COMPOSITE INTEGRATION
INNOVATION IN COMPOSITES TECHNOLOGY

CIJECT

EQUIPMENT & PROCESS

RESIN TRANSFER MOULDING

PROCESS GUIDE

The Composite Experts in the Moulding Industry

INTRODUCING

COMPOSITE INTEGRATION
INNOVATION IN COMPOSITES TECHNOLOGY

Supported by Our Knowledge

Specialising in resin transfer moulding (RTM) and resin infusion (RI), Composite Integration is committed to providing market-leading, innovative, and well-engineered solutions to the composites industry – whatever the scale of your project, we have the practical experience and technical capacity to find a solution that works.

> “Composite Integration worked with us to understand our process-specific requirements. The team configured a bespoke Ciject machine with integrated material tanks and heating, providing unique solutions to our specific processing parameters whilst also retaining a simple, easy to use system.”

Christian Keim

OWNER | KEIM KUNSTSTOFFTECHNIK, GERMANY.

Above: **Ciject® equipment build carried out on site by our in-house engineering team**

Typical Resin Transfer Moulding Set-up

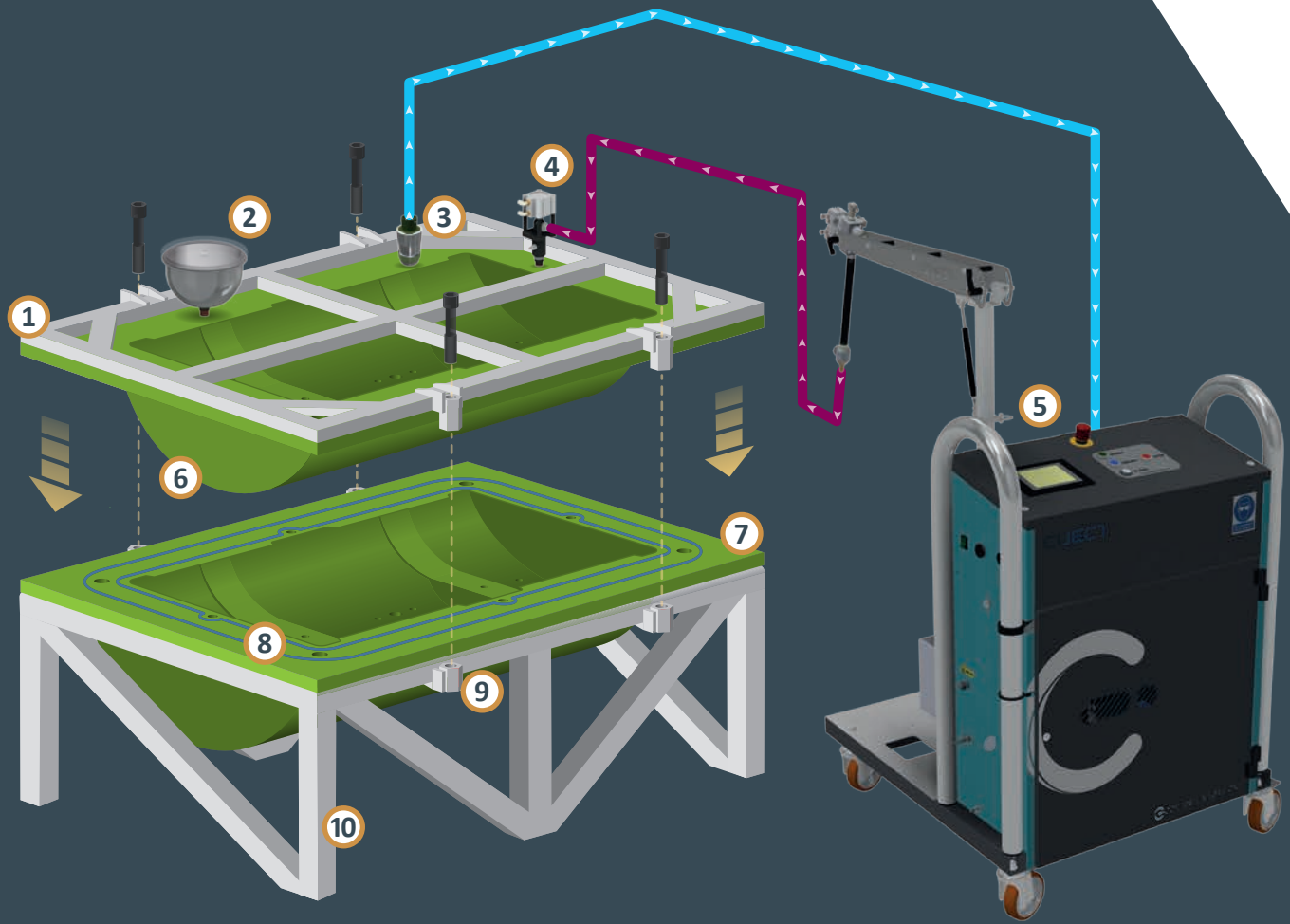
EQUIPMENT SET-UP

RTM is the process of producing composite components within a mechanically-clamped, rigid, matched two-part mould.

Flanges compress peripheral seals to prevent leaks before thermosetting resin is injected directly into the fibre-pack, and the mould is filled by positive pressure from the Ciject machine.

CONTROLLED APPLICATION

The use of a closed mould avoids much of the 'craft' skill required for a successful open-moulding or infusion process. A mechanically clamped RTM mould can form part of a fully automated and highly controlled process.



1. **Support frame** – lightweight metal
2. **Catch-pot** – waste removal
3. **Sensor monitoring** – data measurement
4. **Injection valve** – resin input
5. **Ciject Two** – resin mixing & injection
6. **Mould** – 'B' surface
7. **Mould** – 'A' surface
8. **Seals** – standard groove fitting
9. **Clamping point** – manual nut/bolt
10. **Support frame** – steel reinforcement

Resin flow Data feed

RTM EXPLAINED

Resin Transfer Moulding is the process of producing composite components within a mechanically clamped, rigid, normally two-part mould.

The advantages of a 'closed mould' process are considerable and include:

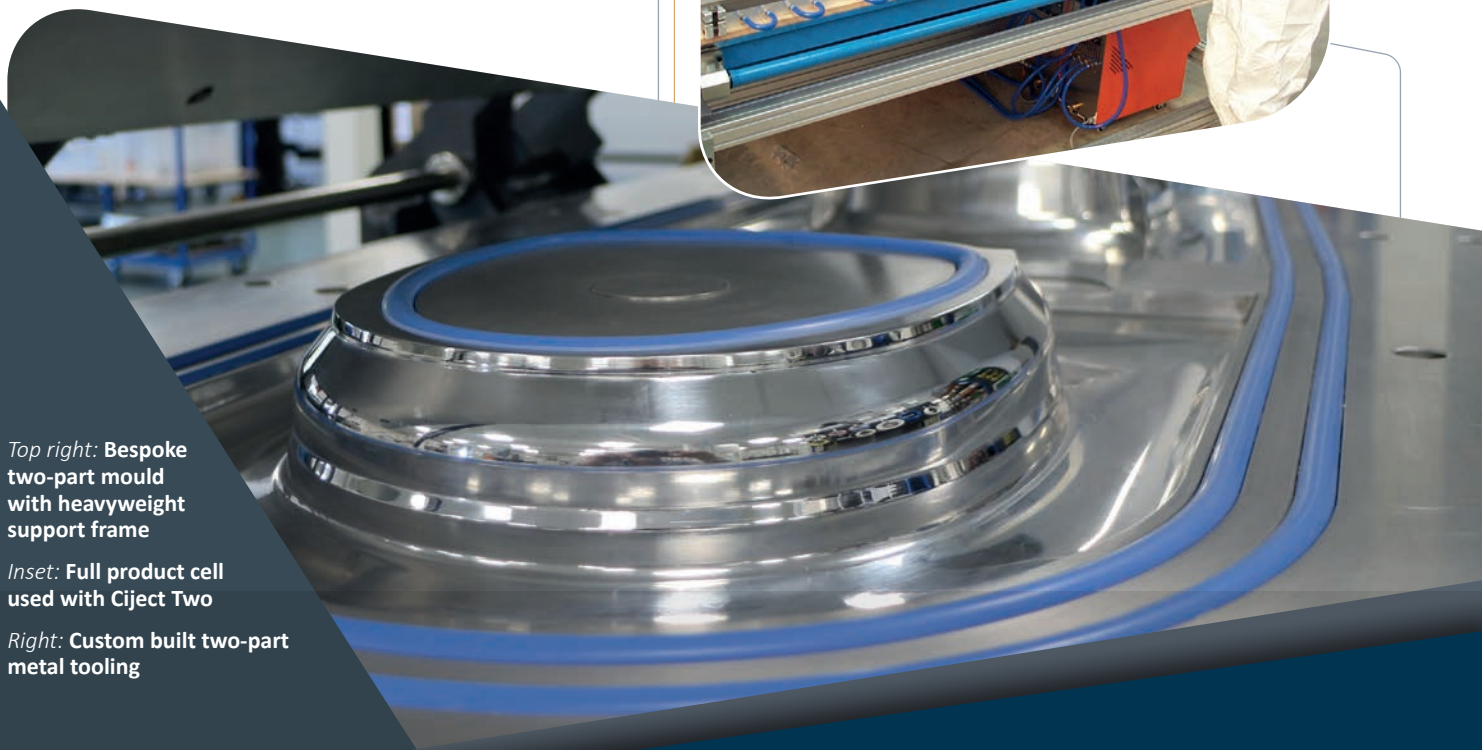
- **Volatile emissions (styrene etc.) are massively reduced**
- **It can be a fast, clean and repeatable process**
- **The laminate thickness and Vf can be closely controlled**
- **The process is far less reliant on the manual skills of the operator**
- **Both 'A' and 'B' surfaces of the moulding can be accurately defined**
- **The process can be automated**

Dry reinforcement is placed between a two-part mould and the mould is clamped shut using mechanical force such as hydraulic press, nuts and bolts or heavy duty toggle clamps.

Thermosetting resin is injected directly into the fibre-pack, and the mould is filled by positive hydraulic pressure from the injection machine. The mould is normally vented at the furthest points from the injection point allowing the air to escape.

Vacuum can also be drawn from the vents to improve laminate quality when necessary.

Traditional RTM relies on the mould/clamping structure being stiff enough to withstand the pressure of the injected resin without opening or distorting.



Top right: **Bespoke two-part mould with heavyweight support frame**

Inset: **Full product cell used with Ciject Two**

Right: **Custom built two-part metal tooling**

Typical Vacuum Resin Transfer Moulding Set-up

EQUIPMENT SET-UP

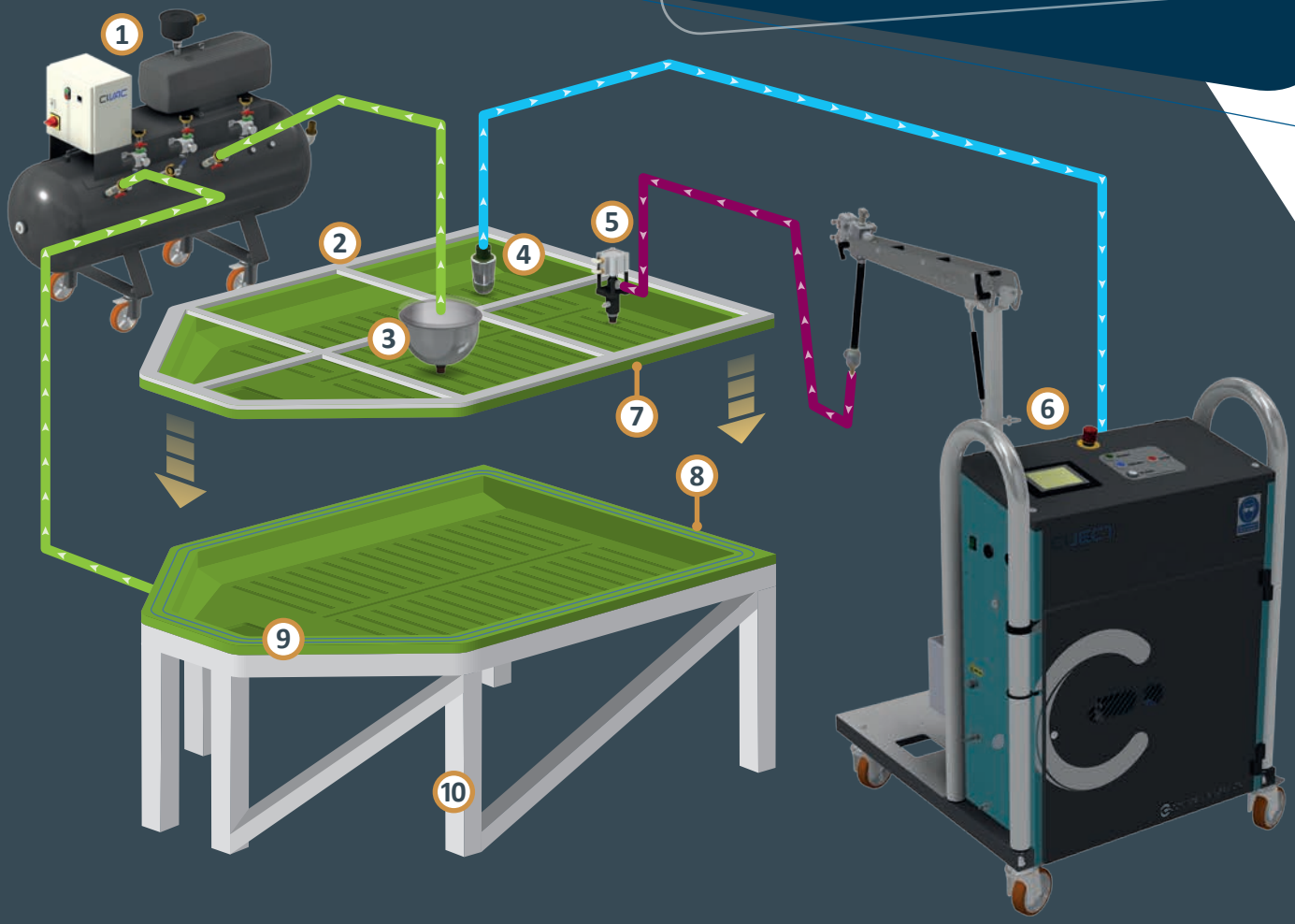
Vacuum RTM (VRTM or RTM Light) is the process of producing composite components within a vacuum-clamped, two-part mould.

Compared with traditional RTM, VRTM tooling is relatively lightweight and thus considerably more economical. Atmospheric pressure is used as the mould closing force, as opposed to the mechanical clamping methods and heavily reinforced mould structures used in RTM.

CONTROLLED APPLICATION

Vacuum is applied to the mould cavity and the resin is introduced peripherally under low pressure. This injection strategy provides the most efficient method of filling the mould, with the minimum of reaction pressure against the clamping force.

As with Resin Infusion, any moulding process in which the laminate is fully enclosed during the filling and curing process will be higher quality and produce far fewer volatile emissions than an 'open mould' process such as hand or spray laminating.



1. **Civac pump** – vacuum system
2. **Support frame** – lightweight metal
3. **Catch-pot** – waste removal
4. **Sensor monitoring** – data measurement
5. **Injection valve** – resin input
6. **Ciject Two** – resin mixing & injection
7. **Mould** – 'B' surface
8. **Mould** – 'A' surface
9. **Seals** – standard groove fitting
10. **Support frame** – lightweight steel

Resin flow Data feed Vacuum

VRTM EXPLAINED

Vacuum RTM (VRTM or RTM Light) is the process of manufacturing composite components within a vacuum-clamped two-part mould.

Unlike infusion processes that use a vacuum bag, the VRTM process uses a semi-rigid upper mould that provides good definition of the moulded 'B' surface. Extra detail such as encapsulate inserts, cores or surface textures are readily mouldable.

The resin fills the mould cavity and is vented near the centre of the component. Any excess resin is contained within a catch-pot positioned at this point. The vacuum is drawn from the mould cavity via the catch-pot. The catch-pot also prevents excess resin from being drawn into the vacuum pump.

The primary mould, usually representing the 'A' surface of the component, is built as a relatively stiff structure with a simple framework to prevent distortion.

The 'B' mould is often a much lighter structure and consists of a 4 – 6mm semi-translucent laminate over the mould cavity and a reinforced and stiffened flange area. A simple frame can be incorporated to aid handling and to prevent distortion.

The mould is built with double seals; an outer vacuum seal and an inner resin seal. The flange area between the seals is evacuated to provide the main clamping force. This double seal also provides excellent security against vacuum leaks through the seals.

Vacuum is applied to the mould cavity and the resin is introduced under low pressure (<1 bar) into a peripheral feed channel running around the outside edge of the component. This peripheral injection strategy provides the most efficient route to fill the mould, with the minimum reaction pressure against the clamping force.

Due to the use of vacuum to provide a uniform clamping force, the VRTM process can be successfully used to mould large structures using relatively simple and low-mass tooling.

Top right: **Mould construction at our tooling facility**

Above: **Lightweight composite tooling**

Right: **Bespoke tooling to be used in the marine sector**

Business Philosophy and Working Practice

Optimised for Efficiency

We take a fully collaborative approach to every project we undertake; the best results are always achieved through balanced partnerships with a mutual respect for each party's knowledge and experience.

As a learning organisation, and members of Composites UK, ADS and UK National Composites Centre, our commitment to the practical development of resin transfer and infusion technologies is exemplary.

From our HQ in the south-west of England, we design, manufacture and comprehensively test our extensive range of equipment and software, and have links to distributors in more than twenty countries across the globe.

CUSTOMER LIAISON

- One-to-one client consultation
- Understanding your objectives
- Initiating an efficient action plan

SOLUTION FINDING

- Intrinsic knowledge of own brand products
- Options to tailor peripherals and accessories
- Specifying equipment for individual needs

RESEARCH & DEVELOPMENT

- Assessment of project parameters
- Feasibility and proof of concept studies
- Prototype production of components and tooling

COMPOSITE INTEGRATION

INNOVATION IN COMPOSITES TECHNOLOGY

> "The Composite Integration team are extremely knowledgeable and committed to providing ongoing support for our Ciject One, the CI team have always been readily available to address any issues that we may have encountered along the way."

Dillon Muir
MANAGING DIRECTOR | HEREFORD GLASS FIBRE LTD.

PROCESS MANAGEMENT

- Installation team to implement on-site set-up
- Extensive supervision and guidance
- Projects overseen to maximise productivity

TRAINING & EDUCATION

- Theoretical, practical and technical support
- Delivery of application focused courses
- Member of the National Composites Centre

AFTERSALES SUPPORT

- On-going process support and development
- Cloud based support network
- Long-term customer collaboration

The Ciject Range – Versatile, Economic & Expandable

The Heart of Your Project

With over 20 years of experience behind us, we've continually evolved and innovated to meet the needs of our clients. Our close working relationship with industry leaders has generated a mutually beneficial climate of inspiration and innovation.

The Ciject range of resin mixing and injection equipment for single, two and three component systems is widely acknowledged as being the most sophisticated available, and combines award winning design with the highest quality engineering.

Our core line-up of injection machines are highly configurable, from factory standard to uniquely bespoke to meet the exacting standards required by our global client base.

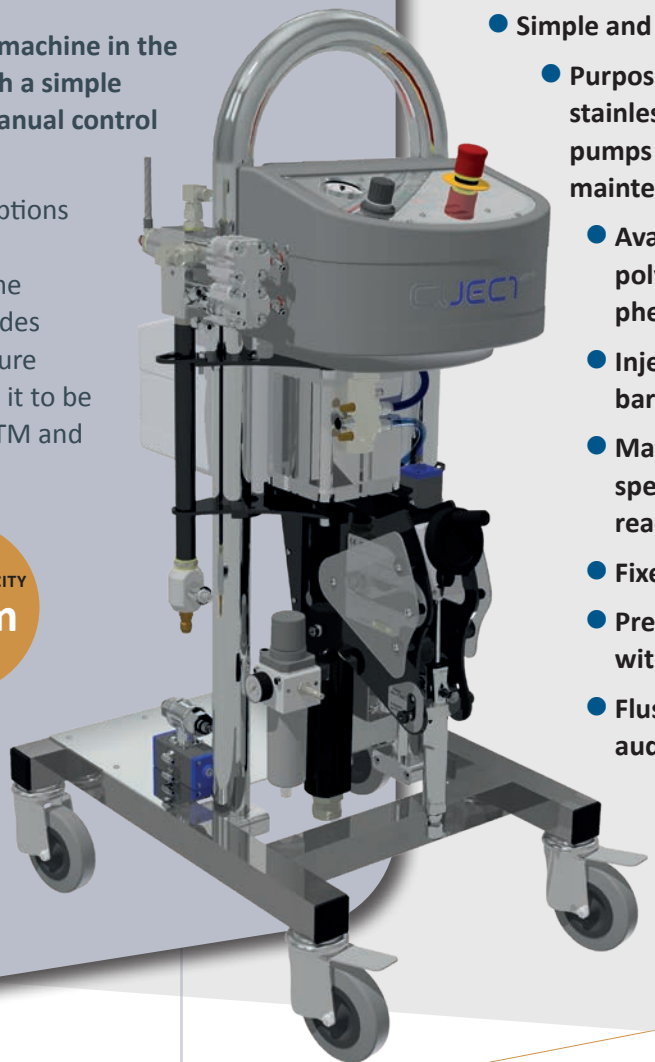
CIJECT ZERO

RTM/VRTM INJECTION MACHINE

The entry level machine in the Ciject range with a simple and effective manual control system.

With multiple options for job-specific configuration, the Ciject Zero includes electronic pressure control allowing it to be used for both RTM and VRTM.

MIXED OUTPUT CAPACITY
8 Kg/m



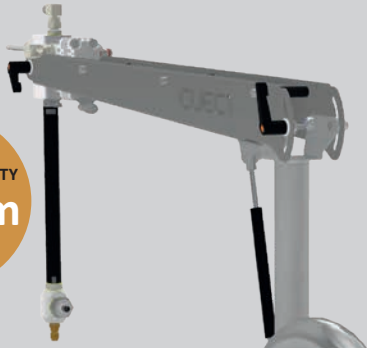
Features include:

- **Simple and reliable operator control**
- **Purpose designed resin and 316 stainless steel catalyst/hardener piston pumps for high reliability and simple maintenance**
- **Available with mix ratios to suit polyester/vinylester, epoxy or phenolic systems**
- **Injection pressure range –0.9 to 8.0 bar (G)**
- **Manually adjustable injection speeds with digital pump count readout**
- **Fixed automatic mix-head**
- **Pre-settable volume/pump counter with auto-stop**
- **Flush alarm which provides timed audible warning after injection**
- **Lockable settings**

CIJECT ONE

RTM/VRTM INJECTION MACHINE

A sophisticated machine with programmable functions and an extensive level of control options.

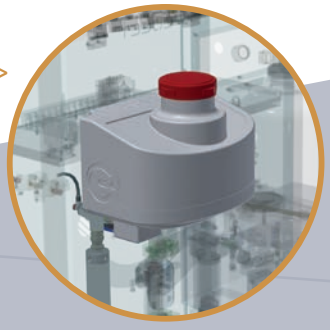


MIXED OUTPUT CAPACITY
10 Kg/m

The Ciject One's resin and 316 stainless steel piston pumps are built for high reliability with a unique pivoted mounting that provides easy access for maintenance.

A versatile combination of simplicity, durability and control.

Integrated flush system to ensure simple, quick cleaning >



Features include:

- **Advanced seal technology preventing leaks without the need for lubrication**
- **Available with mix ratios to suit polyester/ vinylester, epoxy or phenolic systems**
- **Injection pressure range of -1 to 9 bar (G) with full PID pressure control**
- **Alarm monitored injection pause control and gel timer with flush indicator**
- **110—240V industrial micro-electric PLC control with colour touchscreen operator display**
- **Fully enclosed cabinet with full operator control**
- **Pre-Injection vacuum test**
- **Catalyst system with return isolation valve**
- **Solvent level sensor**
- **Low volume, non-pressurized mix-head flush system**
- **Storage area for hardener/solvent**
- **Inline resin filter allowing cleaning without removal of loading hose**

The Ciject Range – Versatile, Economic & Expandable

CIJECT TWO

RTM/VRTM INJECTION MACHINE

MIXED OUTPUT CAPACITY
10 Kg/m

Modular and highly expandable, the Ciject Two offers a versatile, programmable logic controller, accessed by Siemens PLC Large touchscreen interface. The Ciject Two also provides the option of tank module connectivity.

An ideal solution for small to medium sized projects requiring mixed outputs of 0.1 to 10 Kg a minute (viscosity dependent).

Upgraded comprehensive yet flexible control system to be used for RTM, LRTM and Direct Infusion™ >

Features include:

- **Fully enclosed cabinet with full operator control**
- **Siemens PLC and large touchscreen for ease of use and powerful data acquisition**
- **Configurable mix ratios to suit polyester/ vinylester, epoxy or phenolic systems**
- **Injection pressure range of -1 to 9 bar (G) with full PID pressure control**
- **Seamless compatibility with our range of in-mould pressure sensors (IMPS)**
- **Low volume/high velocity mix-head flush system to ensure simple and quick cleaning with minimum solvent use**
- **Comprehensive configuration and recipe control**
- **Remote display access**
- **Inline flow meters to ensure material ratio accuracy**
- **Catalyst/hardener monitoring system**
- **Catalyst system includes return isolation valve to provide additional security**

< Software includes onboard monitoring of material tanks via full colour touchscreen GUI

CIJECT THREE

ADVANCED COMPOSITES MACHINES

The Ciject Three range is the result of extensive development work in advanced composite manufacturing technology.

Working with tier-one aerospace and advanced materials manufacturers in combination with collaborative project work has enabled us to develop the most advanced equipment currently available.

Originally developed for R&D and lab-scale processing, the Ciject Three has been developed further to suit the specific requirements of the aerospace and other hi-tech composite manufacturing industries. These machines allow different resin systems to be prepared (i.e. heated, mixed, degassed) and then dispensed without the need to clean and re-prime a mechanical pumping system.

Controlled via a powerful PLC enabling the addition of complex control and monitoring options >

Features include:

- **Total volume of vessel 27 litres, maximum resin capacity 10 litres**
- **Pneumatically actuated and damped vessel lid system**
- **Vessel incorporates an angled base to allow maximum amount of resin to be used**
- **Working pressure 1 mbar to 7 bar (ABS)**
- **12 mm disposable mould outlet tube with pneumatically actuated pinch valve to start or stop process controlled from HMI.**
- **Mechanical over-pressure valve with integrated exotherm management system**
- **0 to 10 bar (ABS) pressure transducer**
- **Through-lid viewing port**
- **Modular Siemens PLC**
- **Electronic pressure control accessed and displayed via HMI**
- **Fabricated steel chassis supporting vessel and control cabinet**
- **Machine mounted on wheels (2 x locking)**
- **Adjustable boom to support outlet hose**

Peripheral Kit List for Dependable Engineering

Completing the Picture

Precision engineering requires every link in the manufacturing chain to perform its function with the highest possible accuracy. That's why we've developed our own catalogue of peripheral and ancillary equipment, specifically designed to complement the Ciject injection machinery range.

Guaranteed compatibility, combined with unrivalled quality and reliability make our accessories the premier choice for any Ciject-based operation.

Covering every aspect of resin transfer applications, our extensive parts list has evolved to keep pace with the latest developments in moulding technology, regularly updated and curated by our industry-leading team of experts.

And what's more, the knowledge gained through the real-life implementation of our own products is passed on to our clients, with solid practical advice available to help your project run smoothly.

INJECTION VALVE

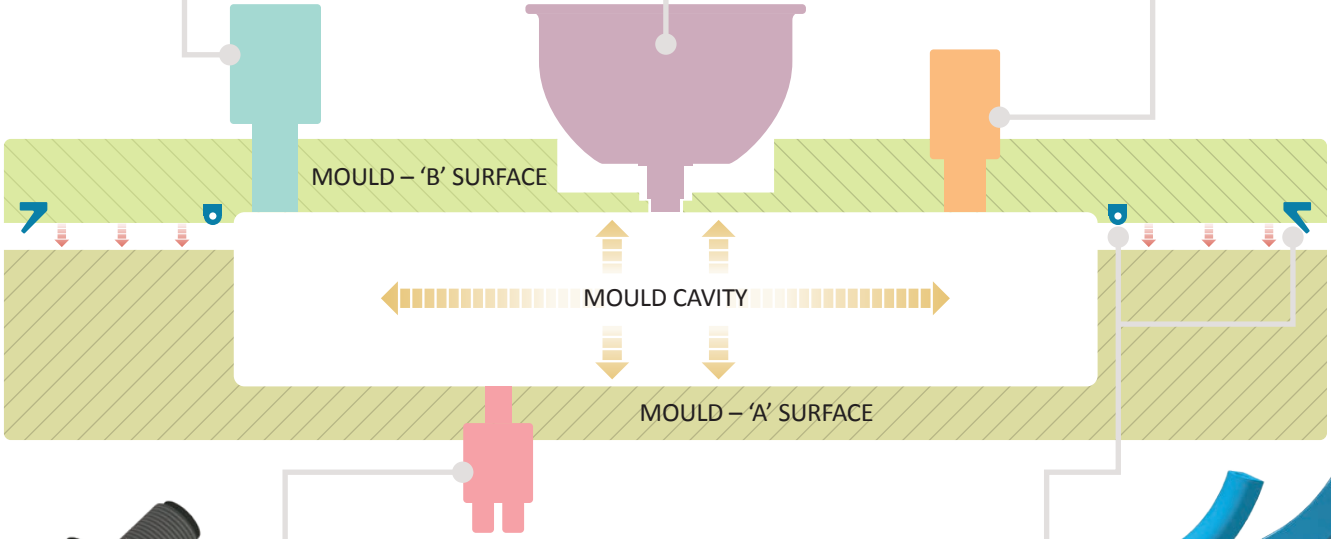
Ensures easy isolation of the mould cavity and vacuum tight seals, for reliable and clean operation.

CATCH-POT

Positioned between the mould and vacuum pump to prevent excess resin being drawn from the mould cavity and into the pump.

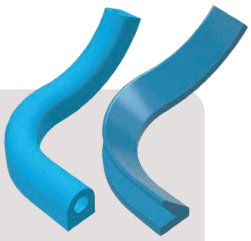
IMPS SENSOR

Developed specifically for accurate pressure monitoring and control, providing in-mould feedback to Ciject injection machines.



AIR EJECTOR VALVE

Provides an efficient method of removing cured mouldings without the damage associated with wedges or mechanical force.



SILICONE SEALS

With a service rating temperature of 200°C, our seals allow the majority of moulds to be built with a standard seal groove.

VACUUM EQUIPMENT

ROTARY-CLAW SYSTEM

Rotary-claw type pumps are ideally suited to large scale RTM and VRTM processes, combining exceptional toughness, high-flow rates and low output noise.

This type of vacuum system is not adversely affected by air-admittance during the moulding process, unlike oil-lubricated pumps, which will vent oil vapour if used in this type of application.

Available as a stand-alone pump or in a range of configurations.

Features include:

- **Choice of regulated or non regulated outputs**
- **High output, oil free rotary-claw type vacuum pump up o 80m³/h**
- **Standard vacuum pump is three phase, 415 V supply**
- **Achievable vacuum levels of <1.0 mbar (absolute)**
- **Highly reliable and relatively quiet**
- **High-flow rate ideally suited for multiple mould operations**
- **Long service intervals**
- **Fitted with a replaceable cartridge filter to prevent dust and fibre entering the pump**

TOOLING FACILITIES

BUILD AND DESIGN CAPABILITIES

Our engineering department is on hand to provide technical help and specialist advice for all your bespoke projects.

SERVING THE COMPOSITES INDUSTRY WORLDWIDE

COMPOSITE INTEGRATION
INNOVATION IN COMPOSITES TECHNOLOGY

+44 (0)1752 849998
info@composite-integration.co.uk
www.composite-integration.co.uk

1F LONG ACRE | SALTASH | CORNWALL | PL12 6LZ | UK