oil
- **Water:** For initial fill prior to use and as required during the process



ArmBus-LCD-15.6 – Optional Touchscreen Control

The ArmBus-LCD-15.6 is an optional 15.6-inch industrial touchscreen that provides full local control, real-time visualisation, and data logging via the ArmBus system, eliminating the need for an external PC.

By making the unit fully stand-alone, it improves reliability, simplifies installation and operation, reduces dependence on IT infrastructure, and ensures consistent, repeatable use in teaching laboratories while retaining full data export capability.



1 Oil tank
2 Water tank
3 Oil pump
4 Water pump
5 Air pump
6 Water flow meter
7 Oil flow meter
8 Air flow meter
9 Mist extractor

Ordering codes

- UOP30-A
- UOP30-B
- UOP30-G
- ArmBus-LCD -15.6: Optional LCD touchscreen

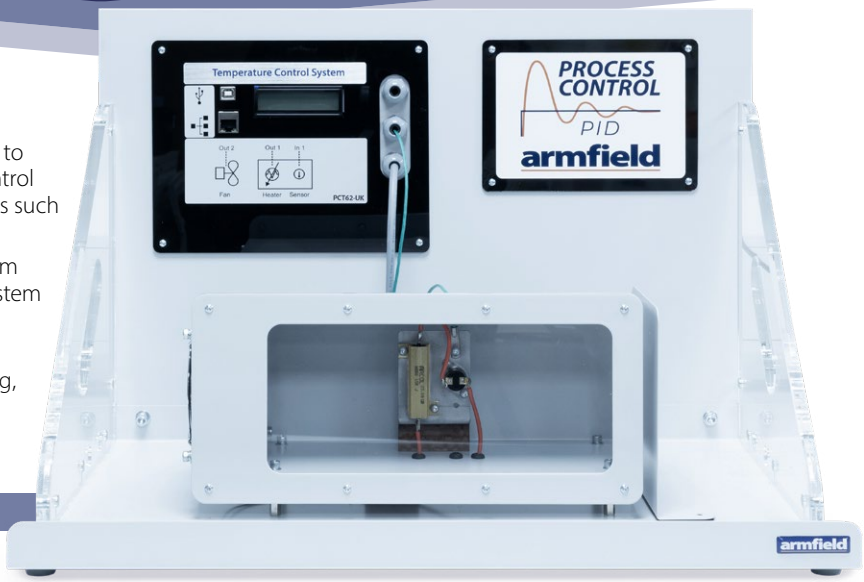
We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

University teaching & Industry Relevance

The PCT60–64 Essentials of Process Control range is highly suited to Chemical Engineering university teaching as it translates core control theory into hands-on experience with realistic industrial processes such as level, flow, temperature, pressure, and dynamic systems.

The modular, bench-scale design allows students to progress from fundamental concepts to PID tuning, disturbance rejection, and system stability in a safe and repeatable laboratory environment.

It's direct relevance to industry lies in the use of standard sensors, actuators, and control strategies found across chemical processing, water and wastewater treatment, energy, pharmaceuticals, and manufacturing, ensuring graduates develop practical control competence directly transferable to professional practice.



Relevant Curriculum Modules

- Process Control & Instrumentation
- Transport Phenomena *(dynamic systems and momentum effects)*
- Systems Dynamics and Control
- Unit Operations
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Digitalisation & Automation in Process Engineering
- Industrial Engineering Practice

Relevant Theories and Laws

- Feedback Control Theory
- Open-Loop and Closed-Loop System Behaviour
- Proportional, Integral, and Derivative (PID) Control
- Dynamic Response *(first- and higher-order systems)*
- Stability, Overshoot, and Damping
- Disturbance Rejection and Load Changes
- Sensor, Actuator, and Process Dynamics
- Control Loop Tuning Methods *(manual, Ziegler–Nichols, trial-based)*

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of fundamental process control concepts by explaining the roles of sensors, actuators, controllers, and feedback loops. They distinguish between open-loop and closed-loop control and interpret basic measurements of level, flow, temperature, pressure, or position to describe system behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, instrumentation, safety, and control system operation.

Apply & Analyse

Students apply control theory to experimental systems, analysing dynamic response to setpoint changes and disturbances. They tune P, PI, and PID controllers, evaluate system stability, overshoot, and response time, and compare the behaviour of different controlled processes across level, flow, temperature, pressure, and servo systems.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative control strategies and tuning approaches, justify controller selection using quantitative performance criteria, and design experimental programmes addressing robustness, stability, and industrial relevance. They demonstrate professional judgement in balancing control performance, safety, and operational constraints.

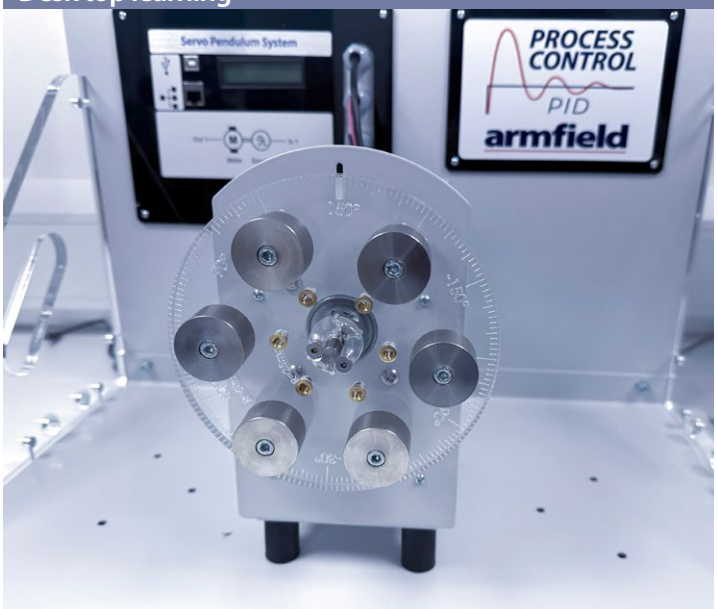
- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph PC USB COLD	Length:	0.640	
	Width:	0.450	
	Height:	0.330	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Cold water:** For initial fill prior to use and as required during the process
- **PC and Display** Recommended minimum (1920 by 1080) full HD



Desk top learning



Ordering codes

Each PCT60 unit is supplied in a regional electrical configuration.
Please specify the appropriate suffix when ordering:
PCTxx-UK: Level Process Control System (UK specification)
PCTxx-EU: Level Process Control System (EU specification)
PCTxx-USA: Level Process Control System (USA specification)

- PCT60
- PCT61
- PCT62
- PCT63
- PCT64

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Essentials of Process Control Range UOP60-64

The Armfield PCT60–64 Essentials of Process Control range is a modular suite of bench-scale trainers designed to teach the fundamentals of industrial process control through realistic level, flow, temperature, pressure, and dynamic servo systems.

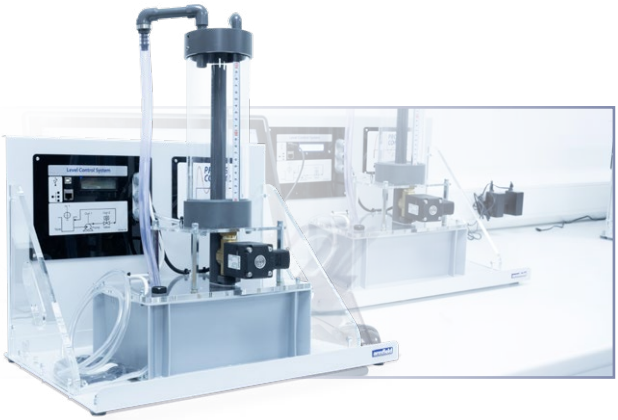
Each unit incorporates an integrated digital controller/logger with USB, Wi-Fi, Bluetooth, and LAN connectivity, together with dedicated software for manual control, on/off control, and full PID control.

The range enables students to progress from basic sensor and actuator understanding through to controller tuning, system dynamics, disturbance handling, and advanced control concepts using safe, transparent, and repeatable processes.

PCT60 – Level Control

A bench-scale level control system that introduces feedback control using a tank, pump, level sensor, and control valve. Students investigate on/off, P, PI, and PID control, system dynamics, and tuning methods through direct regulation of liquid level.

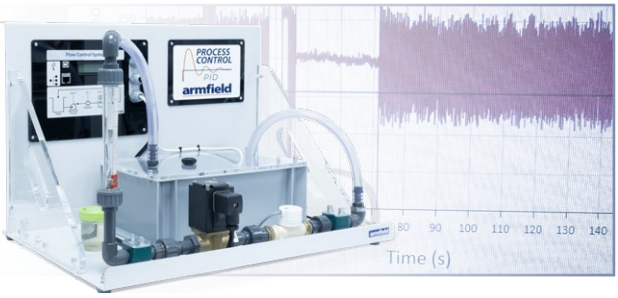
Link to PCT60



PCT61 – Flow Control

A practical flow control trainer using a variable-speed pump, proportional valve, and flow sensors to demonstrate closed-loop control of fluid flow. The unit enables study of controller tuning, disturbances, and dynamic response in a representative industrial flow process.

Link to PCT61



PCT62 – Temperature Control

A temperature control system based on a heated plate with forced-air cooling, allowing students to regulate temperature under changing thermal loads. The unit demonstrates PID control, time constants, disturbances, and energy-efficient temperature regulation.

Link to PCT62



PCT63 – Pressure Control

A pressure control trainer using a variable-speed air pump and pressure vessel to study pressure regulation and safety-critical control. Students analyse system dynamics, step changes, and PID tuning while reinforcing the importance of safe operating limits.

Link to PCT63



PCT64 – Servo Pendulum

A dynamic control system based on a servo-driven pendulum that illustrates advanced control concepts through an unstable process. The unit is ideal for demonstrating PID control, system stability, and real-world control challenges relevant to robotics and mechatronics.

Link to PCT64



armfield Academy

At Armfield, we are committed to delivering innovative solutions that drive success for all our customers!

The Armfield academy is a testament to our dedication to excellence, the state-of-the-art facility is designed to provide an immersive and interactive experience for our valued customers and agents, allowing us to showcase our products/services.

Scheduling a visit to our Customer Demonstration Suite is easy.

Simply reach out to our dedicated team at sales@armfield.co.uk to book a convenient time slot.

We look forward to hosting you.



Computer Controlled Tray Dryer UOP8-MKIIe



The Armfield UOP8-MKIIe Computer Controlled Tray Dryer is a laboratory-scale unit designed to teach the fundamentals of convective drying of solids using heated air flowing over stationary trays.

The unit enables direct investigation of drying kinetics, heat and mass transfer, and air–solid interaction by continuously measuring air temperature, humidity, velocity, and sample mass loss.

Computer control and integrated data acquisition allow detailed analysis of drying behaviour under steady-state and transient conditions representative of batch industrial drying operations.state and transient operation.

Relevant Curriculum Modules

- Transport Phenomena *(heat and mass transfer)*
- Separation Processes *(drying and dewatering operations)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Food, Pharmaceutical & Materials Engineering
- Energy & Thermal Engineering

Relevant Theories and Laws

- Convective Heat Transfer
- Mass Transfer in Gas–Solid Systems
- Drying Kinetics and Drying Curves
- Constant-Rate and Falling-Rate Drying Regimes
- Psychrometric Relationships
- Energy and Mass Balance Principles
- Moisture Diffusion and Capillary Transport

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of drying fundamentals by explaining moisture removal mechanisms, drying rate regimes, and the role of air temperature, humidity, and velocity. They interpret measurements of mass loss, air properties, and temperature profiles to describe dryer operation.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply heat and mass balance concepts to experimental data, constructing drying and drying-rate curves, identifying critical and equilibrium moisture contents, and analysing the influence of operating conditions on drying performance. They use psychrometric data to relate air property changes to moisture removal.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative drying conditions and strategies, justify operating decisions using quantitative thermal and mass-transfer evidence, and design experimental programmes addressing optimisation, energy efficiency, and scale-up relevance for industrial batch drying processes.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
PC USB	Length:	1.780	
	Width:	0.340	
	Height:	0.315	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software

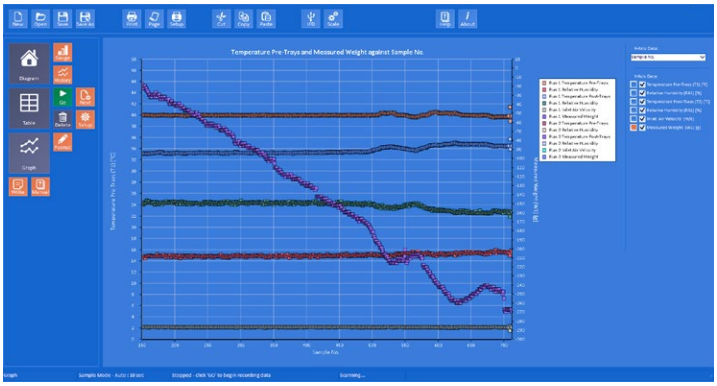
Software

The unit is supplied with a powerful educational software package, which includes a wide range of facilities and functions.

The computer is the primary interface between the user and the equipment. A mimic diagram displays the process in real-time with readings from the relevant sensor inputs and control outputs displayed numerically.

Results can be displayed graphically, or in tabular format, with full control over the displayed graphs, including scaling, axes and which variables are displayed.

Data exports seamlessly to spreadsheets and word processors.





Ordering codes

- **UOP8-MKIIe-A:** 220-240V / 1ph / 50Hz, 13A
- **UOP8-MKIIe-B:** 120V / 1ph / 60Hz, 13A
- **UOP8-MKIIe-G:** 220V / 1ph / 60Hz, 13A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Spray Dryer FT30-MKIII

The Armfield FT30-MKIII Spray Dryer is a laboratory-scale unit designed to teach the principles of simultaneous heat and mass transfer, atomisation, and phase change in spray drying operations widely used in chemical, pharmaceutical, food, and materials processing industries.

The unit demonstrates co-current contact between a fine liquid spray and a hot air stream, enabling study of droplet formation, evaporation, particle formation, and cyclone separation.

Transparent glassware and comprehensive temperature and flow control allow quantitative evaluation of drying performance under steady-state and transient conditions.



Relevant Curriculum Modules

- Transport Phenomena *(heat and mass transfer)*
- Separation Processes *(drying and particle separation)*
- Unit Operations
- Process Control & Instrumentat
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Pharmaceutical, Food & Materials Engineering
- Energy & Thermal Systems

Relevant Theories and Laws

- **Heat and Mass Transfer in Drying Processes**
- **Evaporative Drying Theory**
- **Atomisation and Droplet Size Formation**
- **Psychrometric Relationships**
- **Energy and Mass Balance Principles**
- **Particle Formation and Residence Time Effects**
- **Cyclone Separation Principles**

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of spray drying fundamentals by explaining atomisation, evaporation, and particle formation, and the role of air temperature and residence time in moisture removal. They interpret inlet and outlet temperature measurements and visual observations to describe dryer operation and product behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply heat and mass balance principles to experimental data, analysing the effects of inlet temperature, feed rate, atomisation conditions, and air flow on drying efficiency, product moisture content, and particle collection. They assess thermal efficiency, residence time effects, and cyclone separation performance.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative drying strategies and operating conditions, justify process choices using quantitative performance and product-quality criteria, and design experimental programmes addressing optimisation, scale-up relevance, and suitability for heat-sensitive materials.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph, COMP. AIR	Length:	0.500	
	Width:	0.500	
	Height:	1.200	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Compressed air:** 27 l/min @ 3 bar

Applications



- Beverages
- Flavours & Colourings
- Milk & Egg Products
- Pharmaceuticals
- Heat Sensitive Materials
- Plastics
- Polymers and Resins
- Perfumes
- Soaps & Detergents
- Dyestuffs
- Foodstuffs
- Adhesives
- Oxides
- Textiles
- Fish extracts
- Heat sensitive materials
- Plant & Vegetable Extracts
- Ceramics & Advanced Materials

Ordering codes

- **FT30-MKIII-A:** 220-240V / 1ph / 50Hz, 10A
- **FT30-MKIII-B:** 120V / 1ph / 60Hz, 15A
- **FT30-MKIII-G:** 220V / 1ph / 60Hz, 10A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Fluidised Bed Dryer FT31

The Armfield FT31 Fluidised Bed Dryer is a laboratory-scale unit designed to teach the principles of gas–solid contact, fluidisation, and drying of particulate solids.

The unit demonstrates the formation and behaviour of bubbling fluidised beds, heat and mass transfer during drying, and the influence of operating conditions on drying kinetics.

Using a heated air stream passing upward through a bed of solid particles, the FT31 enables students to investigate minimum fluidisation velocity, bed expansion, pressure drop, and moisture removal under controlled and repeatable conditions. Comprehensive instrumentation and computer-based data acquisition allow quantitative analysis of fluidisation and drying behaviour in both steady-state and transient operation.

Relevant Curriculum Modules

- Transport Phenomena *(heat and mass transfer in gas–solid systems)*
- Separation Processes *(drying and dewatering operations)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Energy Engineering
- Food, Pharmaceutical & Particulate Processing Engineering

Relevant Theories and Laws

- **Fluidisation Theory and Regimes**
- **Minimum Fluidisation Velocity *(Ergun Equation)***
- **Pressure Drop in Packed and Fluidised Beds**
- **Heat and Mass Transfer in Gas–Solid Systems**
- **Drying Kinetics and Drying Curves**
- **Critical and Equilibrium Moisture Content**
- **Residence Time and Bed Hydrodynamics**
- **Energy Balance Principles**

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of fluidised bed fundamentals by explaining the transition from fixed to fluidised beds, the role of gas velocity and particle properties, and the mechanisms of heat and mass transfer during drying. They interpret measurements of temperature, airflow, pressure drop, and visual bed behaviour to describe dryer operation.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply momentum, heat, and mass balance concepts to experimental data, analysing fluidisation curves, minimum fluidisation velocity, drying rate periods, and the effects of airflow and temperature on moisture removal. They construct drying curves, identify constant-rate and falling-rate regimes, and assess gas–solid contact efficiency.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative drying strategies and operating conditions, justify dryer performance using quantitative evidence, and design experimental programmes addressing optimisation, scale-up relevance, and comparison of fluidised bed drying with other industrial drying technologies.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph	Length:	0.260	
	Width:	0.320	
	Height:	0.465	

- **Electrical Supply:** Single phase (see Ordering codes)



Applications

- Catalysts, resins, and polymers
- Granular products
- Powders
- Particulates
- Cereals and grains
- Pigments and dyes
- Biomass
- Metal powders



Ordering codes

- **FT31-A:** 220-240V / 1ph / 50Hz, 10A
- **FT31-B:** 120V / 1ph / 60Hz, 15A
- **FT31-G:** 220V / 1ph / 60Hz, 10A

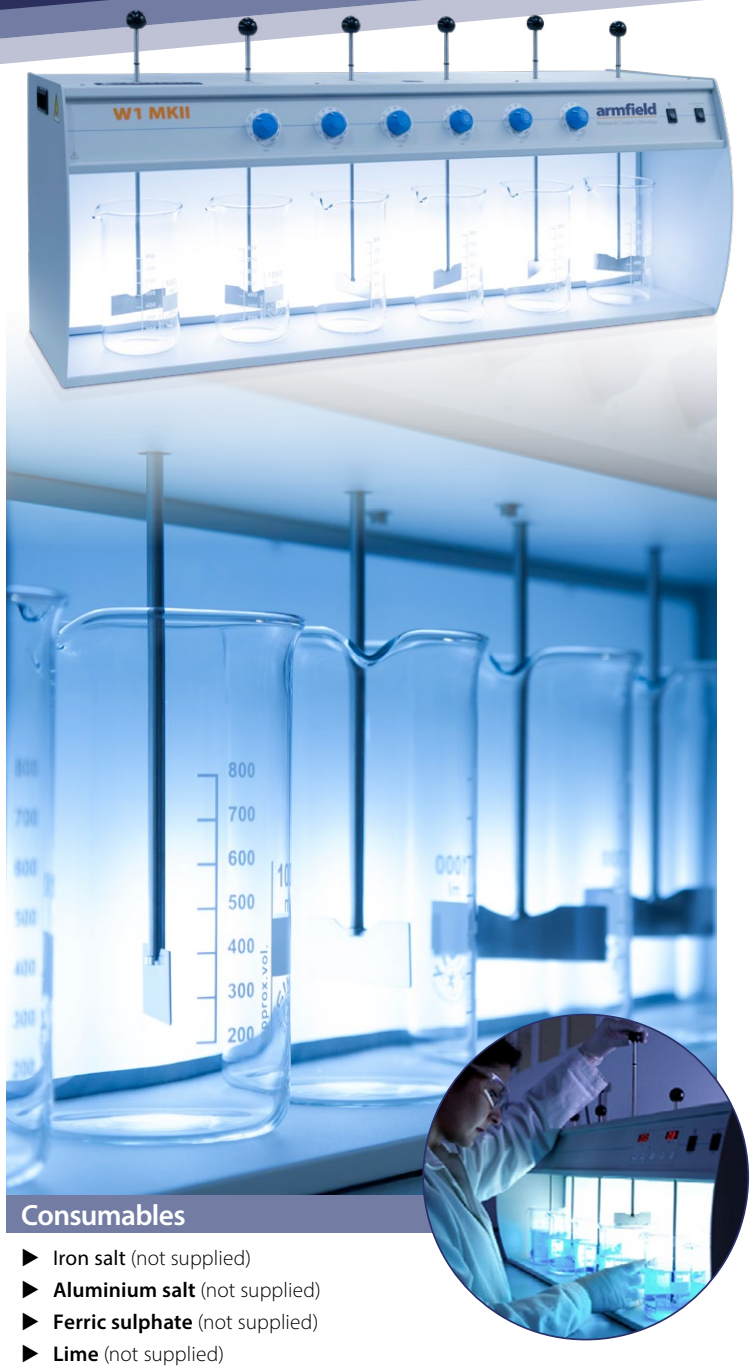
We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Flocculation Test Unit W1-MKII

The Armfield W1-MKII Flocculation Test Unit (Jar Test Apparatus) is a laboratory-scale system designed to teach the principles of coagulation, flocculation, and sedimentation in water and wastewater treatment.

The unit enables six simultaneous jar tests using independently variable-speed stirrers (0–200 rpm), allowing investigation of coagulant dosage, pH control, mixing intensity, and floc formation behaviour.

LED back illumination enhances visual assessment of floc growth and settleability, while controlled mechanical agitation supports quantitative evaluation of aggregation kinetics and supernatant clarity under representative treatment conditions.



Relevant Curriculum Modules

- Environmental & Water Engineering
- Separation Processes *(solid–liquid separation)*
- Transport Phenomena *(mixing and particle aggregation)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Sustainable Process Engineering

Relevant Theories and Laws

- Coagulation and Flocculation Theory
- Colloidal Stability and DLVO Theory *(conceptual framework)*
- Sedimentation and Gravity Settling Principles
- Mixing Intensity and Energy Input Effects
- Particle Aggregation Kinetics
- pH Influence on Metal Hydroxide Formation
- Mass Balance Principles in Water Treatment
- Reaction Stoichiometry for Iron and Aluminium Salts

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of coagulation and flocculation fundamentals by explaining the role of coagulant dosage, pH, and mixing intensity in destabilising colloidal suspensions. They interpret visual floc formation, turbidity changes, and settling behaviour in relation to particle aggregation and sedimentation mechanisms.

- IChemE outcomes: Knowledge and understanding of core chemical and environmental engineering principles; awareness of laboratory practice, chemical safety, and water-borne hazard considerations.

Apply & Analyse

Students apply mass balance and reaction principles to experimental data, analysing the effects of coagulant concentration, pH adjustment, and mixing energy on turbidity removal efficiency and sludge formation. They construct performance comparisons across parallel tests and evaluate agglomeration rate as a function of controlled agitation speed.

- IChemE outcomes: Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate optimal operating conditions for water treatment based on quantitative and qualitative performance metrics, justify dosage and mixing strategies using technical evidence, and design experimental programmes to inform preliminary full-scale treatment plant design decisions.

- IChemE outcomes: Design; ; evaluation; independent investigation; professional engineering judgement and decision-making.

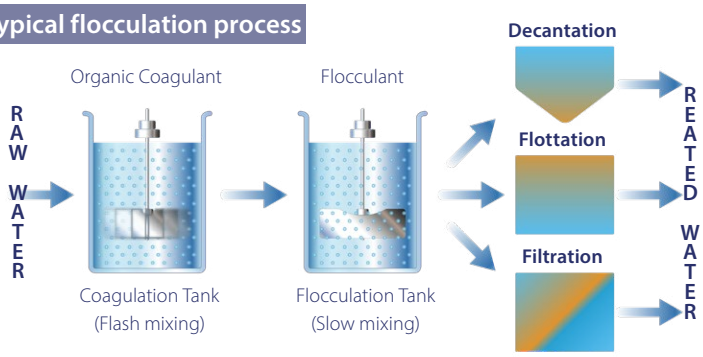
Requirements		Unit	Scale
1Ph	Length:	0.940	
	Width:	0.290	
	Height:	0.420	

- Electrical Supply:
  Supplied with a universal mains adaptor suitable for 100-240V / 1ph / 50-60Hz

Consumables

- Iron salt (not supplied)
- **Aluminium salt** (not supplied)
- **Ferric sulphate** (not supplied)
- **Lime** (not supplied)
- **Bentonite clay/Kaolin/coffee granules** (optional)

Typical flocculation process



Ordering codes

- W1-MkII
- INSTA059 (optional)
- INSTA060 (optional)

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Ion Exchange Unit

W9-MKII

The Armfield W9-MKII Ion Exchange Unit is a bench-top, computer controlled apparatus designed to demonstrate water softening and two-bed demineralisation using cation and anion exchange resins in transparent columns.

The unit enables full study of regeneration, backwashing, breakthrough behaviour, exchange capacity and regeneration efficiency, with real-time monitoring of conductivity, temperature and pH at inlet and outlet.

The system incorporates two 16 mm ID vertical resin columns, five peristaltic pumps, seven solenoid valves, dual pH probes, and dual conductivity/temperature sensors, all controlled via Armfield software for automated stage selection and data logging W9MkII ION Exchange Unit Detailed operating stages, theory and laboratory exercises (softening and demineralisation) are provided within the instruction manual.

Relevant Curriculum Modules

- Transport Phenomena *(mass transfer and multiphase flow in packed beds)*
- Separation Processes *(ion exchange and adsorption systems)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Environmental & Water Engineering
- Energy & Utilities Engineering

Relevant Theories and Laws

- Ion Exchange Equilibrium Theory
- Water Hardness Chemistry *(Ca^{2+}/Mg^{2+} exchange)*
- Stoichiometric Regeneration Theory
- Breakthrough Curve Analysis
- Mass Transfer in Packed Beds
- Bed Expansion & Fluidisation *(Backwashing)*
- Exchange Capacity (meq/g and kg $CaCO_3/m^3$ basis)
- Conductivity–Concentration Relationships
- pH Control and Acid–Base Neutralisation

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the principles of ion exchange, water softening and demineralisation, describing breakthrough, regeneration and backwashing processes. They interpret pH and conductivity trends to identify process stages and resin exhaustion.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; safe laboratory practice; understanding of separation processes.

Apply & Analyse

Students apply mass balance and stoichiometric relationships to determine exchange capacity, regeneration efficiency and hardness removal. They analyse breakthrough curves, evaluate bed performance under different flow conditions, and quantify conductivity reduction across single- and two-bed systems.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation and reporting.

Evaluate & Create

Students evaluate operational trade-offs between regeneration efficiency and column utilisation, design optimised regeneration strategies, and develop experimental programmes to compare resin types and operating configurations. They relate laboratory results to industrial water treatment and deionisation systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB COLD	Length: 0.900 Width: 0.450 Height: 0.800	

- **Electrical Supply:** Supplied with a universal mains adaptor suitable for 100-240V / 1ph / 50-60Hz
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software



Consumables

- **Deionised water** (not supplied)
- **5% sodium hydroxide** (not supplied)
- **10% hydrochloric acid**(not supplied)
- **10% sodium chloride** (not supplied)
- **Water supply:** Initial fill and drain

Software

ArmBUS software allows the operator to select the required process stage, displaying a mimic diagram with live measured variables. Pump speed can be adjusted to achieve the desired flow rate. Results are logged, viewable within the ArmBUS results viewer.

Data exports seamlessly to spreadsheets and word processors.

Technical specifications

2 x vertical columns	16mm ID
Solenoid valves	5 x Two-way valves (suitable for 10% HCl, 5% NaOH and 10% NaCl)
Pumps	4 x 0-50mL (suitable for acid and alkali)
Pump	1 x 0-75mL (suitable for acid and alkali)
PH sensors	2
Conductivity/temperature sensors & probes	2 x 0 – 2mS/cm
Regenerant bottles	2 x 1L
Waste-water container	25L
Feed & wash water containers	2 x 10L

Ordering codes

- W9-MkII

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Aeration Unit W10-MKII

The Armfield W10-MKII Aeration Unit is a laboratory-scale system designed to demonstrate gas–liquid mass transfer, specifically oxygen transfer from air into water.

The unit comprises a 27-litre transparent acrylic vessel fitted with a variable-speed digital stirrer (with torque feedback), interchangeable diffusers (single stone, treble stone, and sparger), electronic air flow measurement, and a dissolved oxygen (DO) probe with integrated temperature measurement.

Air is supplied via a pressure regulator and flow control valve, allowing controlled investigation of bubble size, mixing intensity, and hydrodynamic effects on oxygen transfer. Integrated ArmBUS data acquisition enables real-time monitoring, logging, and analysis of dissolved oxygen concentration, temperature, airflow, stirrer speed, and torque.

Relevant Curriculum Modules

- Transport Phenomena *(gas–liquid mass transfer)*
- Separation Processes *(interphase mass transfer)*
- Environmental & Water Engineering
- Biological Chemical Reaction Engineering *(aeration in bioprocesses)*
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Two-Film Theory of Mass Transfer
- Oxygen Transfer Coefficient (K_s)
- Oxygenation Capacity (R)
- Henry's Law
- Fick's Law of Diffusion
- Gas–Liquid Interfacial Area Effects
- Mixing and Turbulence Effects on Mass Transfer
- Temperature Dependence of Gas Solubility
- Unsteady-State Mass Balance

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the principles of gas–liquid mass transfer and describe how oxygen dissolves into water under equilibrium and non-equilibrium conditions. They interpret dissolved oxygen, airflow, temperature, and mixing data to describe aeration system behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; laboratory safety and equipment operation awareness.

Apply & Analyse

Students determine the overall absorption coefficient (K_s) and oxygenation capacity (R) using unsteady-state methods. They analyse the influence of mixing intensity, diffuser type, airflow rate, water depth, temperature, and fluid composition on oxygen transfer performance. Experimental data are processed to evaluate mass transfer coefficients and temperature correction factors.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

Students evaluate aeration system design variables and justify operating strategies using quantitative mass transfer analysis. They design experimental programmes investigating optimisation of oxygen transfer efficiency and assess relevance to wastewater treatment, activated sludge systems, and bioreactor aeration.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB COMP. AIR DRAIN	Length: 0.510 Width: 0.470 Height: 1.010	

- **Electrical Supply:** Supplied with a universal mains adaptor suitable for 100-240V / 1ph / 50-60Hz
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software



Consumables *(not supplied)*

- **Chemicals:** 10% solution Sodium Sulphite
  1% solution Cobalt chloride
- **Air:** Compressed airline (not supplied)
- **Water supply:** Distilled water and mains water supply for initial fill only

Technical specifications

Open tank	27 Litre
Diffusers	3 (sparger, treble stone and single stone)
Flowmeter range	0 -10L/min
Oxygen /temperature meter ranges:	
	-5 to 199% DO
	-5 to 25.0% DO
	-5 to 19.99mg/L
	-10 to 105oC
Length of oxygen probe	300mm

Ordering codes

- W10-MkII
- INSTA059 (optional)
- INSTA060 (optional)

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Crystallisation Unit UOP14-MKII

The Armfield UOP14-MKII Crystallisation Unit is a laboratory-scale system designed to demonstrate batch cooling crystallisation and, with optional accessory, continuous MSMPR crystallisation. The unit comprises a 2-litre jacketed glass crystallisation vessel with acrylic outer jacket, variable-speed agitation with pitched impeller and internal baffle, a PID-controlled hot water heating system (2 kW), regulated cold-water cooling circuit, and a conductivity probe for real-time concentration monitoring.

Supersaturation is generated through controlled temperature reduction, allowing direct investigation of nucleation, crystal growth, metastable zone width (MSZW), and crystal size distribution. Three temperature sensors monitor vessel, jacket inlet, and hot water tank temperatures to ensure precise thermal control. Cooling rate is adjusted via a needle valve and flowmeter, enabling systematic investigation of crystallisation kinetics.

Integrated Armfield data acquisition provides real-time monitoring, logging, and analysis of temperature, conductivity, agitation speed, and heating/cooling behaviour. The optional UOP14-11 Continuous Feed Accessory converts the unit to steady-state MSMPR crystallisation, enabling study of population balance behaviour and continuous operation dynamics.

Relevant Curriculum Modules

- Transport Phenomena *(heat and mass transfer)*
- Separation Processes *(crystallisation)*
- Thermodynamics *(phase equilibrium and solubility)*
- Particle & Crystallisation Engineering
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Pharmaceutical & Fine Chemical Processing

Relevant Theories and Laws

- Phase Equilibrium and Solubility Relationships
- Supersaturation and Crystallisation Driving Force
- Classical Nucleation Theory
- Crystal Growth Kinetics
- Metastable Zone Width *(MSZW)*
- Population Balance Theory *(MSMPR model)*
- Heat Transfer in Jacketed Vessels
- Batch Mass and Energy Balances
- Diffusion-Controlled Growth Mechanisms
- Agitation and Hydrodynamic Effects on Crystallisation

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the principles of cooling crystallisation and describe how supersaturation is generated through controlled temperature reduction. They interpret temperature, conductivity, agitation rate, and cooling profile data to describe nucleation and crystal growth behaviour under equilibrium and non-equilibrium conditions.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; thermodynamics and phase equilibrium; laboratory safety and equipment operation awareness.

Apply & Analyse

Students determine crystallisation driving force and perform batch mass and energy balances. They analyse the influence of cooling rate, agitation intensity, concentration, and temperature on nucleation kinetics, metastable zone width, and crystal size distribution. Experimental data are processed to evaluate crystallisation performance and crystal growth behaviour.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

Students evaluate crystalliser design variables and justify operating strategies using quantitative crystallisation kinetics and population balance concepts. They design experimental programmes investigating optimisation of crystal size distribution and assess relevance to pharmaceutical production, fine chemical manufacture, and continuous MSMPR crystallisation systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.



Software

Opening ArmSOFT Desktop software takes you to the process screen, showing real-time equipment readings, calculated variables, and controls. Navigate via bottom tabs to access data, graphs, tables, and filtering options. Results can be printed or exported. Closed-loop PID control lets the software adjust outputs, e.g., varying pump speed to maintain flow.

Data exports seamlessly to spreadsheets and word processors.

UOP14-11 Continuous Feed Accessory

The UOP14-11 converts the UOP14-MKII from batch operation to continuous MSMPR crystallisation. The accessory comprises a 20-litre acrylic feed tank with integrated PID temperature control and a variable-speed peristaltic pump (0.5–10 L/hr), enabling steady-state crystallisation studies.

This allows investigation of population balance behaviour, crystal residence time effects, and direct comparison between batch and continuous crystallisation strategies.

UOP14-12 Buchner Filtration Kit

The UOP14-12 provides vacuum-assisted solid–liquid separation for recovery of crystals following batch or continuous operation. The kit includes a Buchner funnel, filtration flask, filter media, and water-driven vacuum ejector, enabling efficient crystal isolation, washing, and preparation for particle size distribution analysis. This accessory extends the unit to include downstream separation and product recovery operations.

Requirements		UOP14-MKII	UOP14-11	UOP14-12	Scale
1Ph PC USB COLD	Length:	0.800	0.690	0.500	
	Width:	0.900	1.000	0.500	
	Height:	0.500	0.500	0.500	

- **Electrical Supply:** Single phase (see Ordering codes)
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software
- **Cold water:** 1 l/min @ 1 bar

Ordering codes

- **UOP14MkII-A:** 220-240V / 1ph / 50Hz, 13A
- **UOP14MkII-B:** 120V / 1ph / 60Hz, 20A
- **UOP14MkII-G:** 220V / 1ph / 60Hz, 13A
- **UOP14-11** Continuous Feed Accessory
- **UOP14-12** Buchner Filtration Accessory

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Chemical Reactors Teaching Equipment CEXC



The Armfield CEXC Computer Controlled Chemical Reactors Teaching Equipment is a modular service unit designed to support and control a range of interchangeable laboratory-scale reactors, enabling comprehensive study of fundamental reactor types.

The system facilitates experimentation with Continuous Stirred Tank Reactors (CSTR), tubular (plug and laminar flow) reactors, and batch reactors, providing students with direct comparison of steady-state and dynamic reactor behaviour.

The CEXC provides integrated services including dual variable-speed peristaltic feed pumps (0–110 ml/min), a hot water circulator with PID temperature control, optional chilled water operation, conductivity measurement for conversion monitoring, and temperature sensing.

All functions are computer-controlled via USB interface with real-time data acquisition, graphical display, and automated logging, enabling quantitative kinetic and residence-time analysis.

Relevant Curriculum Modules

- Chemical Reaction Engineering
- Transport Phenomena *(mass, momentum & energy transfer in reactors)*
- Process Dynamics & Control
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Industrial Reactor Design & Scale-Up

Relevant Theories and Laws

- Mole and Energy Balance Equations
- Rate Laws and Reaction Order Determination
- Continuous Stirred Tank Reactor (CSTR) Design Equation
- Plug Flow Reactor (PFR) Design Equation
- Batch Reactor Kinetics
- Residence Time Distribution (RTD)
- Conversion and Selectivity Analysis
- Arrhenius Equation
- Heat Transfer in Jacketed Reactors
- PID Control Theory

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the operational principles of batch, Continuous Stirred Tank (CSTR), Plug Flow (PFR), and laminar flow tubular reactors, describing differences in mixing, residence time distribution, velocity profile, and conversion behaviour. They interpret temperature and conductivity data to relate measured variables to reaction progress and reactor hydrodynamics.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; laboratory safety and equipment operation awareness.

Apply & Analyse

Students apply mole balance and kinetic models to determine reaction order, rate constants, and conversion in CSTR, plug flow, and laminar flow reactors under steady-state and transient conditions. They analyse the influence of residence time, axial position, temperature, and flow regime on conversion and compare ideal plug flow behaviour with laminar and mixed-flow systems.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

Students evaluate reactor selection by quantitatively comparing CSTR, PFR, and laminar flow reactor performance, assessing scale-up implications, axial dispersion effects, and temperature control strategies. They design experimental programmes to investigate optimisation of conversion and selectivity across different reactor geometries and flow regimes.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph PC USB COLD	Length: 1.000 Width: 0.500 Height: 0.500	

u **Electrical Supply:** Single phase (see Ordering codes)
u **PC and Display** Recommended minimum (1920 by 1080) full HD

Compatible Reactors and Recommended Chiller:

- **CEB-MKIII** Transparent Batch Reactor
- **CEM-MKII** Continuous Stirred Tank Reactor **(CSTR)**
- **CET-MKII** Tubular Reactor
- **CEY** Plug Flow Reactor
- **CEZ** Laminar Flow Reactor
- **CW-17** Water Chiller

The modular configuration allows each reactor to be operated independently through the comprehensive educational software with minimum maintenance and operational setup times. The CW-17 is a thermostatically controlled chilled water circulating unit which can be used for providing water at below ambient temperature. It is essential for use with the CEZ reactor and for the CEB-MKIII isothermal demonstration and can be used with the other reactors.

Essential Accessories

CEXC	CEM-MKII	CET-MKII	CEB-MKIII	CEY	CEZ
At least one reactor necessary	**CEXC**	**CEXC**	**CEXC**	**CEXC**	**CEXC**
Windows PC with 2 spare USB ports			**CW-17** (for isothermal operation)		**CW-17**

Software

The CEXC software provides integrated control, real-time data acquisition, and graphical visualisation of reactor temperature, flow rate, and conductivity for all connected reactor modules. It enables automated logging of steady-state and dynamic experiments, supporting kinetic analysis and residence time studies. Built-in graphing tools allow immediate comparison of conversion versus time or temperature, with direct export to Excel for further processing and reporting. The software also supports safe, repeatable experiment setup, reinforcing good laboratory and process control practice.

Ordering codes

- **CEXC-A:** 220-240V / 1ph / 50Hz, 10 amp
- **CEXC-B:** 120V / 1ph / 60Hz, 10 amp
- **CEXC-G:** 220-240V / 1ph / 60Hz, 10 amp

- **CW-17-A:** 220-240V / 1ph / 50Hz, 13 amp
  CW-17-G:* 220-240V / 1ph / 60Hz, 13 amp

***CW-17-G** version has optional 3kVA transformer available to accommodate 120V / 1ph / 60Hz supply. If you require this option please specify at time of order.

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Accessory Options CEXC

To extend the capability and teaching flexibility of the CEXC service unit, a range of dedicated accessories is available.

CEB-MKIII – Transparent Batch Reactor

The CEB-MKIII is a 1-litre double-skinned glass batch reactor designed for isothermal and adiabatic reaction studies. The vessel includes a variable-speed agitator and external jacket for temperature control via the CEXC hot water supply (or optional chilled water).

Conductivity and temperature probes allow monitoring of reaction progress, enabling kinetic determination under controlled mixing and thermal conditions.

Link to CEB-MKIII

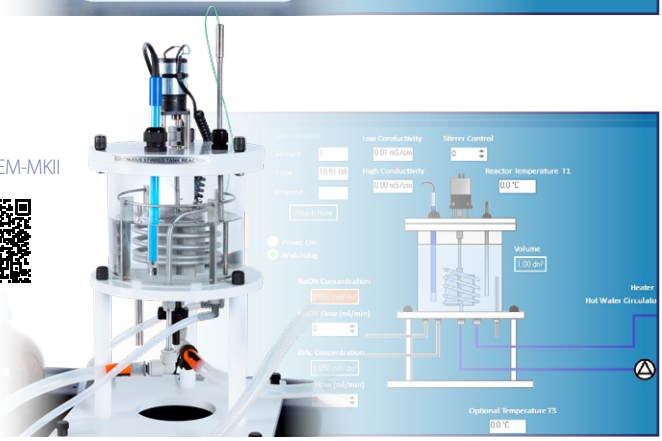


CEM-MKII – Continuous Stirred Tank Reactor (CSTR)

The CEM-MKII is a laboratory-scale CSTR with adjustable working volume (0.4–1.5 L) allowing investigation of residence time and holdup effects. It incorporates a variable-speed turbine agitator, internal baffles for enhanced mixing, and a stainless steel heat transfer coil for temperature control.

The reactor supports steady-state and dynamic studies including RTD determination and kinetic modelling .

Link to CEM-MKII

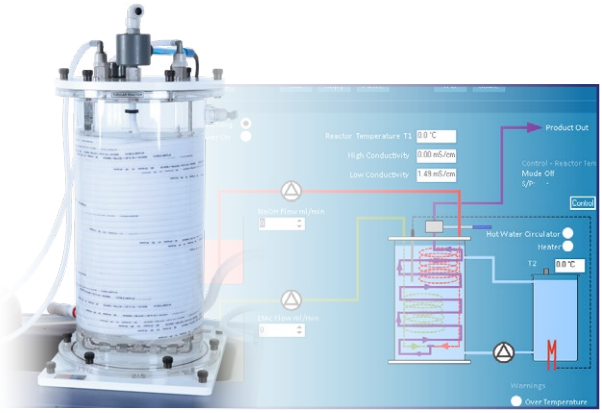


CET-MKII – Tubular Reactor

The CET-MKII is a 20-metre coiled tubular reactor (0.4 L volume) mounted within a temperature-controlled water bath.

Reactants are preheated in stainless steel coils before mixing and entering the reactor, allowing investigation of temperature-dependent kinetics, residence time distribution, and flow-through conversion in a non-mixed tubular system.

Link to CET-MKII

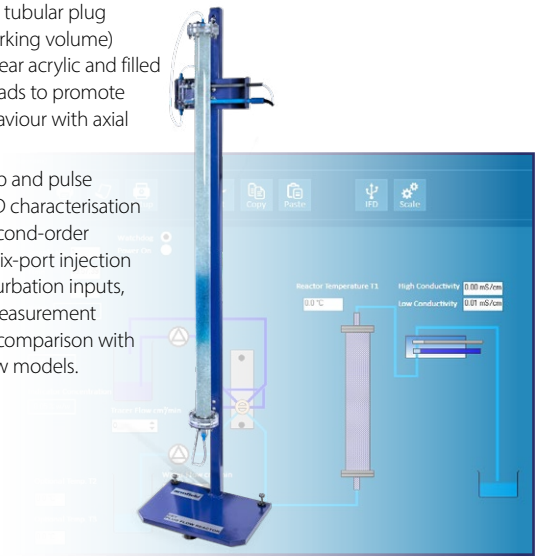


CEY – Plug Flow Reactor

The CEY is a packed tubular plug flow reactor (1 L working volume) constructed from clear acrylic and filled with 3 mm glass beads to promote near plug-flow behaviour with axial dispersion.

It enables tracer step and pulse experiments for RTD characterisation and steady-state second-order reaction studies. A six-port injection valve provides perturbation inputs, and conductivity measurement allows quantitative comparison with theoretical plug flow models.

Link to CEY

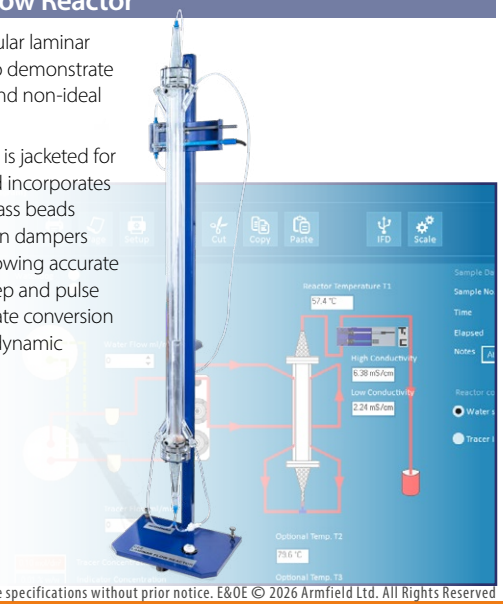


CEZ – Laminar Flow Reactor

The CEZ is a 400 ml tubular laminar flow reactor designed to demonstrate velocity profile effects and non-ideal flow behaviour.

The clear acrylic column is jacketed for temperature control and incorporates diffusers packed with glass beads to stabilise flow. Pulsation dampers ensure smooth feed, allowing accurate study of laminar RTD, step and pulse response, and steady-state conversion under controlled hydrodynamic conditions.

Link to CEZ



We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Catalytic Reactor Unit CEU

The Armfield CEU Catalytic Reactor Unit is a laboratory-scale system designed to teach the fundamentals of chemical and biochemical reaction engineering using packed bed reactors.

The unit demonstrates heterogeneous catalytic reactions through the inversion of sucrose to glucose and fructose using immobilised catalysts, with optional comparison between chemical and enzymic catalysis.

Precise control of flow rate and reactor temperature, combined with optical concentration measurement and optional flow injection analysis (FIA), enables detailed study of steady-state and dynamic reactor behaviour, kinetics, and transport effects in packed beds.



Relevant Curriculum Modules

- Chemical Reaction Engineering
- Biological Chemical Reaction Engineering (enzymatic & immobilised biocatalysis)
- Transport Phenomena (Reaction–diffusion interactions)
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Packed Bed Reactor Design Equations
- Reaction Kinetics *(Zero-, First-, and Pseudo-First-Order)*
- Steady-State and Unsteady-State Reactor Behaviour
- Thiele Modulus and Effectiveness Factor
- Reaction–Diffusion Limitations
- Residence Time Distribution (RTD)
- Mass Balance Principles

Learning Outcomes & Bloom Alignment

Remember & Understand

Students demonstrate understanding of catalytic reactor fundamentals by explaining heterogeneous catalysis, packed bed operation, reaction kinetics, and the role of temperature and residence time in determining conversion. They interpret concentration and temperature measurements in relation to reactor performance.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation

Apply & Analyse

Students apply mass balance and kinetic theory to experimental data, analysing the effects of flow rate, temperature, catalyst particle size, and feed concentration on conversion and reactor performance. They distinguish between reaction-controlled and diffusion-limited regimes and assess steady-state versus transient behaviour.

- **IChemE outcomes:** Analysis; investigation; experimental design; data interpretation and technical reporting.

Evaluate & Create

Students evaluate alternative catalytic and reactor configurations, justify operating conditions using quantitative and kinetic evidence, and design experimental programmes addressing optimisation, scale-up relevance, and comparison of chemical versus biological catalysis.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements	Unit	Scale
1Ph | PC | USB	Length: 1.000 Width: 0.500 Height: 0.600	

u **Electrical Supply:** Single phase (see Ordering codes)
u **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software

Software

Educational software and data logging are supplied as standard. Sensor outputs can be logged and analysed via the armSOFT data logger, which connects to the CEU through USB. The software includes graph plotting, setup guidance, theory, and comprehensive help tools.



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

Options

- **CEU-3 Flow Injection Analysis (FIA)**
  The FIA module is a self-contained unit mounted on the CEU plinth, incorporating a multichannel pump and multi-port valve. The CEU absorbance sensor is repositioned on the module for online measurement. The system delivers product, reagent, and carrier liquid to the valve, where they are mixed in controlled ratios before passing to the optical sensor for product yield analysis.
- **CEU-5 Third Reaction Column**
  An additional reactor using the same sucrose inversion reaction with an alternative biological enzyme catalyst. This enables direct comparison between chemical and biological catalysis.
  Note: The biological reactor column requires regular recharging due to the lower stability of the catalyst.

Ordering codes

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

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Fluid Mixing Studies

CEK-MKII

The Armfield CEK-MKII Fluid Mixing Apparatus is a bench-top, variable-speed mixing system designed to demonstrate fundamental mixing and agitation principles in liquid–liquid and solid–liquid systems.

The unit comprises a clear acrylic cylindrical vessel mounted on a stainless-steel plinth, fitted with a precision digital stirrer providing variable speed control (50–2200 rpm) and integrated electronic torque measurement for direct power determination.

Interchangeable impellers include a true stainless-steel Rushton turbine, a three-bladed propeller, and adjustable flat-blade paddles with selectable blade angles. Removable baffles (two- or four-baffle configurations) enable investigation of vortex formation and improved mixing performance. Armsoft software logs rotational speed and torque, calculates power consumption, and displays real-time graphical data for quantitative analysis.

Relevant Curriculum Modules

- Transport Phenomena *(momentum transfer and turbulent flow)*
- Unit Operations (mixing and agitation)
- Process Engineering Fundamentals
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Scale-Up & Dimensional Analysis
- Environmental & Bioprocess Engineering

Relevant Theories and Laws

- Reynolds Number in Agitated Systems
- Froude Number (vortex and surface effects)
- Power Number Correlations
- Dimensional Analysis & Similarity *(Geometric, Kinematic & Dynamic Similarity)*
- Laminar vs Turbulent Flow Regimes in Mixing
- Torque–Power Relationship ($P=T\omega$)
- Shear Rate and Suspension Dynamics
- Viscosity–Temperature Relationships

Learning Outcomes & Bloom Alignment

Remember & Understand

Students describe flow patterns generated by flat-blade paddles, Rushton turbines, and propellers, and explain the influence of baffles on vortex formation and mixing efficiency. They interpret speed and torque readings to relate mechanical input to fluid motion.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; laboratory safety and equipment awareness.

Apply & Analyse

Students calculate mixing power from measured torque and rotational speed, construct power–speed curves, and analyse the effect of impeller type, blade angle, liquid viscosity, and baffle configuration on mixing performance. They apply dimensional analysis and Reynolds number correlations to interpret laminar and turbulent behaviour.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

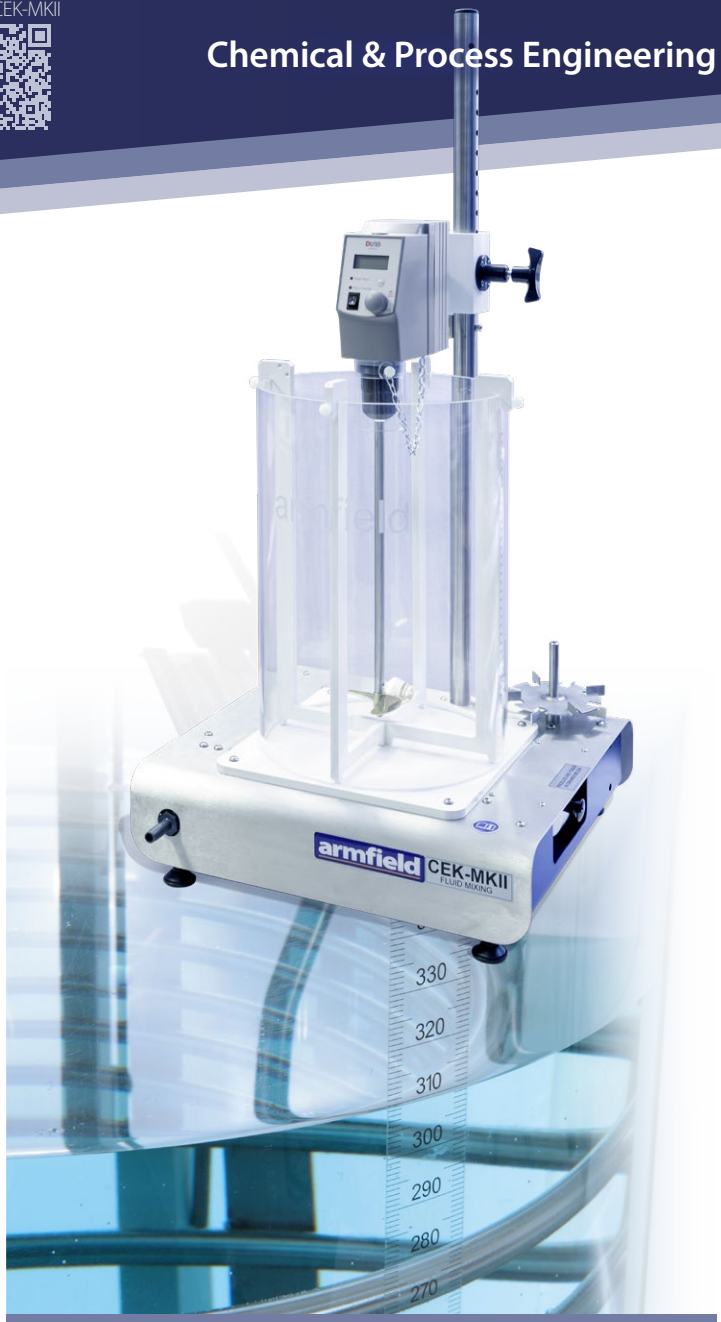
Evaluate & Create

Students evaluate impeller selection and operating conditions for suspension, dispersion, and scale-up applications. They design experimental programmes to investigate geometric similarity, predict full-scale mixer power using dimensionless correlations, and justify mixing strategies for industrial processes including solids suspension and liquid blending.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph PC USB	Length:	0.500	
	Width:	0.400	
	Height:	1.000	

- **Electrical Supply:** Supplied with a universal mains adaptor suitable for 100-240V / 1ph / 50-60Hz
- **Computer:** Requires a Windows PC (Windows 7 or later) with USB for data logging software



CEK-MKII-3 Heat Transfer Coil (Option)

The optional CEK-MKII-3 Heat Transfer Coil extends the capability of the CEK-MKII by enabling controlled variation of liquid temperature within the mixing vessel, allowing direct investigation of viscosity–temperature effects on mixing performance.

The accessory comprises a removable stainless-steel coil mounted inside the vessel (within the baffle assembly), a thermocouple positioned in the stirred liquid, and a dedicated handheld temperature display.

Hot or chilled water from an external laboratory supply (user provided) is circulated through the coil, enabling the liquid temperature to be increased or decreased in a controlled manner.

- This facilitates quantitative studies of:
- The influence of temperature on fluid viscosity and resulting changes in Reynolds number
- Variation in torque demand and power consumption with viscosity
- Transition between laminar and turbulent mixing regimes
- Changes in vortex formation, circulation patterns, and suspension behaviour

The option therefore supports advanced investigations into non-isothermal mixing, rheological effects, and scale-up considerations where temperature-dependent physical properties significantly influence agitator performance.

Consumables:

- **20lt** vegetable oil

Ordering codes

- **CEK-MkII-EU** with Shuko-style mains lead
- **CEK-MkII-UK** with UK-style mains lead
- **CEK-MkII-B** with 115V US NEMA 5-15 style mains lead

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Fluid Mixing Studies

CEL-MKII

The Armfield CEL-MKII Fixed and Fluidised Bed Apparatus is a bench-top laboratory system designed to demonstrate the hydrodynamics of fluid flow through packed and fluidised beds of granular solids. The unit comprises three transparent 50 mm diameter columns mounted above a recirculating water reservoir: one water column and two air columns, allowing direct comparison between liquid–solid and gas–solid systems.

Water flow is provided by a variable-speed submersible pump with electronic flow measurement (0–2.5 L/min), while air flow is supplied via regulated compressed air and measured using orifice pressure sensors with microcontroller-based flow calculation.

Differential pressure sensors measure pressure drop across each bed (0–50 mbar range), enabling quantitative analysis of fixed-bed behaviour, onset of fluidisation, and bed expansion. Two particle sizes (0.50–0.75 mm and 0.20–0.30 mm glass beads) are supplied to facilitate comparison of particle diameter effects.

Integrated instrumentation with USB data acquisition supports real-time monitoring, data logging, and graphical analysis, enabling rigorous comparison between theoretical predictions and experimental behaviour.



Relevant Curriculum Modules

- Transport Phenomena (momentum transfer in porous media)
- Multiphase Flow & Fluidisation
- Separation Processes (packed beds, backwashing, ion exchange)
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Energy & Environmental Engineering
- Powder & Particulate Technology

Relevant Theories and Laws

- Ergun Equation
- Carman–Kozeny Equation
- Darcy's Law
- Minimum Fluidisation Velocity (Umf)
- Archimedes Number & Reynolds Number in Packed Beds
- Pressure Drop–Velocity Relationships
- Bed Voidage *(Porosity)*
- Two-Phase Flow Hydrodynamics
- Particulate vs Aggregative (Bubbling) Fluidisation
- Momentum Balance in Porous Media

Learning Outcomes & Bloom Alignment

Remember & Understand

Students describe the characteristics of flow through fixed and fluidised beds, explaining pressure drop behaviour, bed voidage, and the physical meaning of minimum fluidisation velocity. They distinguish between liquid–solid and gas–solid systems and interpret flow and pressure measurements in relation to bed behaviour.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory practice, safety, and equipment operation.

Apply & Analyse

Students apply momentum balance and packed-bed correlations (e.g., Carman–Kozeny and Ergun equations) to determine pressure drop and predict minimum fluidisation velocity. They analyse the influence of particle size, fluid density, and viscosity on fluidisation behaviour and compare theoretical predictions with experimental data.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

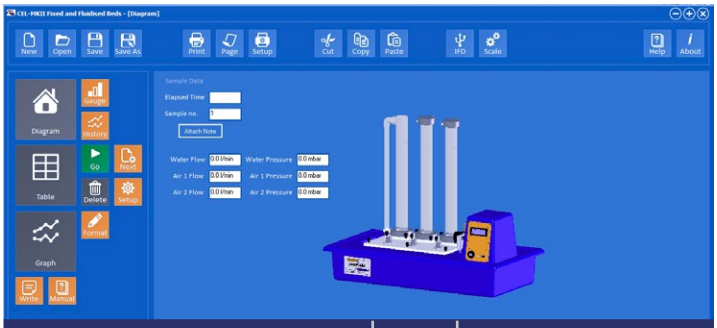
Evaluate & Create

Students evaluate design and operational factors influencing industrial packed and fluidised bed systems, including reactor beds, ion exchange columns, drying systems, and solids processing equipment. They design experimental programmes to investigate scale-up implications and optimise operating conditions for industrial fluid–solid systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Software

The CEL-MKII software provides real-time data acquisition, display, and logging of pressure drop, flow rate, and temperature within the fixed and fluidised bed column. Built-in graphical tools allow students to visualise fluidisation behaviour, pressure–velocity relationships, and bed expansion during experiments. Data can be exported directly to Excel for further analysis, enabling evaluation of minimum fluidisation velocity and packed-bed characteristics.



Requirements	Unit	Scale
1Ph · PC · USB · COMP. AIR	Length: 1.000 Width: 0.500 Height: 0.500	

- **Electrical Supply:** Single phase (see Ordering codes)
- **PC and Display:** Recommended minimum (1920 by 1080) full HD
- **Compressed Air:** 50 l/min at 2 bar minimum (8 bar max)
  (Air inlet connection for 6mm rigid plastic pneumatic tube supplied)
  Note: Armfield can provide a suitable portable air compressor

Ordering codes

- **CEL-MKII**
  - CEL-MKII-EU with Schuko mains lead
  - CEL-MKII-UK with UK mains lead
  - CEL-MKII-B with USA 115V mains lead
- **AC1**
  - AC1-A 220-240V / 1ph / 50Hz
  - AC1-B 120V / 1ph / 60Hz
  - AC1-G 220-240V / 1ph / 60Hz

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Stirred Tank Reactors in Series

CEP-MKII



The Armfield CEP-MKII Stirred Tank Reactors in Series is a self-contained, bench-mounted teaching unit designed to investigate the dynamic behaviour of perfectly mixed continuous stirred tank reactors (CSTRs) connected in series. The system enables detailed study of multistage mixing, residence time effects, transient response to step and impulse inputs, and second-order reaction kinetics in continuous flow systems.

The unit comprises three glass reactor vessels mounted in series on a common plinth, each fitted with a variable-speed propeller agitator to ensure controlled and repeatable mixing conditions. Two 5-litre reagent vessels supply the system via independent variable-speed peristaltic feed pumps (nominal range 0–95 ml/min), allowing precise control of flowrate and residence time.

Each reactor is fitted with an individual conductivity probe for real-time monitoring of concentration and conversion, with a fourth probe located at the exit of an adjustable "dead time" coil. Conductivity is displayed digitally and may be logged simultaneously via the optional USB data acquisition interface. The inclusion of the dead time module allows direct investigation of transport lag and time constant effects in continuous systems.

The apparatus supports both non-reactive mixing studies (e.g. KCl tracer experiments) and reactive studies such as the saponification of ethyl acetate with sodium hydroxide, enabling determination of second-order kinetics and steady-state conversion behaviour in multistage reactor configurations.

Relevant Curriculum Modules

- Chemical Reaction Engineering
- Transport Phenomena *(mass transfer and mixing dynamics)*
- Process Dynamics & Control
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Multistage Reactor Design & Scale-Up

Relevant Theories and Laws

- **Continuous Stirred Tank Reactor (CSTR) Design Equation**
- **Multistage Reactor Analysis**
- **First-Order System Dynamics**
- **Time Constant and Transport Lag (Dead Time)**
- **Residence Time Distribution (RTD)**
- **Step and Impulse Response Functions**
- **Second-Order Reaction Kinetics**
- **Mole Balance for Open Systems**
- **Conversion and Selectivity Relationships**
- **Conductivity–Concentration Correlation**
- **Process Control and Transient Analysis**

Learning Outcomes & Bloom Alignment

Remember & Understand

Students describe the operational principles of continuous stirred tank reactors and explain the effect of connecting CSTRs in series. They interpret step and impulse response curves in terms of time constant, mixing behaviour, and residence time.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; safe laboratory operation; awareness of process dynamics.

Apply & Analyse

Students apply mole balance equations to continuous stirred systems to determine conversion, reaction rate, and residence time. They analyse the influence of flowrate, agitation speed, and reactor staging on transient and steady-state behaviour. Students quantify time constants experimentally and compare theoretical first-order predictions with measured conductivity data.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

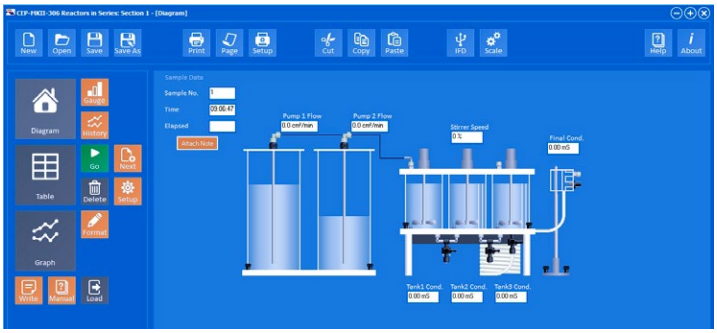
Students evaluate reactor performance in multistage configurations and design experimental investigations to optimise conversion and dynamic response. They assess the impact of dead time and transport lag on process stability and scale-up, integrating kinetic modelling with experimental validation.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Software

The system uses Armfield data logging software to digitise analogue inputs and transfer data to a PC. Temperature, conductivity, and pump rates can be monitored and logged in real time.

Connection is via USB, requiring no additional hardware, allowing use with any PC, laptop, or notebook.



Requirements	Unit	Scale
1Ph PC USB	Length: 1.000 Width: 0.500 Height: 0.550	

- **Electrical Supply:** Single phase (see Ordering codes)
- **PC and Display:** Recommended minimum (1920 by 1080) full HD

Consumables:

- **100g** Potassium chloride
- **20g** NaOH Sodium hydroxide
- **50ml** Ethyl acetate

Ordering codes

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

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Corrosion Studies Kit CEQ



The Armfield CEQ Corrosion Studies Kit is a bench-mounted laboratory apparatus designed to investigate the mechanisms and prevention of corrosion in aqueous environments. The system enables the simultaneous study of up to eight corrosion cells, each accommodating three test specimens to ensure reliable, repeatable measurements.

Each glass test vessel allows direct visual observation of corrosion processes, while quantitative corrosion rates are determined by mass loss measurement after controlled immersion periods. Air or inert gas agitation enables investigation of oxygen effects, and an integrated low-voltage DC power supply supports electrochemical corrosion studies including galvanic action and cathodic protection.

The apparatus includes steel, zinc, copper, brass and platinum specimens, a digital pH meter with electrode for electrolyte preparation, and electrical terminals for electrochemical experiments. The unit supports studies of pH influence, dissolved oxygen, stress corrosion, corrosion inhibition, galvanic coupling, impressed current protection, and electrolytic corrosion.

Relevant Curriculum Modules

- Materials Engineering & Corrosion Science
- Electrochemical Engineering
- Transport Phenomena *(mass transfer in liquid systems)*
- Environmental & Water Engineering
- Energy & Utilities Engineering
- Unit Operations
- Process Control & Instrumentation
- Chemical Engineering Laboratory Skills
- Design & Analysis

Relevant Theories and Laws

- Electrochemical Series and Electrode Potentials
- Galvanic Cell Theory
- Anodic and Cathodic Reactions
- Faraday's Laws of Electrolysis
- Corrosion Rate Determination by Mass Loss
- Influence of pH on Metal Dissolution
- Oxygen Reduction Reactions
- Cathodic Protection Principles
- Passivation and Inhibition Theory
- Localised Corrosion and Stress Corrosion Mechanisms

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the fundamental electrochemical mechanisms of corrosion, including anodic and cathodic reactions, galvanic coupling, and the influence of pH and dissolved oxygen. They interpret visual corrosion behaviour and mass loss measurements to describe corrosion processes in aqueous systems.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; awareness of laboratory safety and electrochemical processes.

Apply & Analyse

Students apply electrochemical and mass balance principles to quantify corrosion rates from experimental weight-loss data. They analyse the influence of pH, salinity, oxygen concentration, inhibitor dosage, electrical connection between dissimilar metals, and impressed voltage on corrosion behaviour.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

Students evaluate corrosion mitigation strategies including material selection, inhibition, galvanic protection, and impressed current systems. They design experimental programmes to compare corrosion environments and develop evidence-based recommendations relevant to industrial water systems, pipelines, marine structures, and process plant integrity.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

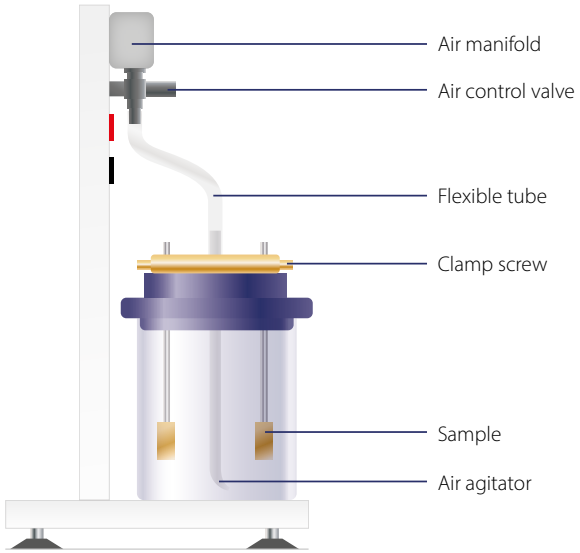
Requirements		Unit	Scale
1Ph	Length:	1.000	
	Width:	0.500	
	Height:	0.550	

- **Electrical Supply:** Single phase (see Ordering codes)

Digital pH microsensor and pH meter:

Range of pH meter:	0-14pH
Resolution:	0.01pH
Accuracy:	±0.01pH
Dimensions:	195 x 29 x 15mm

Side view of equipment



Consumables:

- **17g** Potassium iodine
- **10 ml** Hydrochloric acid
- **60g** Sodium chloride
- **8 litres** De-Ionised water

Ordering codes

- **CEP-A:** 220-240V / 1ph / 50Hz / 12A
- **CEP-B:** 120V / 1ph / 60Hz / 14A
- **CEP-G:** 220-240V / 1ph / 60Hz / 12A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Gaseous Diffusion Coefficient Apparatus CERa-MKII



The Armfield CERA-MKII Gaseous Diffusion Coefficient Apparatus is a bench-mounted system designed to determine the diffusion coefficient of a volatile liquid vapour into air under controlled conditions. A small quantity of liquid is placed in a precision glass capillary tube positioned within a PID-controlled heated aluminium block.

A controlled airflow passes across the capillary opening, establishing a stationary gas film and a defined partial pressure gradient. As vapour diffuses into the air stream, the liquid meniscus recedes within the capillary.

The movement of this phase boundary is monitored using an integrated high-definition USB microscope with time-lapse imaging capability, enabling accurate measurement of diffusion rate.

The heated block maintains constant temperature (ambient to 60°C), allowing investigation of temperature effects on gaseous diffusivity. The digital microscope and measurement software provide automated image capture and precise meniscus position tracking, supporting high-resolution mass transfer analysis.

Relevant Curriculum Modules

- Transport Phenomena *(mass transfer in gases)*
- Separation Processes *(gas-phase diffusion)*
- Unit Operations
- Process Design Fundamentals
- Chemical Engineering Laboratory Skills
- Design & Analysis
- Environmental & Process Engineering

Relevant Theories and Laws

- Fick's First and Second Laws of Diffusion
- Stefan Diffusion *(Diffusion with Bulk Flow)*
- Ideal Gas Law
- Partial Pressure and Vapour Pressure Relationships
- Mass Transfer Coefficient Concepts
- Temperature Dependence of Diffusion *(Arrhenius-type relationships)*
- Stationary Gas Film Theory
- Molar Flux Equations

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the principles of gaseous diffusion and describe how concentration gradients and partial pressure differences drive mass transfer. They interpret meniscus displacement data to relate diffusion behaviour to temperature and vapour pressure.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; laboratory safety awareness; understanding of mass transfer fundamentals.

Apply & Analyse

Students apply Fick's Law and gas-phase mass balance equations to determine diffusion coefficients from experimental meniscus displacement data. They analyse the influence of temperature and volatility on diffusion rate and compare measured values with literature correlations.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

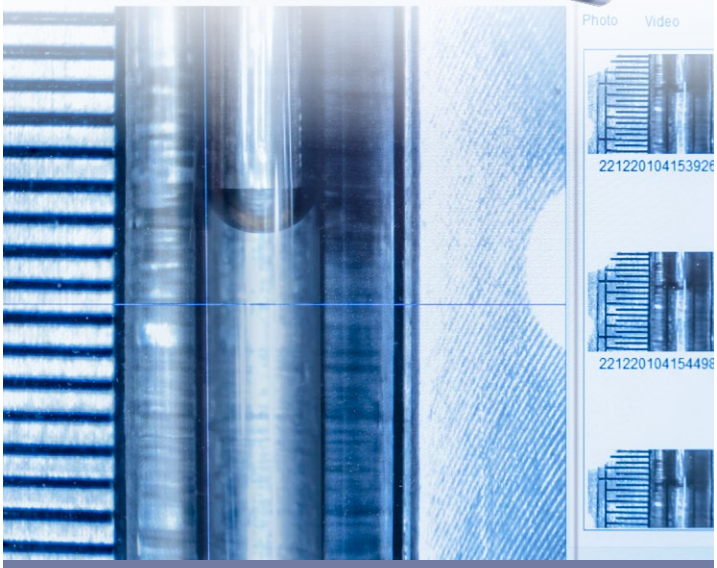
Evaluate & Create

Students evaluate assumptions in gaseous diffusion modelling (e.g. stagnant film approximation), design experiments to investigate alternative liquids or temperature conditions, and assess relevance to evaporation, drying, and vapour-phase mass transfer in industrial systems.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

Requirements		Unit	Scale
1Ph PC USB	Length:	0.270	
	Width:	0.200	
	Height:	0.130	

- **Electrical Supply:** Single phase
- **PC and Display:** Recommended minimum (1920 by 1080) full HD



Software

Software can create individual images under operator control, multiple timed images under automatic control or time lapsed video. Images can be time and date tagged. Time lapse periods can be set from five seconds to many days.



Ordering codes

- CERa-MKII

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Liquid Diffusion Coefficient Apparatus CERb

The Armfield CERB Liquid Diffusion Coefficient Apparatus is a bench-top system designed to determine molecular diffusivity in liquids using an equimolar counter-diffusion technique. The unit incorporates a precision glass diffusion cell containing a honeycomb array of capillaries positioned between two liquid phases of differing concentration.

A concentrated solution is placed within the capillary cell, while the surrounding vessel contains pure solvent. As diffusion occurs across the capillary interface, the concentration of the bulk solution increases. A conductivity probe continuously monitors concentration change, while a magnetic stirrer ensures uniform bulk mixing without introducing convective flow through the capillaries.

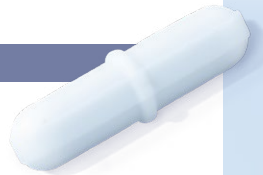
The time-dependent change in conductivity is used to determine the liquid diffusion coefficient, typically using dilute sodium chloride solutions. The apparatus enables reproducible measurement within a standard laboratory session and may be interfaced with a PC for data logging.

Relevant Curriculum Modules

- Transport Phenomena *(liquid-phase mass transfer)*
- Separation Processes *(diffusion and interphase transport)*
- Unit Operations
- Chemical Engineering Laboratory Skills
- Process Engineering Fundamentals
- Design & Analysis
- Environmental & Water Engineering

Relevant Theories and Laws

- Fick's First and Second Laws of Diffusion
- Equimolar Counter-Diffusion
- Unsteady-State Mass Balance
- Concentration–Conductivity Relationships
- Diffusion Through Capillaries
- Molecular Diffusivity in Liquids
- Temperature Dependence of Diffusivity
- Dimensionless Mass Transfer Analysis



CERb: Magnetic stirrer

Learning Outcomes & Bloom Alignment

Remember & Understand

Students explain the mechanism of molecular diffusion in liquids and describe how concentration gradients drive mass transfer in the absence of convection. They interpret conductivity changes as an indicator of solute diffusion.

- **IChemE outcomes:** Knowledge and understanding of core chemical engineering principles; safe laboratory practice; understanding of mass transfer fundamentals.

Apply & Analyse

Students apply unsteady-state mass balance equations and Fick's Law to determine liquid-phase diffusion coefficients from conductivity–time data. They analyse the influence of concentration and mixing on diffusion behaviour and compare experimental values with literature data.

- **IChemE outcomes:** Analysis; investigation; experimental design; quantitative data interpretation; structured technical reporting.

Evaluate & Create

Students evaluate assumptions in diffusion modelling (e.g. negligible convection, constant diffusivity), design experiments to investigate alternative solutes or temperature conditions, and assess the relevance of measured diffusivities to industrial operations such as extraction, membrane separation, and mixing processes.

- **IChemE outcomes:** Design; evaluation; independent investigation; professional engineering judgement and decision-making.

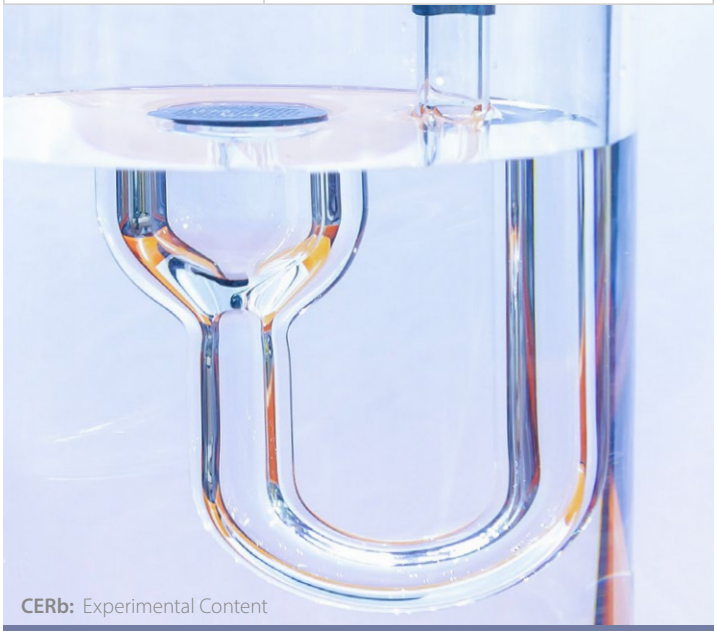
Requirements	Unit	Scale
PC USB	Length: 0.250 Width: 0.200 Height: 0.130	

- **Electrical Supply:** Battery operated
- **PC and Display:** Recommended minimum (1920 by 1080) full HD



Technical specifications

Diffuser vessel	Capacity 1l
Conductivity meter	3 ranges 199.9µ5 to 19.99mS
Computer output	RS232



CERb: Experimental Content

Ordering codes

- CERb

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Thermodynamics for ChemEng

Chemical Engineering Relevance

These units collectively establish the thermodynamic backbone of chemical engineering:

- **TH1 & TH2** Accurate measurement of temperature and pressure (critical to all process systems)
- **TH3** Phase equilibria and steam systems (distillation, evaporation, utilities)
- **TH5** Gas behaviour and energy balances (reactors, compressors, expansion systems)
- **RA1-MKII** Integrated thermodynamic cycle (refrigeration, heat pumps, energy recovery systems)

Together, they provide a complete pathway from fundamental properties and measurement thermodynamic relationships full system analysis, directly supporting process design, simulation, energy efficiency optimisation, and plant operation across chemical, energy, and manufacturing industries.

Alignment

From a Bloom's perspective, this combined range supports progression from understanding fundamental thermodynamic properties and measurement techniques **(Year 1),** through application of energy balances and property relationships **(Year 2)**, to evaluation and optimisation of complete thermodynamic systems **(Year 3).**

In alignment with IChemE learning outcomes, it develops:

- Core thermodynamics and energy systems knowledge (properties, phase equilibria, refrigeration cycles)
- Experimental competence (measurement, calibration, uncertainty analysis)
- Application of the First Law, phase behaviour, and gas relationships
- Systems-level understanding of thermodynamic cycles and performance
- Engineering judgement in interpreting real system behaviour and optimisation

TH1 – Temperature Measurement and Calibration

The Armfield **TH1** introduces the principles of temperature measurement and calibration using a range of industrial sensors including thermocouples, RTDs and thermistors.

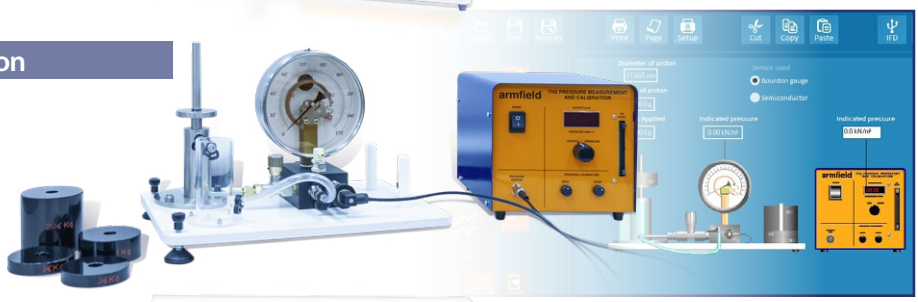
Fixed reference points (ice and boiling) and a controlled water bath enable investigation of sensor behaviour, response time, accuracy, and calibration methodologies.



TH2 – Pressure, Measurement and Calibration

The Armfield **TH2** provides a fundamental study of pressure measurement and calibration using a deadweight pressure calibrator, Bourdon gauge and electronic sensors.

It enables evaluation of accuracy, linearity, hysteresis and measurement error, while also demonstrating Boyle's Law for ideal gases.



TH3 – Saturation Pressure (Marcet Boiler)

The Armfield **TH3** investigates the relationship between pressure and temperature during phase change, enabling students to generate saturation curves and compare with steam tables.

The unit includes a throttling calorimeter for determining steam quality and applying steady flow energy balances.



TH5 – Expansion Processes of a Perfect Gas

The Armfield **TH5** explores thermodynamic processes in gases, including isentropic, isothermal, and polytropic expansion.

Using pressurised and evacuated vessels, students analyse transient pressure–temperature behaviour and apply the First Law of Thermodynamics to real experimental data.



RA1-MKII – Vapour Compression Refrigeration Unit

The Armfield **RA1-MKII** provides a fully instrumented, computer-controlled vapour-compression refrigeration cycle, enabling real-time analysis of system performance including Coefficient of Performance (COP), energy balances, and refrigerant behaviour.

Variable compressor speed, condenser/evaporator flow control, and expansion valve adjustment allow detailed investigation of cycle performance and optimisation under varying operating conditions.



We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Multi-Pump Test Rig C3-MKII

The Armfield C3-MKII is a comprehensive fluid mechanics platform enabling students to experimentally compare rotodynamic and positive displacement pumps under controlled conditions, generating characteristic curves (head–flow, efficiency, power) and analysing system behaviour.

It's modular, multi-pump configuration supports progressive learning from fundamental concepts of head and flow to advanced analysis of system resistance, pump selection, and performance optimisation.



Alignment

The unit spans the full cognitive range: students begin by understanding pump principles, progress to analysing performance data and system interactions, and ultimately evaluate and design pumping systems. Additionally, the C3-MKIII aligns strongly with, developing core knowledge, experimental investigation, quantitative analysis, and engineering judgement.

Chemical Engineering Relevance

The C3-MKII directly reflects real industrial applications including water distribution, process fluid transport, utilities systems, and chemical plant operation. It provides essential grounding in pump selection, system design, and energy efficiency—critical competencies for any practicing chemical engineer

As standard the C3-MKII comes with a centrifugal pump & gear pump.

C3-MKII - 7 Pump accessories avalable



Fluid Machines Range FM50-53

The Armfield FM50 range is a modular suite of fluid machine teaching systems covering centrifugal (FM50), series/parallel centrifugal (FM51), gear (FM52), and plunger pumps (FM53), enabling comprehensive study of both rotodynamic and positive displacement pump behaviour.

The systems incorporate transparent components, electronic instrumentation, and software-driven data acquisition to generate characteristic curves (head–flow, efficiency, power) and analyse system interactions under varying configurations and operating conditions.

Alignment

The range supports progression from understanding pump principles and classifications, through quantitative performance analysis and system curve evaluation, to evaluation and design of complex pumping systems including series/parallel operation and high-pressure applications. The product range also develops core knowledge, experimental competence, data-driven analysis, and engineering decision-making relevant to real process systems.

Chemical Engineering Relevance

The FM50 range directly reflects industrial fluid handling across sectors including water treatment, oil & gas, chemical processing, and utilities.

It provides essential grounding in pump selection, system design, energy efficiency, and operational troubleshooting, key competencies for process design, plant operation, and scale-up.

Single Interface

IFD7: Interface Unit



The Armfield IFD7 Interface Unit provides the core data acquisition and control platform, for all pumps in the FM50 Range enabling real-time monitoring, sensor integration, and variable-speed control of connected equipment via a simple USB interface.

It supports automated data logging, graphical visualisation, and direct export to Excel, ensuring high-quality, repeatable experimental analysis.

FM50 Centrifugal Pump Demonstration Unit

A self-contained centrifugal pump system with transparent acrylic reservoir, pump volute and pipework for clear visualisation of flow behaviour. Supplied with interchangeable impellers to demonstrate the influence of blade design on pump performance.

Software supplied as standard.



FM51 Series and Parallel Pumps Demonstration

A twin centrifugal pump apparatus with configurable single, series and parallel operation. Transparent components and interchangeable impellers allow clear visualisation and investigation of pump characteristics, supported by electronic measurement of pressure, flow rate and temperature.

Software supplied as standard.



FM52 Gear Pump Demonstration Unit

A transparent gear pump system designed to demonstrate positive displacement pumping principles. Variable speed control and electronic sensors enable investigation of pressure, flow rate and pump power characteristics.

Software supplied as standard.



FM53 Plunger Pump Demonstration Unit

A positive displacement plunger pump system for studying high-pressure pumping and reciprocating flow behaviour.

Integrated sensors enable measurement of cylinder pressure, pump displacement and cumulative flow.

Software supplied as standard.

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Fluid Friction Measurements C6-MKII



TThe Armfield C6-MKII provides a comprehensive study of fluid friction head losses in pipes, fittings, and flow measurement devices, enabling detailed analysis across laminar, transitional, and turbulent regimes.

A configurable multi-pipe network allows investigation of friction coefficients, Reynolds number relationships, and energy losses in real hydraulic systems, supported by optional data acquisition and software analysis.

Experimental Capability

An arrangement of six pipes enables investigation of:

- Four smooth bore pipes (varying diameters)
- Artificially roughened pipe
- 90° bends (large & small radii), elbow & mitre
- 45° elbow & 45° Y
- 90° T-junction
- Sudden enlargement & contraction
- Gate, globe & ball valves
- Inline strainer
- Perspex Venturi & orifice meter
- Pitot tube with static tapping

This allows full coverage of major and minor losses, flow measurement techniques, and real pipe network behaviour.

Chemical Engineering Relevance

The C6-MKII directly underpins key ChemEng applications:

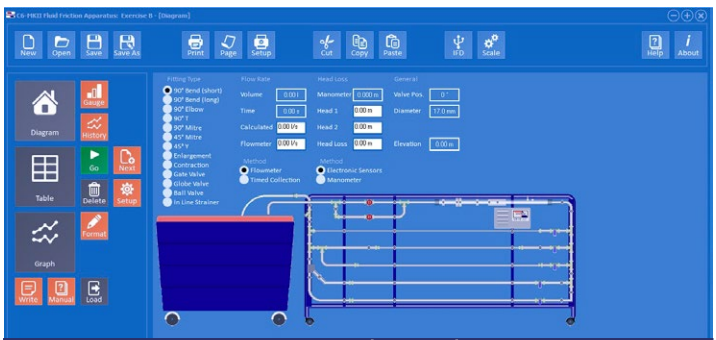
- Pipe flow & transport systems - Core to all process industries
- Energy losses & efficiency - Pump sizing, system optimisation
- Reynolds number & flow regimes-Reactor and pipeline design
- Flow measurement (Venturi, orifice, Pitot) - Industrial instrumentation
- Valve & fitting losses - Real plant pressure drop calculations

It bridges the gap between theoretical fluid mechanics and real industrial systems, providing essential grounding for process design, scale-up, and plant operation.

Alignment -Fluid Mechanics (Chemical Engineering)

From a Bloom's perspective, the C6-MKII supports progression from understanding fluid properties and measurement techniques (Year 1), through application of Reynolds number and friction relationships (Year 2), to analysis and evaluation of complex pipe systems and losses (Year 3).

- **In alignment with IChemE learning outcomes, it develops:**
- **Core fluid mechanics and transport phenomena knowledge**
- **Understanding of Darcy–Weisbach and head loss relationships**
- **Competence in pressure and flow measurement techniques**
- **Ability to analyse pipe networks and hydraulic systems**
- **Experimental design and data interpretation skills**



Requirements		Unit	Scale
F1-10 PC USB	Length:	2.250	
	Width:	0.470	
	Height:	1.190	

- **Electrical Supply:** Single phase (see Ordering codes)
- **PC and Display:** Recommended minimum (1920 by 1080) full HD

Configuration Options

1. Complete (Data Logging + Calculations)
F1-10 + C6-MKII-10 + C6-MKII-DTA-ALITE + H12-2

Full system combining hydraulic supply, digital data acquisition, and low-pressure manometry, enabling both automated data logging and complete thermofluid analysis including energy balances and friction factor determination.

2. Software Logging (Data Logging Only)
F1-10 + C6-MKII-10 + C6-MKII-DTA-ALITE

Computer-based data acquisition with real-time visualisation and graphing of flow, pressure, and derived parameters, ideal for rapid experimentation and repeatable datasets.

3. Digital Readout (Hybrid Instrumentation)
F1-10-2 + C6-MKII + H12-8

Digital flow measurement combined with electronic pressure sensing, providing accurate real-time readings while maintaining manual interpretation of results.

4. Manual Calculation (Traditional Method)
F1-10 + C6-MKII-10 + H12-2

Classic laboratory approach using volumetric flow measurement and manometry, reinforcing first-principles calculations & fundamental understanding of fluid mechanics.

Ordering codes

- **F1-10-A:** 220-240V / 1ph / 50Hz / 10A
- **F1-10-B:** 110-120V / 1ph / 60Hz / 10A
- **F1-10-G:** 220V / 1ph / 60Hz / 10A
- **F1-10-2-A:** 220-240V / 1ph / 50Hz / 10A
- **F1-10-2-B:** 110-120V / 1ph / 60Hz / 10A
- **F1-10-2-G:** 220V / 1ph / 60Hz / 10A

We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved

Heat Transfer HT10X

The Armfield HT10X Heat Transfer Service Unit with HT11X, HT13X, HT15X, and HT19X modules provides a comprehensive platform covering the fundamentals of heat transfer: conduction, convection, and radiation.

The range enables controlled study of steady-state and transient heat transfer, thermal conductivity, convective coefficients, and radiative exchange, with integrated instrumentation and software for real-time analysis.

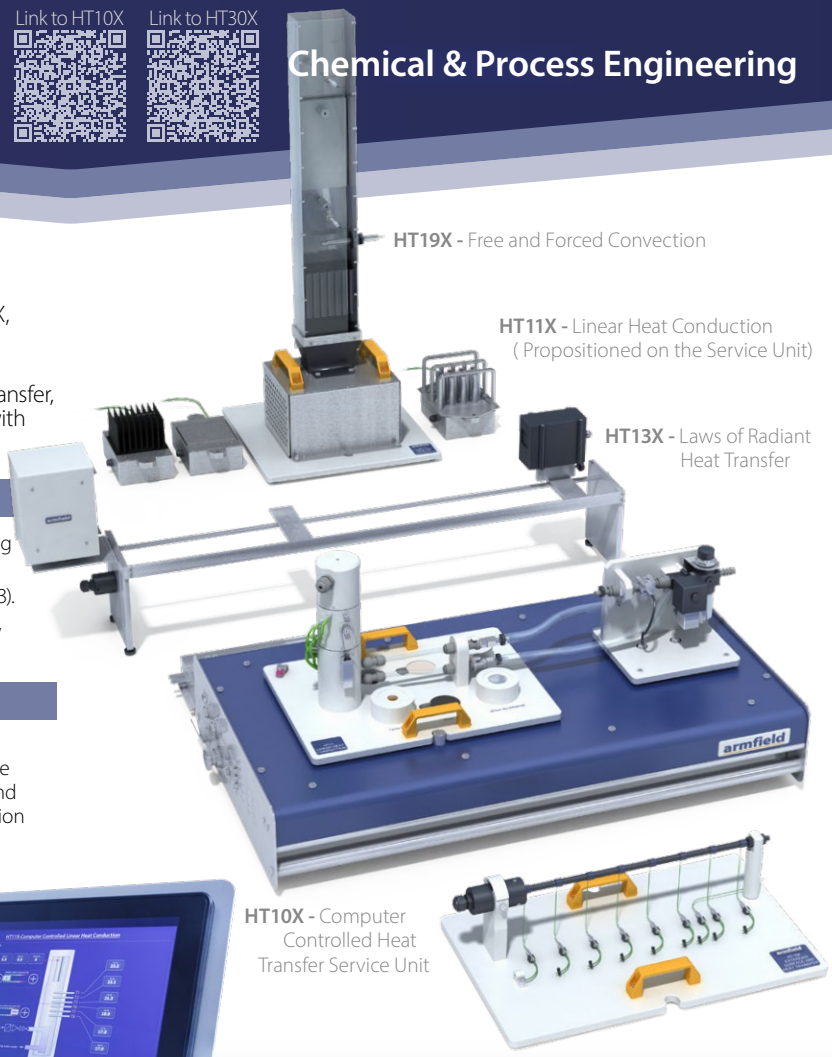
Alignment

From a Bloom's perspective, the range supports progression from understanding heat transfer mechanisms (Year 1), through quantitative analysis of heat flux and temperature profiles (Year 2), to evaluation and design of thermal systems (Year 3). In alignment with IChemE outcomes, it develops core Thermofluids knowledge, experimental investigation skills, and engineering judgement.

Chemical Engineering Relevance

These experiments underpin critical process operations such as heat exchangers, reactors, evaporation, distillation, and energy systems. The range provides essential understanding of heat transfer performance, efficiency, and design key competencies for process design, optimisation, and plant operation across chemical, energy, and manufacturing industries.





Heat Exchange HT30X

The Armfield HT30X is a modular heat exchanger service unit supporting a wide range of interchangeable exchangers (plate, tubular, shell & tube, crossflow, and jacketed systems), enabling comprehensive study of indirect heat transfer between fluid streams and comparison of industrial heat exchanger designs.

The system provides full control of hot and cold fluid streams, including co-current and counter-current operation, with integrated data acquisition for detailed thermal performance analysis.

Alignment

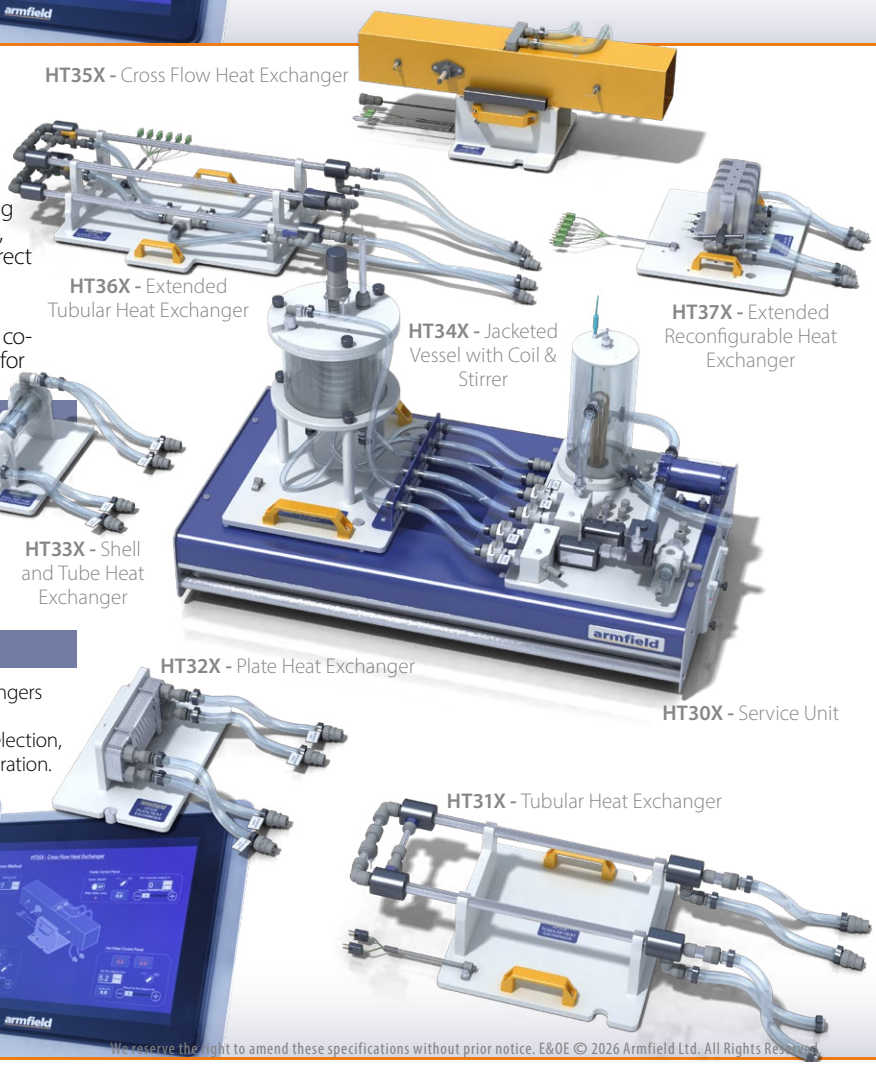
From a Bloom's perspective, the HT30X supports progression from understanding heat exchanger principles and flow configurations (Year 1), through quantitative analysis of LMTD, overall heat transfer coefficient (U), and efficiency (Year 2), to evaluation and design of heat exchanger systems and configurations (Year 3).

In alignment with IChemE outcomes, it develops core thermodynamics knowledge, experimental investigation, and engineering design capability.

Chemical Engineering Relevance

The HT30X directly reflects essential process operations such as heat exchangers in reactors, distillation, evaporation, and energy systems. It provides critical understanding of thermal efficiency, process integration, and equipment selection, key competencies for process design, optimisation, and industrial plant operation.





We reserve the right to amend these specifications without prior notice. E&OE © 2026 Armfield Ltd. All Rights Reserved.

Laboratory Planning & Layout Support

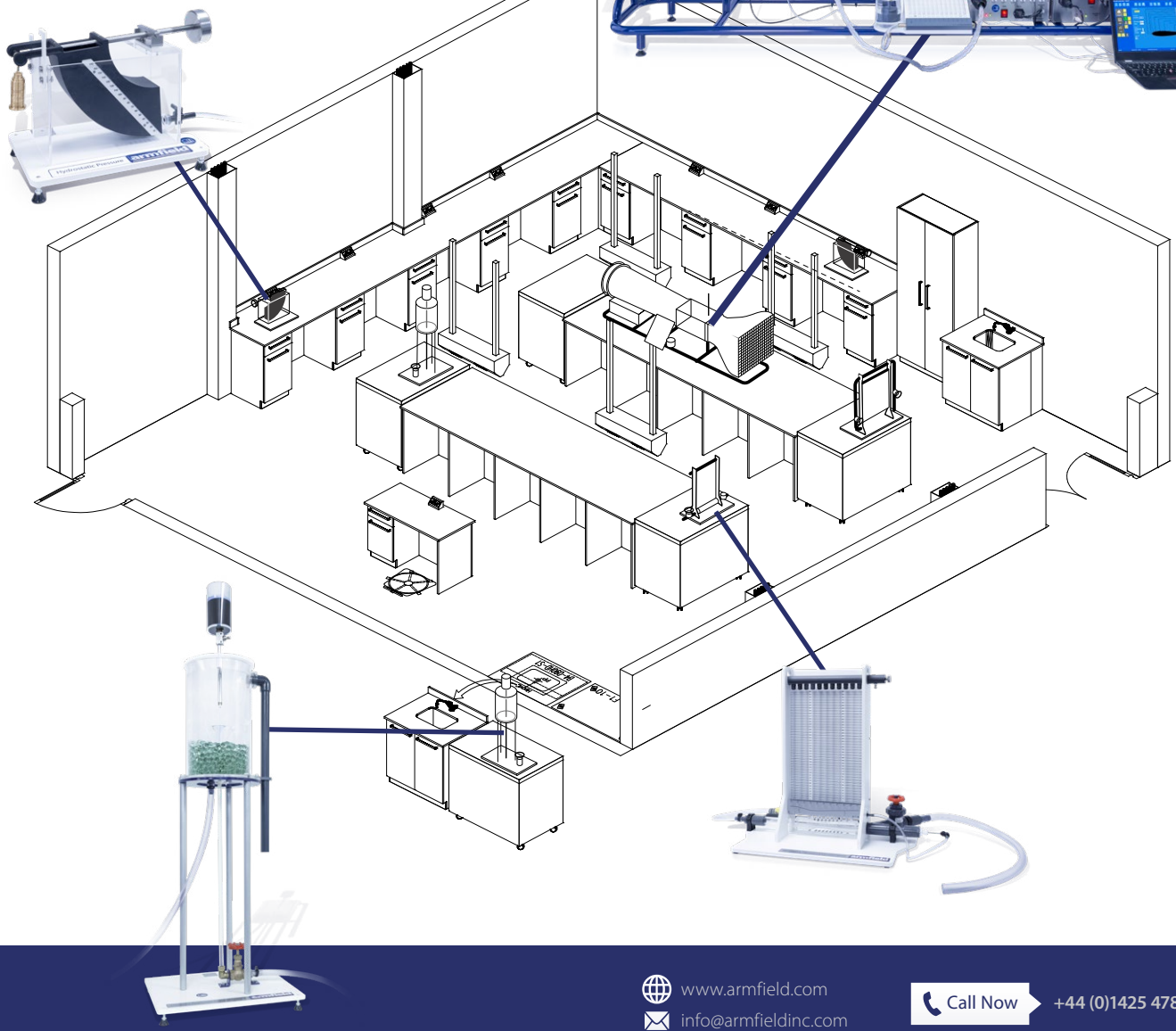
Designing an effective teaching laboratory requires more than selecting equipment. Armfield works with universities and colleges worldwide to help plan laboratory spaces that maximise teaching capability, student engagement, and future expansion.

Our team can provide guidance on equipment selection, laboratory layouts, utility requirements, room utilisation, and phased development plans, ensuring your facility delivers the best possible learning experience while making efficient use of available space and budget.

Our support includes:

- Laboratory layout and space planning
- Equipment selection and curriculum mapping
- Utility and infrastructure guidance
- Multi-disciplinary laboratory design
- Future expansion and development planning
- Expert consultation from experienced engineering specialists





Contact us *Support* *Download Catalogue*

www.armfield.co.uk

armfield
Part of Judges Scientific PLC

Social Media search Armfield Ltd

Armfield Agents

Armfield products are distributed throughout the world. It is our policy in most countries to deal direct or through proven and accredited sales agents, who after suitable approval, may become exclusive representatives.

In exchange for this exclusivity they are required to offer a comprehensive service including the highest degree of after sales support.

Customer Demonstration

To arrange a demonstration please contact your local Armfield representative. Details can be found on our website: **www.armfield.com**

Contact Armfield HQ directly using the information below:

armfield worldwide

www.armfield.com/contact

Head Office:
Armfield Limited
10 Headlands Business Park
Ringwood, Hampshire
BH24 3PB England
Telephone: +44 (0)1425 478781
E-mail: sales@armfield.co.uk
Support: *armfield.com/armfield-support/*

U.S. Head Office:
Armfield Inc.
9 Trenton Lakewood Road
Clarksburg NJ 08510
USA
Tel/Fax: +1 (609) 208-2800
E-mail: info@armfieldinc.com
Support: *armfield.com/armfield-support/*

UK CA

An ISO 9001:2015 Company

CE

Innovative engineering teaching and research equipment

2026 © Armfield Ltd. All Rights Reserved. We reserve the right to amend these specifications without prior notice. E&OE