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Using Ciject™ Injection Equipment to supply resin to infusion processes.

Note: This type of equipment is normally specified to the customer's particular requirements. This document is intended as an introductory guide and Composite Integration Ltd can provide a detailed quotation and specification based on these requirements.

Introduction:

Many options exist for using meter-mixing injection equipment to supply resin into a 'bag-infusion' process.

The advantages of a mechanised resin feed can include the following:

- Avoids manual mixing- sometimes on a very large scale and at very high flow rates
- Accurate and controllable mixing
- Massive reduction in wastage
- Opportunity for recording process data

The Ciject™ range of injection equipment can be configured for this type of use and consideration is first given to the following questions:

- Is the resin to be directly fed into the infusion mould or fed into a bulk container for secondary connection to the mould
- Required flow-rate (this will be directly influenced by the material viscosity and reactivity)
- Required level of sophistication (automatic catalyst level setting, flow monitoring, data acquisition, mould recognition etc)

The following technical summary covers these three main areas, and describes some of the most common features:

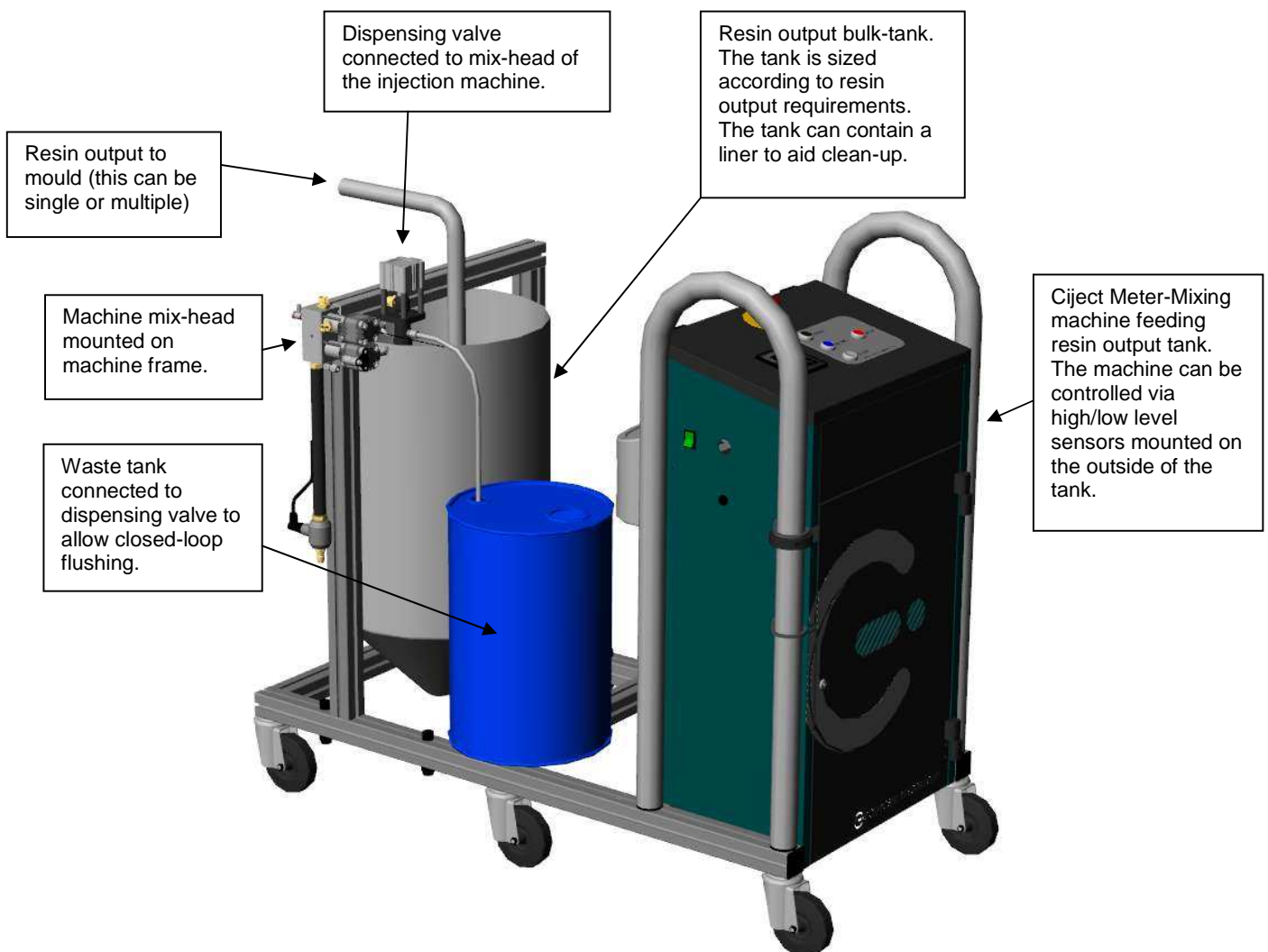
Indirect Resin feed (to 'indirect' bulk tank)

In this configuration the injection machine is used to feed a bulk-tank. The bulk tank is connected to the infusion mould via secondary pipework.

Filling the bulk-tank prior to opening the feed lines can compensate for the very high resin uptake often seen at the start of an infusion cycle. The relative size of the bulk-tank will depend on this factor.

The machine can be automatically controlled to maintain a suitable level of mixed resin in the tank during the infusion process.

This basic concept is illustrated below:

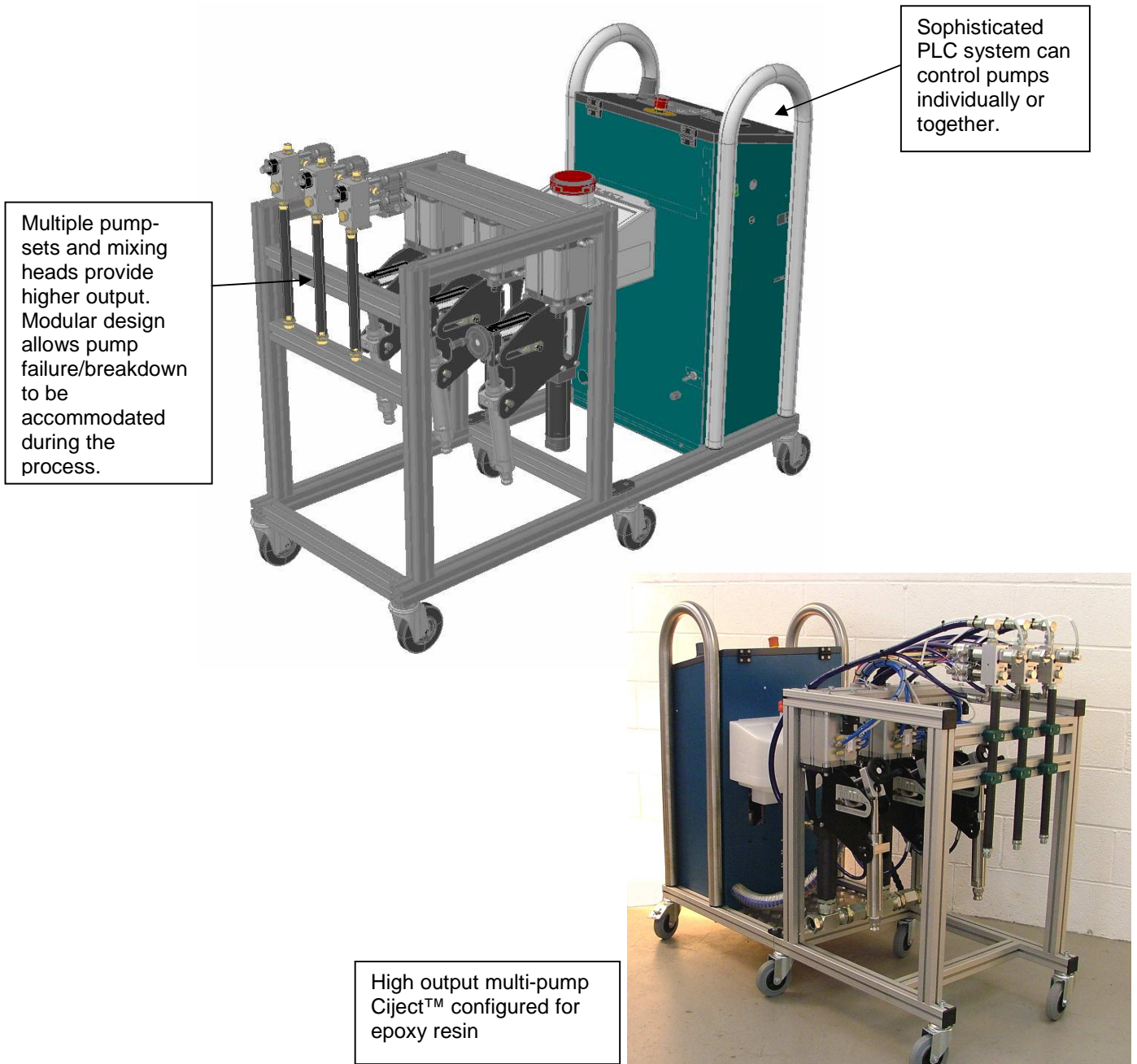


Requirements for High Feed Rate:

If the feed-rate requirements are higher than those achievable with a standard Ciject™ (depending on viscosity and output requirements) a multiple pump system can be specified. This type of machine can accommodate very high flow rates (>30-40 L/min) and can provide excellent flexibility of output.

A multiple pump system can also help guard against failure during an infusion cycle by allowing individual pumps to be shut-down whilst maintaining output to the mould with the remaining pumps.

Typical Multi-pump Ciject™ set-up with three individually controlled pump sets:



Control Systems for Ciject™ Infusion machines

The control of an infusion machine must address the two main parameters.

- **Pressure**
- **Flow**

Pressure:

Indirect Injection:

If the machine is to be used to fill an indirect bulk-tank then the output pressure of the resin is irrelevant. The machine will be controlled according to the requirement for flow-rate and thus the run-speed of the pumps.

Direct Injection:

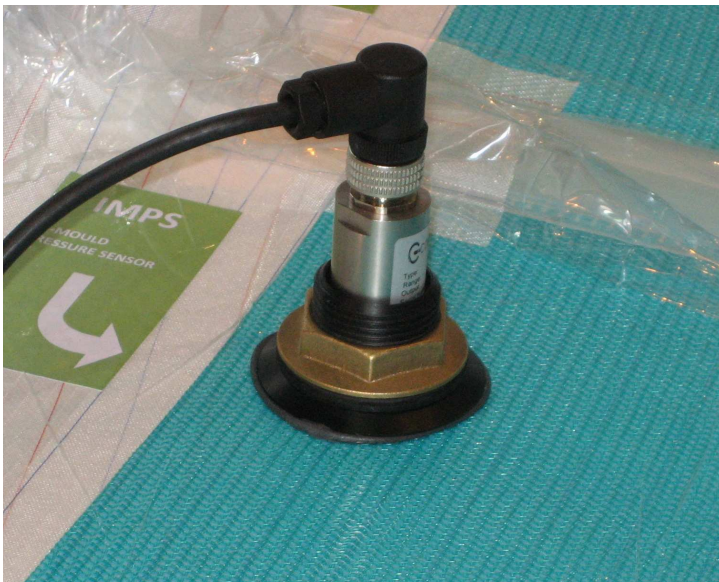
If the machine is to be directly connected to the infusion mould then it is absolutely vital to control the output pressure and prevent over-pressurisation of the bag.

The standard Ciject™ machine includes highly accurate pressure control based on an electronic transducer mounted at the injection head and feeding back to the PLC.

In an infusion process this sensor must be positioned as near the resin feed-point as possible, so that the controller has an accurate indication of the actual in-mould conditions. The exact sensor mounting method will depend on the pipework configuration.

Additional pressure feed-back can be gained from the mould itself with the use of In Mould Pressure Sensors (IMPS). The sensors are mounted through the vacuum bag to provide accurate digital feedback either to the machine PLC or to a self contained read-out unit.

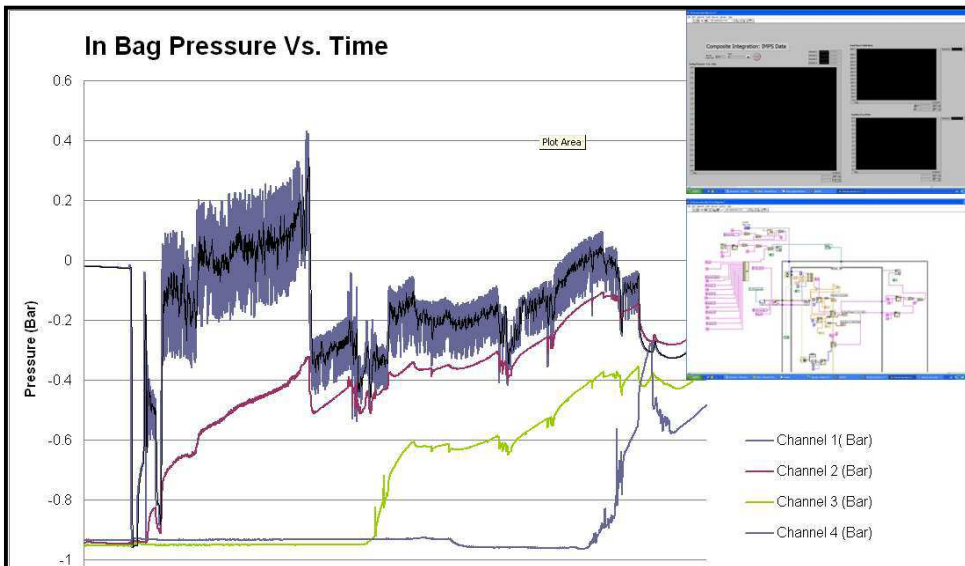
Multiple sensor inputs can be accommodated to provide an excellent understanding of the in-mould conditions.



Through-bag IMPS Sensor in use



IMPS Sensor and digital readout unit



Data acquired during large-scale infusion process.

Flow Monitoring and control:

The Ciject™ machine range includes optional flow monitoring. Flow meters can be mounted in either component stream to provide accurate feedback, and to guard against ratio inaccuracies. The flow meter(s) can trigger an alarm or instigate machine shutdown if the flow rates go outside preset parameters.

The exact specification of these sensors will depend on the specification of the material to be measured and flow-rate range required.

Level sensors can also be included to monitor resin, catalyst and solvent levels during the process.

Typical Sensor used to monitor catalyst flow:



Thermodynamic Catalyst Flow Sensor with scaling LED output and link to control system alarm and operator display.
High accuracy with flow level monitoring from 0.001 litre/min to 1 litre/min

Motorised Catalyst Ratio adjustment System

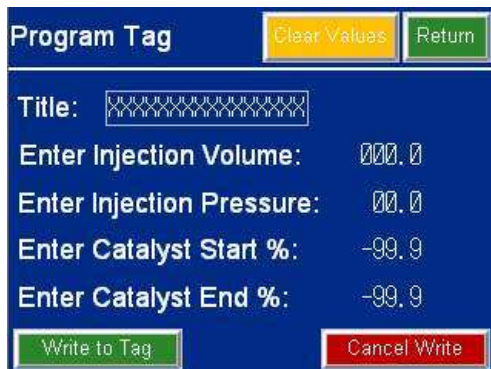
The machine also can be fitted with the option to adjust catalyst/hardener levels during the injection process.

- Automatic motorized catalyst level control linked to recipes
- Progressive catalyst injection for automatic control during injection of large components. Allows injection to start at one ratio and progressively increase during the injection to finish at a second ratio.
- System uses high quality DC servo motor system with digital rotary encoder for continual position monitoring and origin detection.
- Auto origin function on machine start-up.

Radio Frequency Identification System (RFID)

This option enables the machine to recognise individual moulds (by reading a dedicated RFID tag) and to set appropriate process parameters accordingly.

- RFID mould recognition system. Enables supervisor to program tag attached to mould. Operator scans tag which sets machine injection parameters. Allows unlimited number of moulds to be identified by the machine. Prevents incorrect injection settings.
- Tags can be attached to mould and are self powered and highly resistant to damage.
- This system removes the requirement for an operator to select the correct recipe and allows unlimited numbers of moulds to be instantly recognised by the injection machine.



Typical screen from PLC HMI

Arriving at a machine specification:

The following areas will need consideration when specifying equipment for use in this process.

- Material specification (resin type, viscosity, temperature requirements etc)
- Max Flow rate
- Max shot size
- Requirement for direct or indirect resin feed
- Number of infusion feed lines to be used
- Flow monitoring required
- Requirement for automatic catalyst level adjustment
- Level of process monitoring required
- Requirement for heating (either material)
- Requirement for In-mould pressure sensing/monitoring
- Requirement for pre-programmed mould recognition