MuCell® Modular Upgrade

Technical Description

The MuCell Modular Upgrade (MMU) converts a standard injection molding machine into a fully capable MuCell molding machine. The upgrade consists of two distinct modules. A new injection module that is designed as a direct replacement of the existing injection unit and the Series II SCF module.

The MuCell capable injection unit contains all the necessary electrical hardware and interface connections, which are required to be monitored and/or actuated during the MuCell molding process. The existing machine controller is not affected and continues to provide all of the same functions as with the standard machine.

The MuCell Process and all functions are controlled through the Series II SCF PLC interface. This interface also controls the Trexel® SCF System and the MuCell Interface Kit. The MuCell Modular Upgrade does not require any changes or interface to the injection molding machine controller.

I. Eligible machines for a MMU

A. Can any machine at all be upgraded with the MMU ?

There is a short check list of requirements for a machine to be eligible for a MMU. See **Appendix A**

The basic information required on a molding machine is:

1) The machine supplier, machine model number, serial number and date of manufacture
    - Machine age less than 10 years
2) The clamp size
3) The screw diameter and L/D ratio
    - Minimum L/D = 20:1
4) Hydraulic or Electric and if hydraulic, the system pressure
    - Minimum System Pressure = 2000 psi
5) Maximum injection velocity and pressure
    - Minimum 4”/sec
6) Maximum back pressure during screw recovery
    - Minimum 350psi hydraulic
7) Current Safety Conformance
    - Must comply with ANSI standards for date of manufacture

MuCell® Modular Upgrade

II. Logistics

A. Do I need to send the current machine to Trexel for an upgrade ?
No, the machine will be upgraded at the customers facility and the upgrade is estimated to be completed within one week. The customer will supply the support necessary to remove the old screw and barrel and to install the MuCell screw and barrel.

B. What is the lead time for the MMU ?
The lead time for the MMU is equal to the lead time for the fabrication of the screw. Since Trexel insists on wear resistant screws (70mm and less) for the MuCell Process, the lead time will typically be 12-14 weeks.

III. MMU Design Features

A. How has Trexel managed to change from a 28:1 to a 22:1 screw design ?
Trexel has been working on the new screw design for 3 years. Our extraordinary improvements in the control of SCF dosing has made the entire system far more efficient requiring less time to make a single phase solution. Our process knowledge has also improved during this time.

B. Will the performance results for products molded on the MMU be the same as those for products molded on a factory supplied MuCell Machine ?
Yes, the key point of the MMU is that Trexel has developed a screw that permits a single phase solution of gas and polymer to be created more quickly and has developed software that allows for the necessary control to keep it in solution until it is injected into the mold. Once the single phase solution is created and maintained, a microcellular structure will be created when the polymer is injected into the mold.

C. Can I use the MuCell injection unit to process solid parts ?
Yes. Just as with the factory supplied MuCell Machine, the screw may be used for solid processing.

D. Does this mean that I will have to operate two controllers ? What is the implications of this for my operations ?
Yes, you will have to operate two controllers; the injection molding machine controller and the MuCell controller. This is the same as today. If you were to purchase a new MuCell injection molding machine, you would have to operate the injection molding machine and the Trexel SCF System controller. The advantage of the MuCell controller is that all the MuCell specific functions are controlled as specified and programmed by Trexel.

III. MMU Design Features, cont.

E. Is the MPP controlled by locking the hydraulic oil behind the screw at the end of screw recovery, or by controlling the oil pressure during screw idle ?

After the screw recovery phase is completed under standard back pressure control, the MMU controller activates the necessary signals to the MMU hydraulic module to maintain the MPP. The MMU hydraulic modules uses both locked oil and controlled pressure to control MPP during the screw idle phase.

F. Who is responsible for adding accumulators ?

The use of accumulators to increase standard injection rates are not mandatory for MuCell capable machines. The MMU package will not include accumulators. The MMU will not be offered in those applications where the addition of accumulators is required.

IV. System Operation

A. How will Process monitoring be accomplished ? What information will be acquired by the Trexel controller ?

Process monitoring will be accomplished through the MuCell controller. All parameters are measured independently from the injection molding machine instrumentation using Trexel supplied instrumentation. The MuCell controller will output all the MuCell process parameters at the end of each cycle. The data will be outputted through the dedicated RS-485 serial port on the back of the Trexel SCF System. The data will be in a simple ASCII character protocol in a comma delimited format that can be easily imported into data acquisition or statistical process control software. A partial list of parameters outputted is listed below.

- Cycle Count
- Cycle Time
- SCF Flowrate
- SCF Flowrate Setpoint
- SCF Suction Pressure
- SCF Boost Pressure
- SCF Pre-Metering Pressure
- SCF Post-Metering Pressure
- SCF Delivery Pressure
- SCF Delivery Pressure Setpoint
- Total Injector Open Time
- Actual Percent SCF
- SCF Delivery Pressure Drop

IV. System Operation, cont.

B. Who controls the MPP ?

The controller on the SCF system controls all functions necessary to run the MuCell process including the MPP.

C. How does Trexel maintain the MPP without a software and electrical change from the machine supplier ?

The Trexel SCF system controller will contain the necessary software and electrical signals to maintain the MPP. The MMU controller does not require any changes from the machine supplier to software or electrical signals. Pressure during screw recovery will be maintained using the existing back pressure control of the injection molding machine. MPP is activated after the screw has reached shot size and will be maintained through the SCF system controller and MMU hardware.

D. Who controls the injectors ?

The control system for the Trexel SCF unit also serves as the control system for the MMU components including the SCF injectors.

E. With the modular upgrade, how do we control the timing on the gas ?

The SCF controller will also control the introduction of SCF into the barrel of the injection molding machine. The controller will open the SCF injector based on screw position and close the SCF injector based on time. The controller will also sequence the injectors (in a two injector system) based on position. This function is integral to the controller software and does not require user input.

F. How is the shutoff nozzle controlled during standard molding ?

The MMU controller has a single push key function called “Solid Molding”. Once this key is depressed, all MuCell functions are disabled, and the solid molding process is enabled.

G. Who controls the heater bands ?

The temperatures are set and controlled through the controller on the injection molding machine. The MMU package includes an electrical box with solid state relays to control the heater bands. The input signals to the relays in the MMU electrical box are sent from the injection molding machine PLC.

V. System Responsibility

A. If Trexel installs an MMU on a current molding machine, what will be the responsibility of Trexel and what will be the responsibility of the machine supplier ?

ALL of the MuCell functions will be controlled by Trexel supplied components, including the software. The screw, barrel, SCF system and Controller Logic/ software are all integrated by Trexel. The normal functions and the main power source of the molding machine including movement of the clamp system, ejector mechanism, carriage and the injection unit are the domain of the equipment supplier.

B. Who is responsible when something in the on the MuCell machine is not working ?

Trexel is responsible for problems with the MMU package**.**

C. Who will support the maintenance and replacement parts service for the MMU ?

Trexel already supports maintenance and replacement parts services for more than 100 Trexel SCF systems and almost as many MuCell Interface Kits that have been installed throughout the world. Trexel has service and support capabilities in the US, Germany, Singapore, Japan, Korea, China and Australia.

D. Who is responsible for modifying the hydraulics ?

Trexel is responsible for changes to the hydraulic system to control MPP when running the MuCell process.

VI. Components

A. What material is the cylinder made of ?

Material specifications for the barrel have to match the material specifications of the screw. A high wear resistant screw, requires high wear resistant barrel. All barrels are made with bi-metalic liners. High wear resistant barrels use X-Aloy 800 or compatible liner, general purpose barrels use X-Aloy 102 or compatible liner.

B. What kind of shutoff nozzle is used ?

The upgrade system uses the Herzog HP series with position monitoring limit switches and pneumatic actuation.

C. What interfacing is required with the machine?

There is no interfacing between the controller of the injection molding machine and that of the MMU. The instrumentation required to control SCF dosing, the shutoff nozzle and the MPP are part of the MMU equipment and provide the necessary signals between the injection molding machine and the SCF system controller.

VII Safety

A. How has Trexel dealt with the safety requirements of the upgraded machine ?

All injection molding machines built or modified must comply with section 6 of ANSI B151.1-1997 or if built or modified after July 1998 section 5 of ANSI B151.1-1997 safety standards. Once it has been verified that the machine to be upgraded complies with the existing safety standards, Trexel will ensure that the machine will also comply with the most recent standards including those items specific to the MuCell process. The most significant safety issues being the position of the shutoff nozzle pin and the pressure used to maintain the single phase solution. Trexel equipment will comply with EN201 in Europe and ANSI 151.1 in the United States as applicable, and Trexel will attain third party safety assessment from TÜV.

B. How are the safety issues being taken care of ?

The customer must certify that the machine to be upgraded complies with the most current safety standards. Trexel will take responsibility for the safety aspects of the MMU package. Trexel is working with SPI on the safety guidelines for the MuCell process in the US and is working with TUV on compliance with the applicable European Directives.

C. How are the safety systems controlled ?

The existing safety devices in the injection molding machine remain tied to the injection molding machine. A couple of additional switches are added to the injection molding machine and tied to the Trexel SCF system controller. These are used to ensure that when the operator access the nozzle area of the machine, the shutoff nozzle is in the closed position, or the pressure on the polymer melt is released.

D. How does the screw position control function when the safety guard is opened?

The control system for the Trexel SCF system monitors both the shutoff nozzle position as well as the position of the safety guards. If the shutoff nozzle is not confirmed as closed, the MPP will drop out behind the screw when the safety guard is opened. If the safety guard is opened, then the MMU will maintain the shutoff nozzle closed.

VIII Warranty

A. What will Trexel warrant on the MMU ?

A copy of the warranty is attached see **Appendix B**.

Appendix A

MuCell® Modular Upgrade Questionnaire

This questionnaire has been designed to generate critical information necessary to quote a MuCell Modular Upgrade. We look forward to working with you in order to demonstrate the many advantages of the MuCell process and how they will benefit you.

Date: _____

Company Name:		Contact Name:	
Address:		Telephone #	
		Fax #	
		E-mail Address:	
		Fax #	

The basic requirements of any molding machine considered for a MuCell Modular Upgrade is:

- **Machine age less than 10 years**
- **The screw diameter and minimum L/D ratio = 20:1**
- **For a hydraulic machine, the system pressure must be a minimum of 2000 psi**
- **Maximum specific injection pressure at least 20,000 psi**
- **Maximum Injection velocity at least 4"/sec**
- **Minimum 350 psi hydraulic back pressure during screw recovery**
- **Current Safety Conformance must comply with ANSI standards for date of manufacture**

Machine Information

Machine Manufacturer		Injection Unit Size	
Machine Model #		Clamp Tonnage	
Machine Serial #		Screw Diameter	
Date of Manufacture		Screw L/D ratio	
Hydraulic / Electric	Hydraulic☐ Electric☐	Left hand flight / Right hand flight	Left☐ Right☐
Hydraulic / Toggle	Hydraulic☐ Toggle☐	Horizontal/Vertical	Horizontal☐ Vertical☐

Injection Unit Information

Maximum Screw Stroke		Maximum Torque	
Maximum Injection Pressure		Maximum RPM	
Maximum Injection Velocity		Maximum Back Pressure	

MuCell® Modular Upgrade

Appendix A

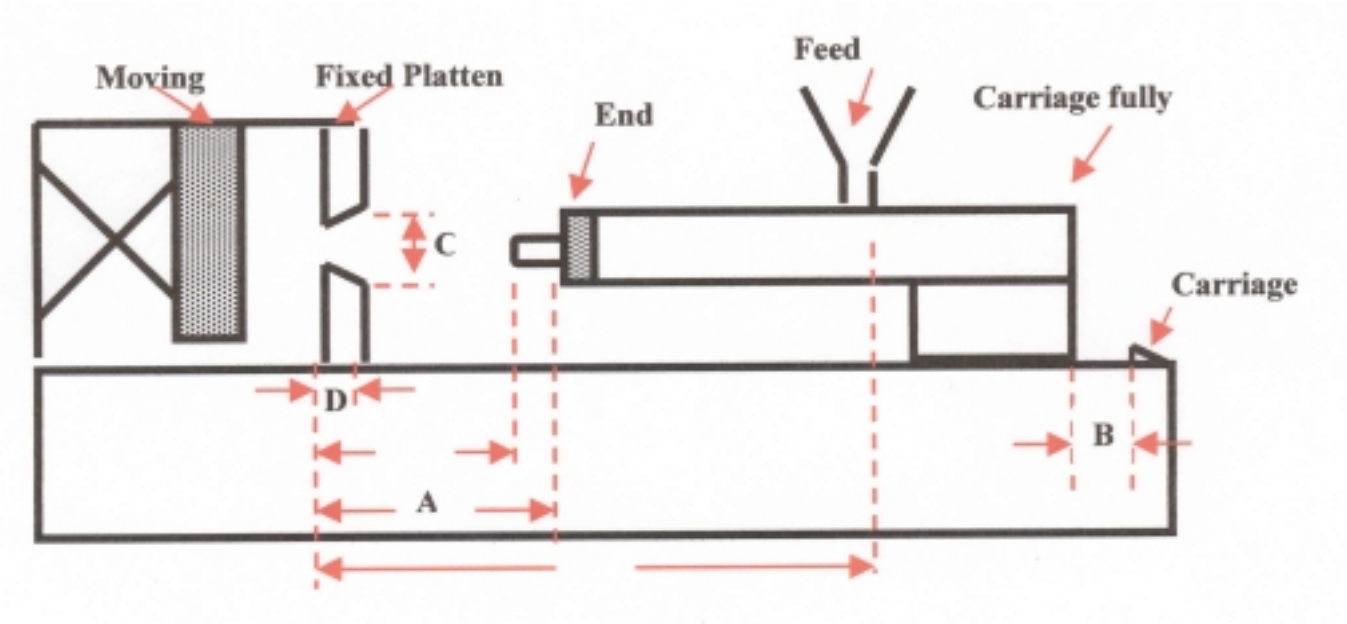
Carriage Information

Barrel Support Yes ☐ No ☐

Machines Dimensions

A_____ B_____ C_____

D_____ E_____ F_____



MuCell® Modular Upgrade

Appendix B

MuCell Modular Upgrade Warranty

a) We warrant solely to Buyer that the products will be free from defects in materials and workmanship, when given normal, proper and intended usage, for a period of ninety (90) days from first startup date or one hundred eighty (180) days from the date of delivery whichever is earlier, provided, further, that, the warranty for any pump, barrel, screw or screw tip purchased hereunder shall be for a period of twelve (12) months from date of delivery. At our expense, we agree to repair or replace at our option all defective products provided that Buyer has given us written notice of such warranty claim and obtained RMA number from Trexel within the warranty period. If we are unable, after reasonable efforts, to repair or replace such defective products, Buyer's sole remedy shall be the refund of an amount not to exceed the actual payments received by us for such products. All repairs will be done during normal working hours. All replaced parts shall become our property. We may require the products to be shipped to us or elsewhere and returned to Buyer, at our expense, for warranty service to be performed. If we determine that products for which Buyer has requested warranty service are not eligible for warranty service, for any reason, Buyer shall pay or reimburse us for all costs of investigating and responding to such request at our then prevailing time and materials rates. If we provide repair services or replacement parts that are not covered by the warranty provided in this Section 7, Buyer shall pay us at our then prevailing time and materials rates.

b) We shall have no obligation to make repairs, replacements or corrections which result, in whole or in part, from (i) normal wear and tear, (ii) catastrophe, fault or negligence of Buyer, (iii) improper or unauthorized use of the products, (iv) use of the products in a manner for which they were not designed, (v) causes external to the products such as, but not limited to, power failure or electric power surges, or (vi) use of the products in combination with equipment not specified or supplied by us.

c) EXCEPT AS STATED ABOVE, WE DISCLAIM ALL WARRANTIES, WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, WITH RESPECT TO THE PRODUCTS, INCLUDING ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT. THE FOREGOING INDEMNIFICATION PROVISIONS STATE OUR ENTIRE LIABILITY WITH RESPECT TO INFRINGEMENT OR ALLEGED INFRINGEMENT OF PATENTS, COPYRIGHTS, TRADEMARKS, TRADE SECRETS AND OTHER INTELLECTUAL PROPERTY OR PROPRIETARY RIGHTS BY THE PRODUCTS.