LMI6000 SERIES

MELT INDEXER WITH LIFT

OPERATING MANUAL

SUPPORT CONTACT INFORMATION

DYNISCO can be contacted for questions and support through the methods listed below:

BY PHONE AND FAX:

USA Headquarters

Phone — +1 508 541 9400
Fax — +1 508 541 6206

To help us handle your questions as quickly as possible, have the following items ready before you call:

- Instrument name and model number (on back panel) Instrument serial number (on back panel)
- Current version of instrument firmware and software (Power up unit, both shown on “Settings” screen.)

BY INTERNET:

Visit us at http://www.dynisco.com/ to get in contact with sales and aftermarket service professionals and to view supplementary resources regarding the specifications, operation and maintenance of this product.

BY MAIL/POST:

Dynisco
38 Forge Parkway
Franklin, MA 02038

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DOCUMENT HISTORY

DOCUMENT NUMBER	DATE	COMMENTS
974982	11/13/2024	Original Edition: Initial Release

BEFORE YOU BEGIN

Please read this manual from beginning to end and observe all safety warnings and symbols. It is important that this instruction manual be made available to all operators of the LMI6000. Please contact us if you have any questions regarding the LMI6000.

Maintenance and/or service should only be performed by a qualified electrician or engineer.

Melt flow index testing methods and apparatus are specified by national standards such as ASTM D1238. The applicable national standard for the test method should be studied by all operators of the LMI6000. This manual in no way supersedes that standard.

TABLE OF CONTENTS

INTRODUCTION 8

UNPACKING THE MELT FLOW INDEXER 14

BENCH REQUIREMENTS AND PLACEMENT 15

LEVEL THE MELT FLOW INDEXER 15

INSTALLING THE SCREEN 15

Installing the post 16

INSTALLING WEIGHTS INTO LIFT SYSTEM 16

INSTRUMENT OVERVIEW 18

FRONT VIEW 19

REAR VIEW 19

LMI SIDE VIEW USB AND ETHERNET CONNECTION PORTS 19

FAMILIARIZE YOURSELF WITH THE PISTON ROD 20

OPTIONAL DIGITAL ENCODER 21

OPTIONAL AUTOCUTTER 22

OPERATIONS GUIDE 23

STARTUP AND USER ACCESS LEVELS 24

RESETTING THE PASSWORD 25

SCREEN ICONS 26

SETTINGS 27

MACHINE SETTINGS 28

CLOUD CONNECTIVITY 31

SECURITY 31

REGISTERING FOR A CLOUD ACCOUNT 32

CONNECTING TO A NETWORK 32

VERIFYING CONNECTION 32

REGARDING WEIGHTS, LOCAL GRAVITY, AND THE OPTIONAL SCALE 33

TOOLING TECHNIQUES 35

LOADING AND PACKING MATERIAL INTO THE BARREL 36

WEIGHING THE MATERIAL CHARGE 37

SETTING A PISTON TRAVEL DISTANCE DURING MVR TESTING 39

WHAT TO KNOW BEFORE YOUR UNA TEST 40

PRE-TEST CHECKLIST 41

TESTING METHODS 41
IMPORTANT INFORMATION 42
THE METHOD A TEST 43
GENERAL DESCRIPTION 44
CALCULATION METHOD A 44
CREATING A PROCEDURE A RECIPE 44
STARTING THE TEST 46
LOADING THE SAMPLE 47
PREHEAT 47
COLLECT SAMPLES 49
RESULTS 50
WEIGH THE SAMPLES 50
THE METHOD A/B TEST 52
GENERAL DESCRIPTION 53
CALCULATIONS, METHOD A/B 53
CREATING A PROCEDURE A/B RECIPE 54
STARTING THE TEST 56
LOADING THE SAMPLE 57
PREHEAT 57
COLLECT SAMPLES 58
RESULTS 58
WEIGH THE SAMPLES 59
THE METHOD B TEST 60
GENERAL DESCRIPTION 61
CALCULATIONS, METHOD B 61
TYPICAL MELT DENSITIES 62
CREATING A PROCEDURE B RECIPE 64
STARTING THE TEST 66
LOADING THE SAMPLE 67
PREHEAT 67
COLLECT SAMPLES 68
RESULTS 68
THE METHOD C TEST 69
GENERAL DESCRIPTION 70
CALCULATIONS, METHOD C 70
TYPICAL MELT DENSITIES 71
CREATING A PROCEDURE C RECIPE 73

STARTING THE TEST 76
LOADING THE SAMPLE 77
PREHEAT 77
COLLECT SAMPLES 78
RESULTS 78
THE METHOD D TEST 80
GENERAL DESCRIPTION 81
CALCULATIONS, METHOD D 81
CREATING A PROCEDURE D RECIPE 82
STARTING THE TEST 84
LOADING THE SAMPLE 85
PREHEAT 85
COLLECT SAMPLES 86
RESULTS 86
DESCRIPTION OF RESULTS 87
INTRINSIC VISCOSITY 88
MAINTAINING YOUR LMI 90
SECURE THE ENCODER ARM 91
CLEANING UP 91
CLEANING TOUGH POLYMER RESIDUE WITH SOLVENTS 92
INSTRUMENT RECOMMENDED MAINTENANCE SCHEDULE 93
ADDITIONAL SUPPORT 95
NIST STANDARD REFERENCE MATERIALS (SRM) 98
GETTING WRONG OR NON-REPEATABLE TEST VALUES 99
AUTOCUTTER DOES NOT OPERATE 99
GLOSSARY OF TERMS 100
APPENDIX I 103
APPENDIX II 107
APPENDIX III 110
REPLACEMENT MICA INSULATORS 111

INTRODUCTION

SECTION 1: INTRODUCING THE LMI6000

INTRODUCTION

Of all the tests used by the plastics industry, melt flow rate testing (or melt flow index) is most widely used. It has been traditionally associated with the testing of polyethylene materials to determine lot–to–lot consistency of resin lots or batches for quality control purposes. It is, however, also used for other purposes such as testing new materials, determination of material stability versus residence time within plastics processing equipment, or the assessment of regrind content within materials or moldings. It is generally a low shear rate test, however, using larger weights can increase the shear rate.

A flow rate test is a measure of a polymer's mass flow rate (grams extruded in 10 minutes) using an orifice under specified conditions of temperature and load. Machines that determine flow rate are generally called Melt Indexers or Extrusion Plastometers. Test methods by ISO, DIN, ASTM and others specify heat chamber and piston tip diameter such that the shear stress on the polymer is the same in all machines for a given load. In addition, material specification guidelines (by ISO, DIN, ASTM, GM etc) may exist which give further constraints on how a particular type of material may be run.

The melt flow rate (MFR) is reported, (ASTM D1238) as the rate of extrusion expressed as grams per 10 minutes. The results are sometimes shown as MFR (190, 2.16) =2.3. They could also be shown as, MFR (190, 21.2) =2.3. This means that the temperature was 190ºC and a load of 21.2 kg was used. It is important to specify, in any report or table, the test procedure used for testing, the nature and physical form of the material tested, the temperature, the load used, details of any material conditioning (for example, drying), the procedure used (for example, Method A or B), and any unusual behavior of the plastic material seen during the test.

The tests performed are those described by national standards ASTM D1238 and ISO 1133-1, 1133-2. The precision and accuracy of the test has been determined by the applicable national standard. Contributing to both precision and accuracy are operator variances such as; packing technique, cleaning, cutting, weighing etc. With moisture sensitive polymers, dryness can also play a major role, and time can be a factor with thermally unstable polymers, so procedures must be identical. DYNISCO has found that charging a consistent mass of material into the barrel (±0.1 grams) is the most critical factor in getting precise data.

Several methods have been developed for running flow rate tests under D1238, with Methods A (mass of material over time) and B (volume of material over time) being the basic of all methods. Method A is simply the collection of extrudate over time, while Methods B, C and D are the measurement of time for the flow of a fixed volume of polymer. All but Method A require an encoder to measure distance traveled to determine volume of material extruded during the test.

SAFETY SUMMARY

The following are recommended safety precautions unrelated to any specific procedures in this manual and therefore do not appear elsewhere. Personnel must understand and apply them as appropriate during all phases of operation and maintenance.

IN ALL CASES, BE PRUDENT.

KEEP AWAY FROM LIVE CIRCUITS

Do not replace components or adjust inside equipment with power turned on. To avoid injuries, always remove the power source and discharge and ground a circuit before touching it. When making electrical connections, the services of a qualified electrician must be employed. Contact with live electrical circuits can cause serious personal injury or death. Be sure no circuits are energized during installation, connection or removal of any electrical cables or lines.

PROVIDE ADEQUATE VENTILATION

Provide ventilation to remove heat and noxious odors and to prevent the accumulation of asphyxiates such as nitrogen gas. Many polymers (PVC, PVR etc.) are well known for giving off hazardous fumes at elevated temperatures. An exhaust system that removes fumes from both the die exit and near the top of the barrel is strongly recommended. Consideration should also be given to additives that may degrade or decompose at elevated test temperatures.

WEAR PROTECTIVE CLOTHING

Wear protective clothing (gloves, apron, goggles, etc.) approved for the materials and tools being used. Dies and piston rods are extremely hot and are designed to quickly transfer heat to the sample being tested. Even brief contact can cause a burn.

USE GLOVES AND PPE, EQUIPMENT AND TOOLS CAN BE HOT

To prevent burns, gloves and a long sleeve shirt (or lab coat) are essential. Dies and piston rods are extremely hot and are designed to quickly transfer heat to the sample being tested. Unfortunately, this means they will transfer heat very quickly to you as well. The indexer barrel housing can also get very hot. However, at any barrel temperature, these should not cause burns if touched for a very brief period except very near the barrel top and bottom. Consider where dies may fall. If they are dropped on nylon carpeting or similar materials, they can quickly form holes. Protective mats may be needed.

DYNISCO recommends keeping hot piston rod and hot die in the chamber/barrel; this precludes someone picking it up inadvertently. Be sure to hold the piston by the top insulator.

AVOID HOT SURFACES AND MATERIALS ON THE MACHINE

Keep hands away from hot surfaces and materials. Contact with hot surfaces or materials can cause blistering and third-degree burns. Wear approved, clean, thermally insulated gloves when handling these components. Should injury occur; immerse injured area in cold water and get immediate medical attention.

ELECTRICAL HAZARD

Your DYNISCO Lab Melt Flow Indexer contains high voltage inside the housing. DO NOT remove the housing or any part of its outer covers; there are no user serviceable parts inside. Service should only be done by a qualified DYNISCO Service Technician. Be sure the outlet used to power the indexer is properly grounded.

PINCH POINTS

Do not place weights in precarious positions where they can be bumped and fall to the floor. For large test weights (over 10 kg) the electromechanical lift system is recommended. The lift system has a mechanical capture rod which will not allow the weights to “fall” out of the machine. When the machine is operating, the lift system moves the weight downward somewhat quickly, creating an area where anything lying beneath could be crushed. The lift system has a safety door that, when installed correctly and not tampered with, will prevent the lift from moving when opened. There are redundant internal firmware and mechanical hardware safeties in place in the lift system.

OBLIGATION OF THE OPERATOR TO EXERCISE DUE CARE

The LMI6000 was designed and constructed taking into consideration a hazard analysis having carefully adhering to the harmonized safety standards as well as further technical specifications. Thus, the LMI6000 conforms to state-of-the-art technology and ensures a maximum of safety.

In practical operation, this safety can, however, be achieved only if all necessary measures are taken. The obligation of the plant operator to exercise due care includes planning these measures and supervising their execution.

The operator must ensure that:

- The LMI6000 will be used only in accordance with the intended purpose.
- The LMI6000 will be operated in a flawless, functionally efficient condition and that the functional efficiency of the safety devices will be checked at regular intervals.
- No modifications will be made to the component except by a DYNISCO service person.
- The necessary personal protective equipment for the operation, maintenance, and service will be available and used by any personnel performing these functions.
- The operating instructions are always available completely and fully legible at the installation location of the LMI6000. It must be guaranteed that all persons who work with the LMI6000 can consult the operating instructions at any time.
- Only sufficiently qualified and authorized personnel will operate, maintain, and repair the LMI6000.
- All safety and warning labels attached to the LMI6000, must not be removed and must remain fully legible.
- Additional instructions, in accordance with facility, local, state and federal industrial safety regulations and their corresponding, related ordinances for the use of work materials, will have to be made available as a supplement to the operating instructions.

SPECIFICATIONS

UTILITIES	
ELECTRICAL REQUIREMENTS	100 - 120 VAC / 220 - 240 VAC, 6A / 4A peak at power up, 5A / 2.5A, 500VA normal operational power, 50Hz / 60Hz
DIMENSIONS, LIFT MODEL	
HEIGHT [in/cm]	51 in. / 129.54 cm
WIDTH [in/cm]	18 in. / 45.72 cm
DEPTH [in/cm]	21 in. / 53.34 cm
WEIGHT, LIFT MODEL [lb/kg]	152 lbs / 68.946 kg 31.6kg Full stack ASTM 21.6kg Full stack ISO
CERTIFICATIONS & COMPLIANCES	
Complies with ISO ASTM D1238 and ISO 1133-1	

The LMI6000 is designed to determine the melt flow index and other thermal properties of polymers and is not intended for any other use.

The LMI6000 is designed for indoor use only:

- Temperature range 5ºC to 40ºC, maximum R.H. of 80% at 30ºC.
- Maximum operating altitude is 3,200 meters.
- The area that it is located shall be free from vibrations.

EQUIPMENT SETUP

UNPACKING THE MELT FLOW INDEXER

The Laboratory Melt Flow Indexer comes in a heavy-duty cardboard box. To unpack:

1. Cut three straps around the cardboard box.

2. Remove the box lid.

3. Remove all the foam sleeves on the top and around the LMI.

4. Take the packing list and documents folder from the area in front of the LMI.

5. All the accessories and parts are in a U-Section on one side of the cardboard

6. Remove the plastic bag covering the machine.

7. Carefully remove the machine from the box and place it on flat surface. box walls. Take care when removing the cardboard walls to prevent the accessories and parts from dropping out.

8. Remove the bottom flat cardboard and the weight that is in the cardboard grid.

9. Check all parts and accessories against the packing list.

It is recommended that the shipping container be saved in case you need to return the unit to our factory.

BENCH REQUIREMENTS AND PLACEMENT

Typical laboratory benches are too high for efficient use of the indexers. Cleaning and material packing can be difficult and requires awkward hand positions and forces that could lead to carpal tunnel syndrome or back discomfort. We strongly suggest a bench height of 29 inches (desk top height) for an average height operator. Place the front of the indexer flush with the front edge of the table. This will prevent the operator from having to bend forward excessively when cleaning and packing the barrel and allow easier access to the back of the machine. As a minimum, the lab bench should easily be able to support the indexer and operator (total approx. 300lbs/136.36Kg).

Shake test the melt indexer for stability. The bench top should also be able to withstand hot dies and tools being dropped on them. If carpet is present on the floor near the LMI6000, carpet protection is necessary since a hot die, hot material or hot piston dropped on the carpet will quickly burn spots in it.

Adequate ventilation will also be required to remove potentially harmful fumes from samples being tested. Consult the Safety Data Sheets (SDS) on the products to be tested and your material supplier to assess the magnitude of your ventilation needs. You will want to consider these ventilation needs when positioning the instrument in the laboratory.

Most of the machine comes pre-assembled to your door. However, certain parts are prone to breakage if they are placed in their normal operating position during shipping. These items will need to be installed before safe operation of the machine is possible. Other issues important to obtaining accurate data must also be addressed before valid testing can begin.

LEVEL THE MELT FLOW INDEXER

Using a small round bubble level, level the melt indexer:

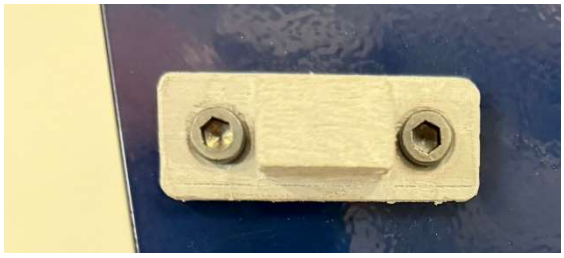
1. Place the level on top of the COLD barrel.
2. Using the adjustable screw feet, bring the machine into level.
3. Tighten the locking nuts to the baseplate to keep the feet in level position.
4. Test shake the melt indexer for stability – if it is not stable, repeat the steps above.
5. Be sure to remove the level before turning on the machine. The level will be damaged if it gets hot.

Some companies may choose to bolt the machines directly to their benches. This can be done by removing the leveling feet and using their mounting holes to mount the instrument to a bench or table. Use caution and remove power before doing so. Mounting the equipment this way will entail removing some covers for internal access to the internal and main instrument plate.

INSTALLING THE SCREEN

The LMI 6000 comes with a screen post that can be installed on either side of the machine. The screen post cleats are preinstalled on the right side of the machine. To move to the left side of the machine, remove the screws holding the cleat to

the side (See below). First loosen the screws holding the post in the post support. Move the cleats to the other side of the machine.



Installing the post

Install the post such that the end fittings slip over the cleats top and bottom.

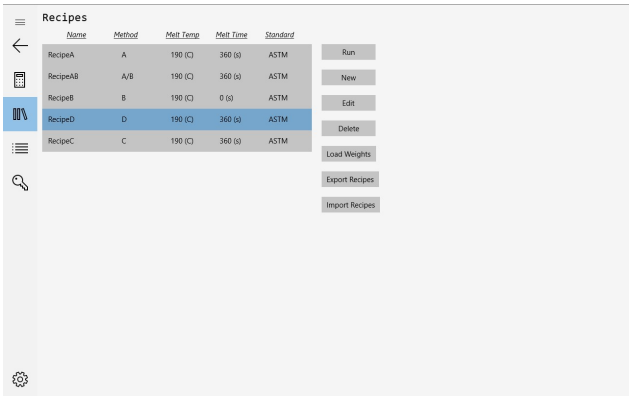
Attach the fittings using the bolts shown below:

The screen mount will already be attached to the pole. Attach the screen to the screen mount. The screen can be adjusted to the desired height and tightened to lock the screen in position.

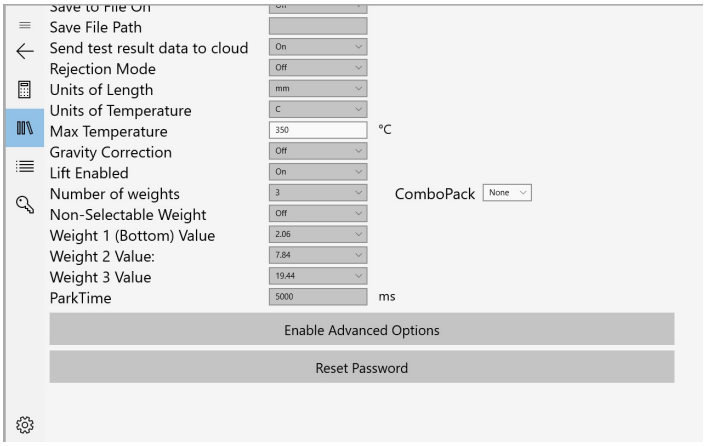
The USB cable attaches to the USB C connector in the middle of the rear of the LMI.

INSTALLING WEIGHTS INTO LIFT SYSTEM

To install weights into the lift system, the bucket must be lowered into the bottom position. This can be done by going to recipes screen and pressing the “Load Weight” button which is located on the right of the screen (See below).



Once pressed, the bucket will move to the lower position. Make sure the door is closed during this operation. Refer to the order guide for the correct order of the weights. If you're purchased one of the combo packs, when selected from the machine settings screen the correct order will be displayed (See below).



The order of weights determines the combination of weights available for tests.

Once weights are loaded into the lift system, the system must be configured to match the weight set loaded. If one of the combo packs has been purchased, select the combo pack from the dropdown on the right side of the screen. This will populate all the necessary fields.

If configuring the weight stack manually, select whether there is a non-selectable weight. Some configurations have a weight that always resides on the bucket. Next select the total number of weights loaded. Finally, for each weight in the stack select the appropriate weight in the dropdown corresponding to it's position in the stack with position 1 being the bottommost weight. The machine weight system is now configured. Note: Selecting incorrect weights or an incorrect number of weights will result in a malfunction of the weight system.

INSTRUMENT OVERVIEW

SECTION 1: INTRODUCING THE LMI6000

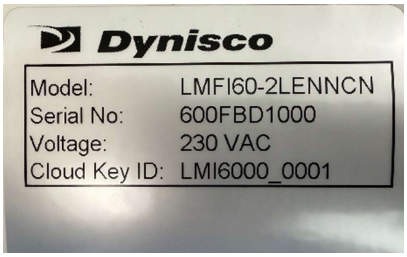
INSTRUMENT OVERVIEW

FRONT VIEW

LMI6000 Base Unit
[No Options Equipped]

LMI6000 Unit With Encoder,
Multiweight Lift, & Autocutter

REAR VIEW



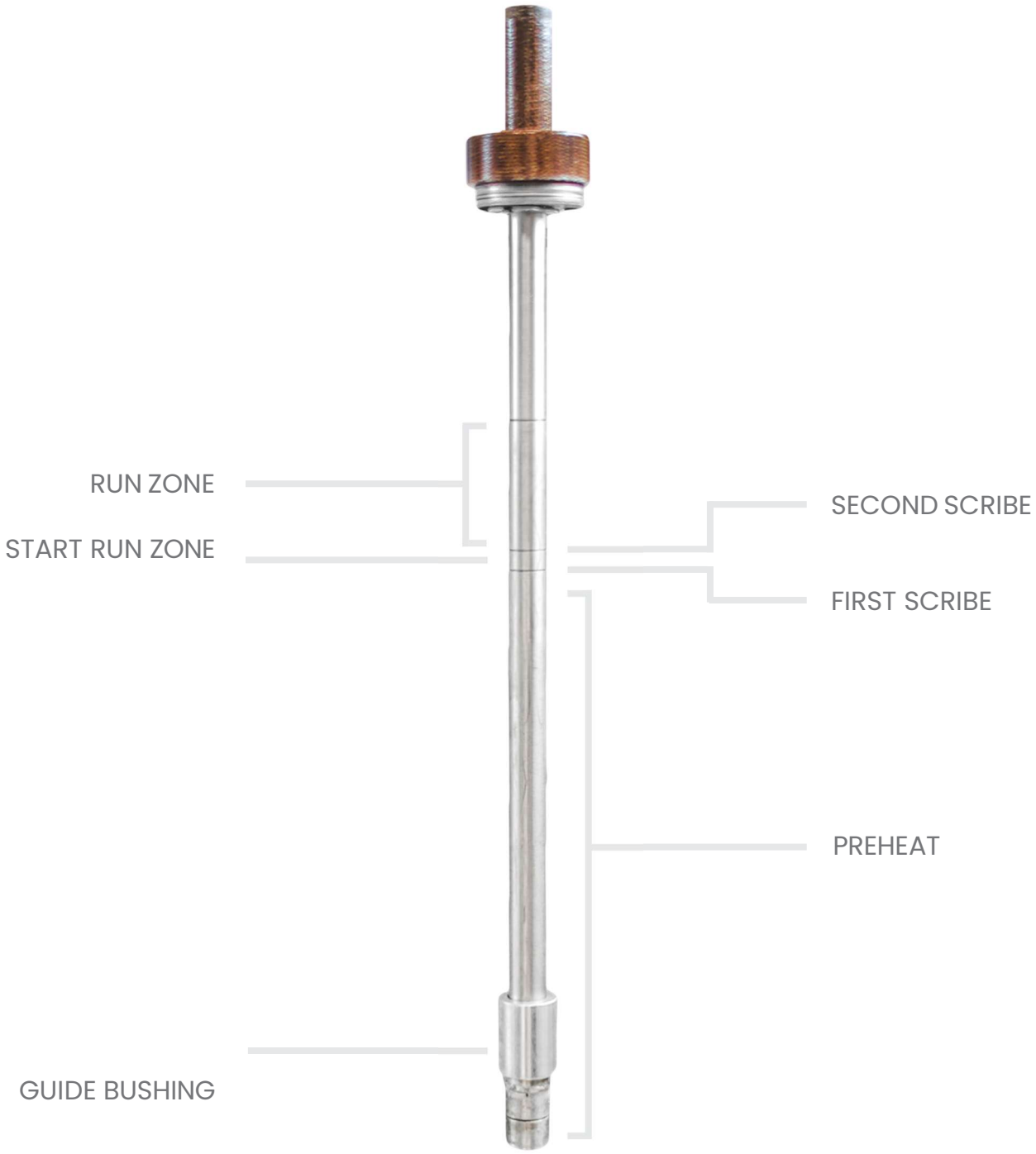
The product sticker on the back of the LMI will show the model, power requirements, and serial number.

LMI SIDE VIEW USB AND ETHERNET CONNECTION PORTS

On the right side of the LMI there are three USB ports and one Ethernet port.

FAMILIARIZE YOURSELF WITH THE PISTON ROD

There are three scribe marks on the piston rod that define the position of the piston tip at various phases of the test. The critical features of the piston rod that allow you to determine its proper location are indicated below.



OPTIONAL DIGITAL ENCODER

A digital encoder module is available from DYNISCO. It permits the collection of multiple data points from one charge of the barrel. The encoder is required if method B, C, A/B or D test wish to be performed. The digital encoder makes operation of the instrument much faster and easier. If your LMI6000 does not have a digital encoder, you can upgrade your LMI by ordering this optional accessory from DYNISCO. Instruction and calibration can be scheduled with DYNISCO Service Department.

Tests using from one digital flag up to fifteen digital flags can be performed. The DYNISCO Encoder for Method B tests employs an encoder coupled to a precisely calibrated arm. The tip of this arm employs a hardened and ground tip for extra-long life. Accuracy over the ASTM measurement range of 6.35mm and 25.4mm is +/-0.4%. The optical encoder, while being very accurate, also enables the test length signal to be processed & varied digitally. Thus, any test length up to 1" (ASTM) or 30 mm (ISO) may be selected. Up to 15 MFR results per barrel filling can be obtained.

The unit is securely fastened to the rear of the Melt Indexer, and the arm latches down to facilitate cleaning of the unit after the test is completed.

ENCODER ADVANTAGES

- Completely Automatic Test Length Selection on Single MFR Tests. Up to 15 MFR readings per barrel filling can be obtained.
- Any test flag length up to 30 mm can be used.
- User Defined test length and test spacing for single or multiple tests can be used. Automatic test length and test spacing, for multiple tests, are used.

WHY USE THE ENCODER?

- No manual cuts are required.
- A sample can be checked as homogeneous within a charge.
- Get better precision (averages are less variable than a single observations) for tests.
- Verification as to whether barrel pressure drop is significant for sample.
- Gain ability to reject data point if bubble or air pocket existed in sample.
- Required for Method B, C, A/B, and D tests.

OPTIONAL AUTOCUTTER

The autocutter option is an integrated palette knife attached to the LMI6000 that automates the cutting of samples during either Method A or Method A/B tests. This option will cut the extrudate at the end of the Melt Time before sampling begins and will automatically cut each sample at the time interval defined in the recipe. The autocutter cuts in a single, 360-degree rotation, and drops the cut sample down below the barrel onto the work surface above and behind the display. The cutting action is accomplished by using a thin, flexible blade cutting across the end of the barrel.

All LMI units equipped with an autocutter are preconfigured in the factory, so when applicable during testing the cutter should simply run. The lower door must be closed for the cutter to work. If the door is not closed the cutter will not cut so the test will not be valid.

The autocutter can be enabled/disabled via the machine settings screen. (See page 28.)

If the cutter is not working, see the troubleshooting section (Page 99).

OPERATIONS GUIDE

SECTION 2: OPERATING THE LMI6000

INSTRUMENT OPERATION

STARTUP AND USER ACCESS LEVELS

The instrument's main power is turned on by flipping the switch located on the rear right bottom corner of the instrument (as one faces the instrument). To turn on the computer, press the switch in the front right. You will see a Dynisco logo as part of the startup process.

After the system is powered-up, select the Permissions Button (KEY ICON) to access user type. The system has 3 levels of default user types.

Below is a list of levels of access. Read below to see permissions for each.

ACCESS LEVELS	
OPERATOR	No login necessary. Can run tests only. Cannot modify recipes. Can't modify the system configuration or calibrate the LMI.
MANAGER	PIN required. Same rights as Operator, plus the ability to create and modify recipes as well as modify the machine configuration. To configure manager PIN, see below.
FIELD SERVICE	Requires a unique PIN generated by a member of the DYNISCO Field Service team that will reset once service is complete. Allows access to calibration and repair diagnostics menus.

The LMI ships without a manager PIN. To set the PIN, perform the following steps:

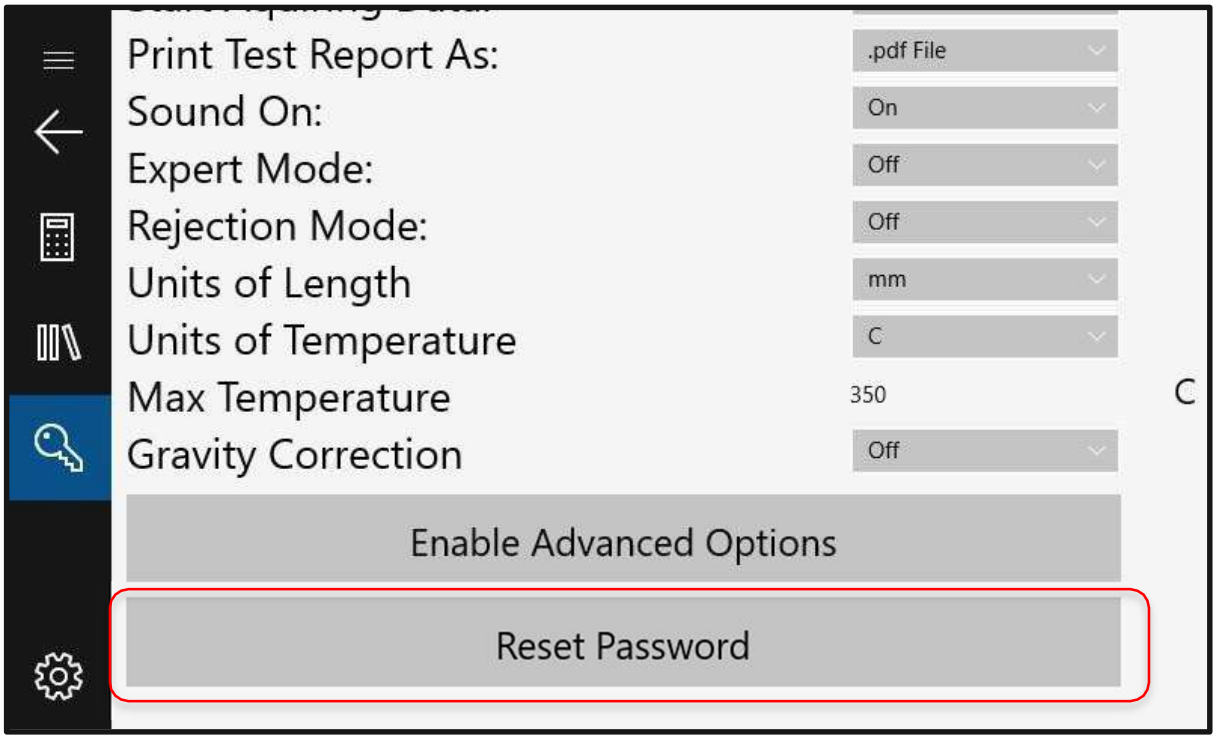
1. Go to the Permissions screen (the key icon of the left of the display).
2. Select Manager
3. Enter a new PIN (Message stating not right PIN)
4. Exit the field
5. Enter new PIN again
6. Manager PIN has been created

RESETTING THE PASSWORD

When the user has forgot their password, they first must contact DYNISCO customer service in order to obtain a field service password for the machine.

Contact Dynisco Customer Service:
https://www.dynisco.com/service-and-support/technical-support-request.cfm

Then log in to the “Field Service” machine account and navigate to the machine settings menu.



If you scroll down to the bottom, you will see a “Reset Password” button, press this and then restart the machine.

Now if you go into the Permissions menu and attempt to sign in to the manager account again, you will be prompted to set a new password.

SCREEN ICONS

The LMI6000 Series Melt Flow Indexer has an intuitive touch screen display in addition to ICON keys for ease of operation. A keyboard is also displayed when settings and values are to be entered.

EXPAND
Expands the menu bar to include text labels for each navigation button.

BACK
Returns to the previous menu.

TEST
Enter the most recently loaded recipe for testing.

RECIPE
Displays all the available recipes with options to run, create new, edit or delete a selected recipe.

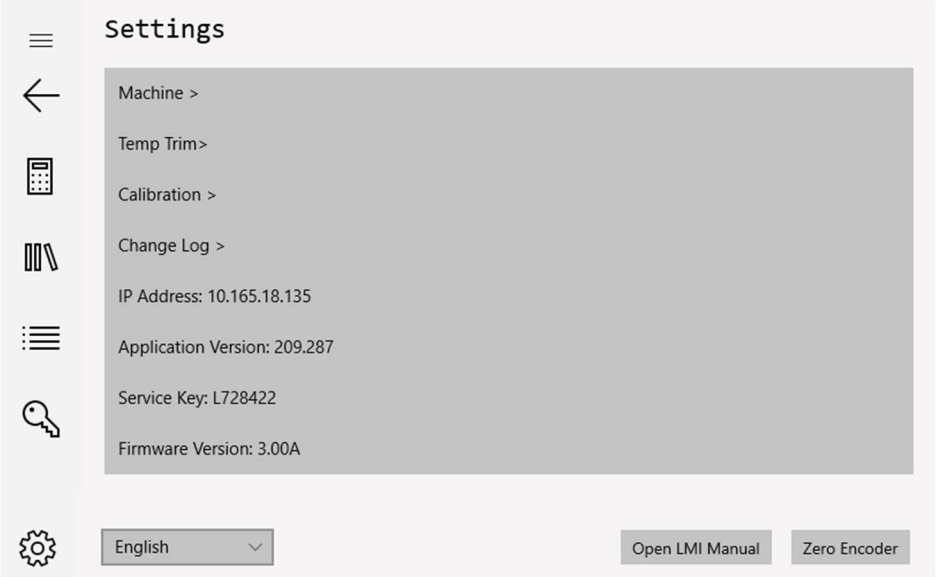
TEST HISTORY
Displays test results for the most recently saved tests.

PERMISSIONS
Displays the permission screen; used to change the user permission level.

SETTINGS
Displays system options.

SETTINGS

When the gear icon is touched, the settings screen is displayed as below:

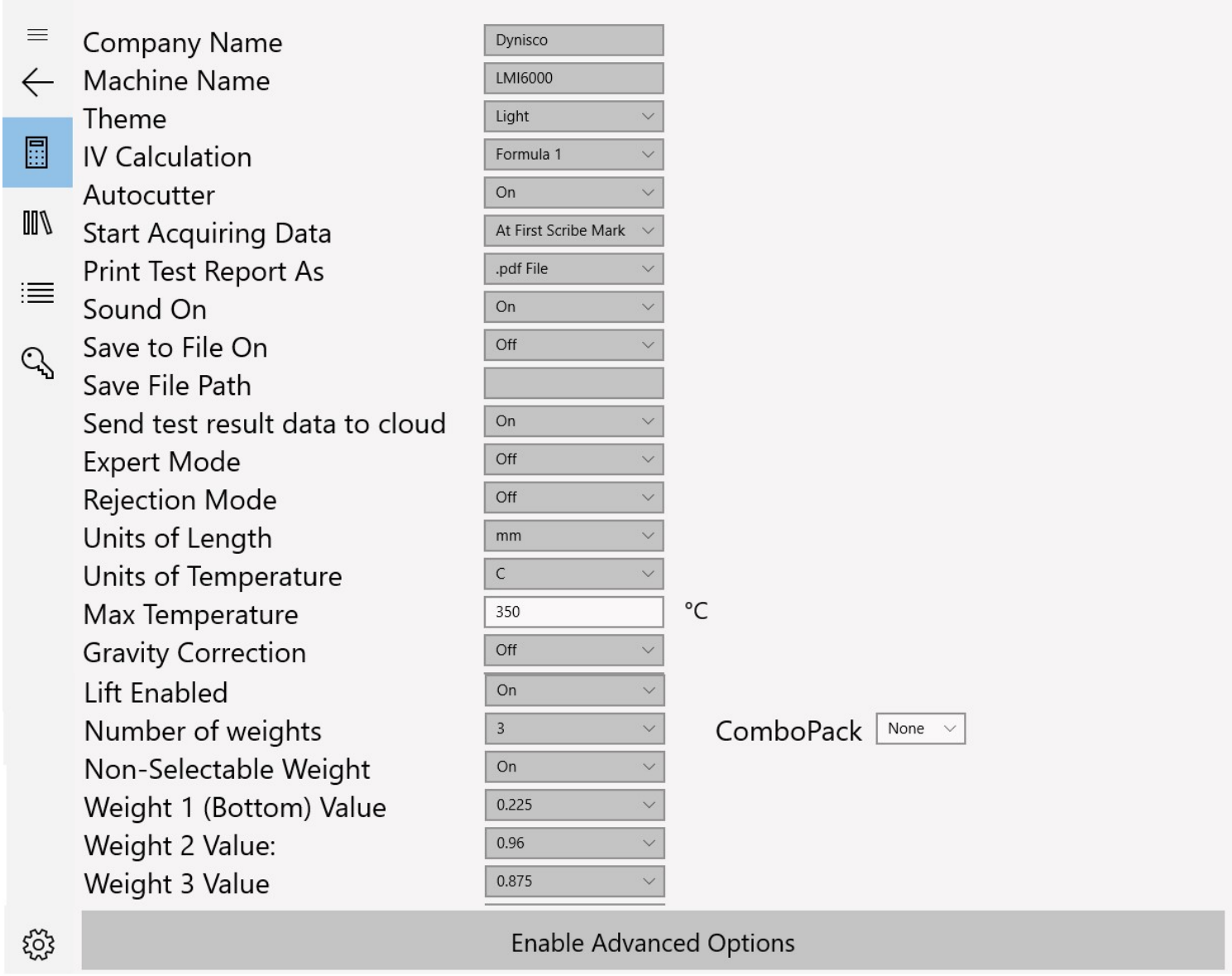


Find a description of each setting option in the table below.

MENU FIELDS	
ZERO ENCODER	Re-zeros encoder position in the event that the machine was started without the encoder in the correct position. If encoder reset is needed, put the encoder in the fully down position and press this button to reset the position.
MACHINE	Navigates to machine settings (See next page).
TEMPERATURE TRIM	Used for calibrating temperature (Field service only).
CALIBRATION	Calibrates encoder and RTD inputs (Field service only).
CHANGE LOG	Lists the recent updates and changes to the machine software and firmware.

IP ADDRESS	Displays IP address if LMI is connected via Ethernet or Wi-Fi.
APPLICATION VERSION	Current version of software.
SERVICE KEY	Key that is used by Field Service workers to generate a field service PIN.
FIRMWARE VERSION	Current version of firmware on control board.
CLOUD KEY ID	Used for linking device to Dynisco IOT (See cloud connectivity below).

MACHINE SETTINGS



MENU FIELDS

COMPANY NAME	Field for the name of the LMI's owner, or owning company
MACHINE NAME	Field used to uniquely identify a LMI machine. Displayed on test report.
THEME	Option that modifies the colors of the UI. Selection options include light mode, dark mode, or custom theme.
IV CALCULATION	Option to change the method of calculation for IV measurements. Formula 1 is the default.
AUTOCUTTER ON	Activates autocutter if present.
START ACQUIRING DATA	Allows user to select whether or not the autocutter begins cutting at the end of preheat or once the first scribe mark of the piston. (Enable the end of preheat option if encoder option was not purchased.)
PRINT TEST REPORT AS	Allows user to select whether the test report saves as a .txt file or a .pdf file to an external USB.
SOUND ON	Option to enable / disable sound (beeps)
SAVE TO FILE ON	Allows user to save test report to path indicated in "Save File Path" field
SAVE FILE PATH	File path to be used to save test report when "Save to File" is set to on
SAVE TEST RESULT TO CLOUD	Allows user to save test report to Dynisco's IoT cloud storage.
EXPERT MODE	Expert mode is an option that allows the user to skip the instructions and animations in order to immediately start the test. Intended for experienced users that are already familiar with setting up the tests.
REJECTION MODE	Allows user to automatically reject data from a test result if that test result falls within a defined number of standard deviations.
UNITS OF LENGTH	Used in flag lengths for methods B and A/B as well as capillary dimensions. Accepted values are millimeters (mm), centimeters (cm), and inches (in).
UNITS OF TEMPERATURE	Display temperature units. Accepted values are Celsius (C), Fahrenheit (F), and Kelvin (K).
MAX. TEMPERATURE	Maximum setpoint temperature of the LMI (Read-only).
GRAVITY CORRECTION	Please see the gravity correction section on page 33.
LIFT ENABLED	Activates automatic lift system. When off, manual weights must be used.

# OF WEIGHTS	Number of weights loaded into weight stack.
COMBO PACK	Automatically loads weight configuration for combo packs of weights
NON-SELECTABLE WEIGHT	For some weight stack configurations, there is a weight that always rides in the weight bucket. If such a weight exists, this must be turned on
WEIGHT 1 VALUE …. WEIGHT N VALUE	The value of each weight in the weight stack with weight 1 being the bottommost weight
ENABLE ADVANCED OPTIONS	Adds a further set of options to assist with field service (requires Field Service permissions to enable).

CAPTURING TEST DATA

There are three ways to capture test data using the “Save Data” button on the results screen.

1. If the optional cloud data portal has been purchased, the test data can be retrieved directly from the cloud. See the appropriate sections below.
2. If a USB memory stick is inserted into the USB port of the left side of the instrument, a test report will be generated and saved to the stick.
3. Tests can be saved in history locally on the machine. Storage is limited to the last 25 tests.

CLOUD CONNECTIVITY

The LMI6000 has optional cloud connectivity utilizing Microsoft Azure services to collect and archive data in the cloud platform across a global network of Microsoft-managed datacenters.

One can leverage this functionality to generate quality records, new insights and control of their process.

The LMI6000 connection to Azure is usually as simple as connecting to the company network via Wi-Fi or Ethernet. Data is pushed into Azure Storage via ports 80/443. These are the same ports that Office 365 requires so they are generally reachable.

BENEFITS OF CLOUD CONNECTIVITY

- Accessing data remotely, via computers or mobile devices using a web browser
- Recording and archiving rheological test data
- Correlating data between machines or test runs
- Ability to download data to a computer

Even without a subscription, connecting to the cloud has benefits:

- A library of historical test results will still be stored in the cloud accessible when a subscription is purchased. This data could be used to evaluate the benefits of a subscription during a trial
- When consulting the factory, that data could be available for both troubleshooting or rheological issues
- Allows DYNISCO to collect anonymous user data enabling us to support you better
- Automatic Time and Location information

SECURITY

The LMI6000 leverages Microsoft Azure services. Microsoft Azure has multiple layers of security including data

encryption. That said, there is no way to fully secure equipment from a hacker with physical access to it.

(DYNISCO believes this is true for all equipment attached to the network, not just our products.)

REGISTERING FOR A CLOUD ACCOUNT

Connect to iot.dynisco.com via a web browser and select the register link in the upper right corner. Fill out the form with your email and password and press the register button. You will receive an email asking to confirm your account.

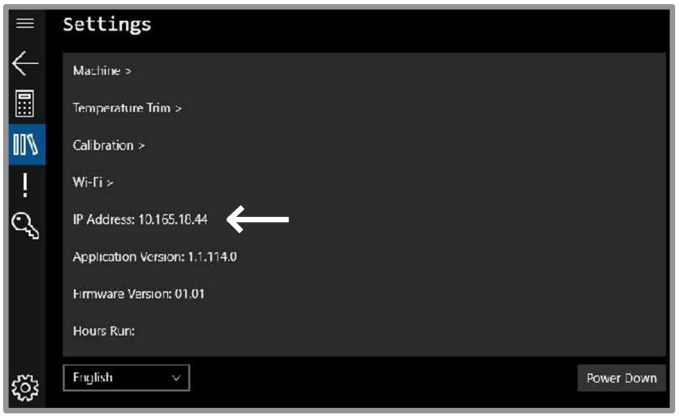
CONNECTING TO A NETWORK

There are two methods to connect the LMI to the network: Via an ethernet cable or connecting wirelessly.

1. Connect an Ethernet cable to the left side of the LMI.
2. Connecting via a Wireless network. To connect, select the wireless follow the standard Windows procedure for connecting to a WiFi network.

VERIFYING CONNECTION

Upon a successful connection, an IP address will be displayed on the settings screen as shown below.



REGARDING WEIGHTS, LOCAL GRAVITY, AND THE OPTIONAL SCALE

WEIGHTS

In most applications you do not have to concern yourself with weights or gravity because ASTM allows for a 0.5% accuracy on the test load. Accuracy can be improved by entering the actuals into the LMI. Remember to subtract the piston guide bushing weight from the total.

LOCAL GRAVITY

INTRODUCTION

The plastometer and standards such as ASTM 1238 were developed primarily in industrialized nations which reside in areas of the earth that experience roughly the same gravitational force. As a result, the variability of gravitational force was not a significant concern in developing the apparatus or procedure.

Manufacturing facilities and other testing facilities are increasingly being located close to the earth's equator such as in countries like Malaysia, Indonesia and India. Gravitational forces in these areas are different than in the USA, Western Europe and China, given that latitude and other factors may cause gravitational force to vary, and that this difference may cause variation in MFI measurements for a given polymer. A difference of this magnitude in such a precise measurement as MFI may have significant consequences.

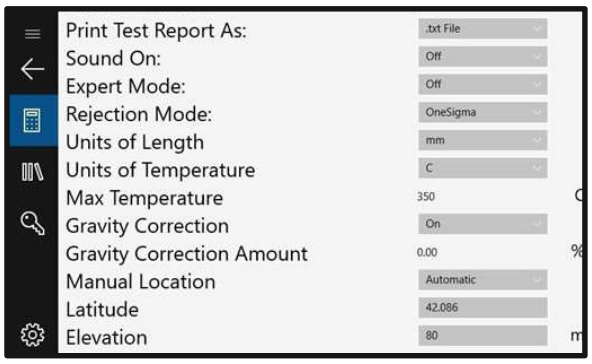
It should be appreciated that fluids such as molten polymer are presumed to be Newtonian over the relatively small changes in shear stress that would result from varying gravitational force, meaning that the driving forces are proportional to the rates of change of the fluid's velocity vector.

If the local gravity is entered into the LMI it will apply a correction for that shift assuming the material is Newtonian. Note, for this correction to be significant, actual weights for the weight and piston combination should be used as well.

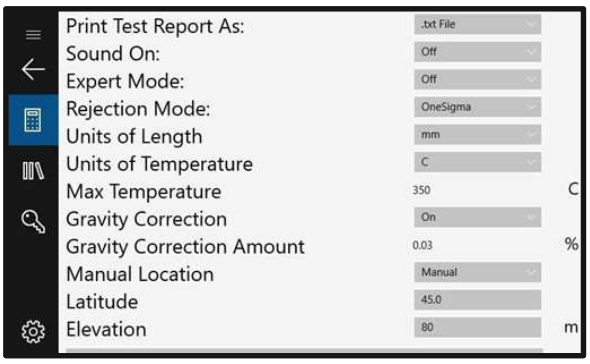
APPLYING GRAVITY CORRECTION

To activate gravity correction, select Gravity Correction to ON. There are two modes to gravity correction, Automatic and Manual. If connected to the cloud, Automatic will retrieve latitude information by design and will calculate the correction factor. In Manual mode, the user can enter location information to set a correction amount. Examples of these screens are below:

AUTOMATIC MODE



MANUAL MODE



OPTIONAL SCALE [P/N 1190001]

Please refer to the manual included with the scale for generic setup procedures.

To configure scale for use with the LMI, please make the following configuration changes:

Print Function: Manual with Stability

Manual Print Format: Value

Device/Protocol: PC Text format

Access to these functions is only available when the scale is attached to a USB port.

TOOLING TECHNIQUES

SECTION 2: OPERATING THE LMI6000

LOADING AND PACKING MATERIAL INTO THE BARREL

TOOLING TECHNIQUES

The barrel, die, and piston of the LMI6000 should always be assumed to be hot. Wear proper PPE, such as gloves, to minimize the risk of contact burns. Remove the piston with care to avoid ejecting the die.

1. The piston rod and the die should be inserted into the barrel during heating, temperature stabilization, and between tests.
2. Remove the piston rod and lay on a cotton cloth.
3. Check to see if the die is at the bottom of the barrel.
4. Fill heat chamber / barrel with an appropriate charge (see page 37 for determining appropriate charge weight) or use about 5 grams if nothing is known about the material.
    - Put the sample into a small beaker.
    - Add about two-thirds of the material into the barrel, using the brown fill funnel.
    - The loading should be done in two increments, the first consisting of approximately two thirds of the material.
    - Tamp down the material with the packing tool using approximately 20 pounds / 9Kg of force. The packing tool can be driven through the fill funnel. If bridging (clogging) of the material occurs in the fill funnel, slide the fill funnel off to one side (without lifting) and use the fill tool to pack the material in the barrel directly. Move the fill funnel back into place. The remaining material should drop down into the barrel.
    - Repeat with the remainder of the material.
    - The procedure should be completed is less than one minute to minimize rod cooling.
5. Bubbles are present in the test sample charge if a snapping/popping sound is heard as the extrudate is forced through the orifice. If bubbles appear in the extrudate, use less material between tamping down. If bubbles continue, the sample may not be sufficiently dry.
6. Place the piston rod into the barrel by placing the piston rod directly over the slot/opening on the top of the indexer barrel cover.
7. Seat the guide bushing down into the barrel if it has not already fallen into place. The guide bushing should be moving freely on the piston plunger.
8. If the lift is enabled, the LMI will automatically place the load on the piston plunger rod and ensure the test starts when the piston is between the start of test scribe marks. Consult your national standard for guidance on this. DYNISCO recommends adjusting the charge weight as described in the next section. For high flow materials use of a high flow plug may be required. For repeatable data this must be consistent run to run.

WEIGHING THE MATERIAL CHARGE

TOOLING TECHNIQUES

The formula below may indicate a charge mass that would require a material volume greater than the volume of the barrel. Generally, 8 grams is the maximum material volume you should use. If you can't put enough material into the barrel such that after the melt time there would be enough left to test, the barrel must have a flow plug inserted at the base of the die to prevent material from escaping.

National standards generally give recommendations for how much material to put in the barrel to perform a test. However, by determining the proper charge and controlling it from run to run, testing can be made easier and more reproducible.

The distance from the top of the die to the piston's first scribe mark is about 5 cm. Filling the barrel up to the first scribe mark is the minimum charge needed to run a test. During the recommended 5-7-minute melt time, some material flows out of the die, so a larger charge is needed. The best situation would be to add just enough material, so that during the melt time, the plunger slowly falls and is just above the first scribe mark when the melt time has expired. In this way, the required melt time is satisfied and there is no excessive waiting before the first cut is made (or timing flag starts in timed tests). A conservative estimate for charge weight can be calculated if an approximate melt flow rate and melt density for the material are known by using the following formula:

$$CHARGE\ MASS = 3.6\rho + 0.6 * MFR$$

Where the charge mass is in grams, ρ is the melt density in g/cc and MFR is the anticipated melt flow rate in the typical units of g/10 min. This equation will tend to slightly overestimate the charge needed. For a Polypropylene, with an anticipated MFR of 3.5 at 230 C, using the melt density of 0.738 from the above formula, the estimated charge mass would be:

$$(3.6 * 0.738) + (0.60 * 3.5) = 4.76g$$

In our lab, we have found that 4.6 grams is a good charge for a 3.5MFR Polypropylene sample. The equation overestimates the charge since it assumes flow from the instant the material is packed into the barrel.

The formula may indicate a charge mass that would require a material volume that is too large to fit in the barrel. Generally, about 8 grams is the maximum you should use. If you cannot put enough material into the barrel such that after the melt time there would be enough left to test, the barrel must have a flow plug inserted at the base of the die to keep the material from escaping during preheat time.

MAKING THE CUT

TOOLING TECHNIQUES

After each cut, ensure the sampled is remove from the landing area so samples don't fuse together.

There are two conditions that must be met before cutting a sample of extrudate.

1. The material must be loaded and brought to temperature by waiting the melt time (or pre-heat time.)
2. The piston must have lowered into the "run area" as denoted by the scribe marks on the piston assembly. See page 20 for details about the piston.

A measurement may start when the 1st scribe mark has lined up with the top of the guide bushing. The run must start before the 2nd scribe mark lines up with the top of the guide bushing.

When using the Autocutter, the cutter engages automatically when the preheat time elapses, so the operator must verify the piston position during the test. To cut manually, use the cutting knife in a wiping like action up against the bottom of the die.

If the second scribe mark has already passed the guide bushing before the preheat time has elapsed, the user has the following options to modify the test procedure:

- Add more material
- Reduce the test load (e.g. 2,160g to 225g)
- Reduce the test temperature (e.g. 230°C to 190°C)
- Use a flow plug
- Support the plunger and piston during melt time
- Change to a non-standard die (e.g. 1/2 diameter, 1/2 height)

If the sample extrudate is so slow that the first scribe mark is not passed before 8 minutes has expired, the user has the following options:

- Add less material
- Increase the test load (e.g. 2,160g to 21,600g)
- Increase the test temperature (e.g. 190°C to 230°C)
- Change to a non-standard die (typically larger diameter)
- ASTM allows material to be purged by hand or using a larger weight. ISO allows preheat time to be increased.

Be sure to document any changes made to the procedure so that consistent results will be achieved over time by different operators.

SETTING A PISTON TRAVEL DISTANCE DURING MVR TESTING

TOOLING TECHNIQUES

For best measurement resolution, use a longer distance for higher flow rates (> 10 g/10 min.) and a shorter distance for lower. The aim is to have a length long enough that the error in determining plunger speed is small resulting in precise flow rate measurements. Long lengths for slowly flowing material can make for extraordinarily long tests and the material may degrade substantially during the test.

ASTM recommends 6.35mm to 25.4mm for the range of piston travel.

ISO recommends the minimum piston displacements for each respective MFR/MVR measurement:

ISO RECOMMENDED MINIMUM PISTON DISPLACEMENT, FROM MFR / MVR	
0.5mm	MFR or MVR of 0.1 - 0.15g / 10 min., or cc / 10 min.
1.0mm	MFR or MVR of 0.15 - 0.4g / 10 min., or cc / 10 min.
2.0mm	MFR or MVR of 0.4 - 1.0g / 10 min., or cc / 10 min.
5.0mm	MFR or MVR of 1.0 - 20.0g / 10 min., or cc / 10 min.
10.0mm	MFR or MVR greater than 20.0g / 10 min., or cc / 10 min.

ISO recommends that the time between the end of charging the barrel and the last measurement should not exceed 25 minutes.

Please note that for improved repeatability, it is critical to maintain the same distance moved for individual runs.

The encoder activates and starts to measure the time/length between the first and second scribe mark of the piston and all the measurements need to be taken before the upper scribe mark on the piston stem reaches the top edge of the cylinder.

WHAT TO KNOW BEFORE YOU RUN A TEST

SECTION 3: TESTING WITH THE LMI6000

PRE-TEST OVERVIEW

PRE-TEST CHECKLIST

Before testing materials with the LMI6000, please follow the actions in the checklist below.

- ☐ Is material properly prepared (dried, mixed, check for contaminates)?
- ☐ Machine on and running for 15 minutes with die and piston inside to temperature stabilize?
- ☐ Correct die in machine? Correct program being run?
- ☐ Hand tools in position for test run (packing funnel and tool, cleaning drill bit, etc.)?
- ☐ Encoder arm in place?
- ☐ Cutter door closed if Autocutter is installed?

TESTING METHODS

TEST METHOD A: DETERMINING MELT FLOW RATE

This test is referred to as Procedure A by the ASTM. DYNISCO has historically referred to this test as Method A. Because this test is the mass measurement method it is also sometimes called the “cut-and-weigh” method Measurement given in g/10min.

TEST METHOD A/B: DETERMINING POLYMER MELT DENSITY

This test requires a digital encoder. It is critical to test and determine the melt density at the proper melt temperature. Melt density is the density of the polymer in the molten state and is not the same as the standard or bulk density. An A/B test MUST be run before Method B testing to determine the polymer’s melt density. In this test, both the melt mass flow rate (A-type test) and mass volume rate (B-type test) results are taken. The melt density is the ratio of these two numbers and is given in g/cc.

TEST METHOD B: DETERMINING MELT VOLUME RATE

Procedure B is a displacement–measurement method. This method is recommended for high flow rate materials because they are hard to cut accurately. This is a “no- cuts” test that is the most convenient for busy laboratories. Measurement in cc/10min. Procedure B can be conducted only if material melt density is known as is determined by an A/B type test.

TEST METHOD C: DETERMINING MELT FLOW RATE FOR HIGH FLOW RATE MATERIALS

Procedure C can be conducted only if material melt density is known as is determined by an A/B type test. This is also known as the “half die” method. A half-length die is used and is generally used for testing high flow rate polymers. This is a “no-cuts” test that is the most convenient for busy laboratories. Measurement in cc/10min.

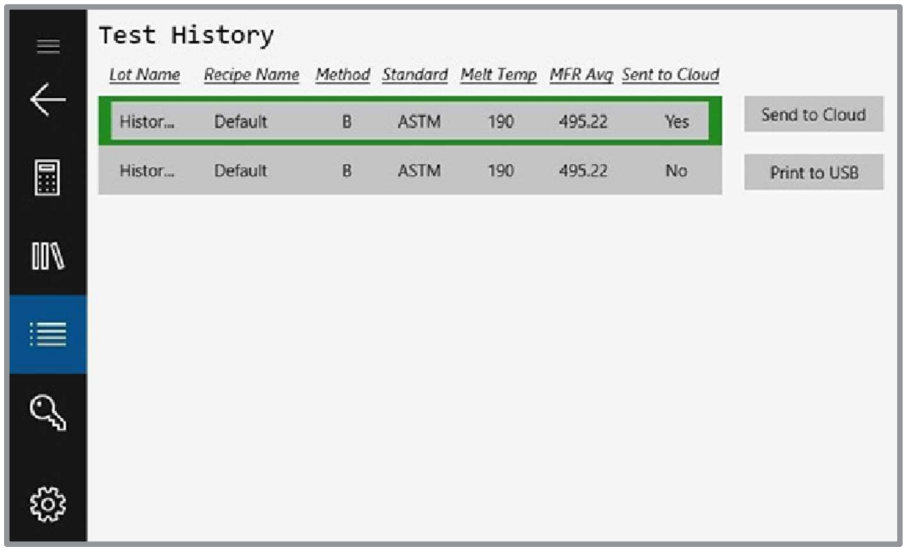
TEST METHOD D: FLOW RATE RATIO TESTING

Procedure D is a multi-weight test. When using a hand weight in combination with the lift system, the test can measure the MFR at different load values and calculate a flow rate ratio. The melt density of the material being tested must be known when running this test.

IV TESTING FOR PET WITH METHOD B

This feature allows the Melt Indexer to correlate Melt Flow Rate (g/10 min.) to Intrinsic Viscosity (dl/g). Intrinsic Viscosity (IV, ASTM D3835) is a "wet chemistry" technique used to assess the specific volume of an isolated polymer chain, when dissolved in a good solvent.

TEST HISTORY



IMPORTANT INFORMATION

- The Test History screen can be navigated to by pressing the button on the left-hand side of the screen
- The LMI software can store information on the last 25 tests that were performed
- Once the 25 test max has been reached, the machine will delete the oldest test to make room for the next test to be added
- If the "Send Test Results to the Cloud" machine setting is enabled, you can choose to send previously completed tests to the cloud using the "Send to Cloud" button on this screen
- You can print off a report of one of the previously completed tests by clicking the "Print to USB" button

In order to save a test to the LMI's test history, you must hit the 'Send Data' button at the end of the test.

THE METHOD A TEST

SECTION 3: TESTING WITH THE LMI6000

THE METHOD A TEST

GENERAL DESCRIPTION

Method A test involves collecting extrudate from the instrument over a fixed period, then weighing and converting the result to grams of flow over 10 minutes.

After the melt time is over and the piston is in the proper position, a sample is collected by first cutting the extrudate across the orifice face, then waiting a predetermined amount of time and then making a second cut. The sample is weighed, and the flow rate is converted to grams of flow over 10 minutes.

Test temperatures can be obtained from the manufacturer, from tables in your national standard such as ASTM D1238, or through experimentation. Material with Melt Flow Rates below 50g / 10min. are generally done using Method A. This test is manual when not using an Autocutter and is sometimes called the “cut-and-weigh” method.

CALCULATION METHOD A

The Calculation for the Method A test is straightforward. The MFR value has units of g/10min (grams/10 minutes).

METHOD A FORMULA

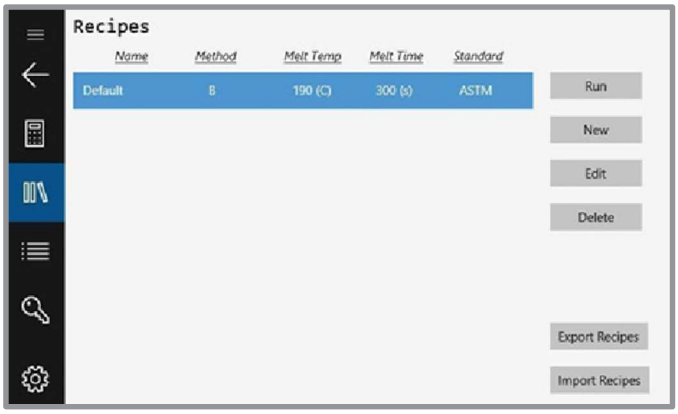
$$MFR = \frac{M600}{T_A}$$

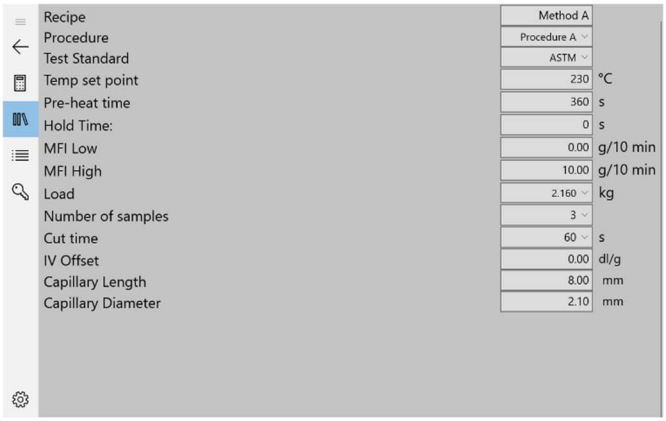
M is the mass in grams of material collected over time T_A, in seconds.

CREATING A PROCEDURE A RECIPE

A test is performed by running a recipe. You must create a recipe if one doesn’t already exist for the material to be tested. This is accomplished by pressing to go to the Recipe screen and pressing the “New” button.

Upon pressing the “New” button, the following recipe menu (lower right) will appear.





PROCEDURE A RECIPE PARAMETERS	
RECIPE	Name of recipe.
PROCEDURE	Configures type of test to be run, can be A, B, A/B, C, or D
TEST STANDARD	Allows user to select whether the test is performed to ISO or ASTM standards.
TEMP SET POINT	Temperature that the test will run at.
PRE-HEAT TIME	The amount of time material must be at temperature before test can start. Generally, choose between 5 and 7 minutes based on your national standard for thermally stable materials.
HOLD TIME	Time after sample has been put in the barrel before the lift system lowers the weights. This time is subtracted from the pre-heat time.
MFI LOW	Lower limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits (Disabled if rejection mode is on).
MFI HIGH	Higher limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits (Disabled if rejection mode is on).
LOAD	The appropriate weight to be applied to the sample. The load is the combination of the piston and weight. (If an actual weight is used for the piston, remember to subtract the weight of the piston guide bushing.)
NUMBER OF SAMPLES	The number of samples to be generated during the test. Valid range is 1-10.
CUT TIME	The time interval over which the sample is extruded between cuts.
IV OFFSET	A value entered by the user to offset the IV measurement, if desired.
CAPILLARY LENGTH	Length of the capillary that is being used for the test.
CAPILLARY DIAMETER	Diameter of the capillary that is being used for the test.

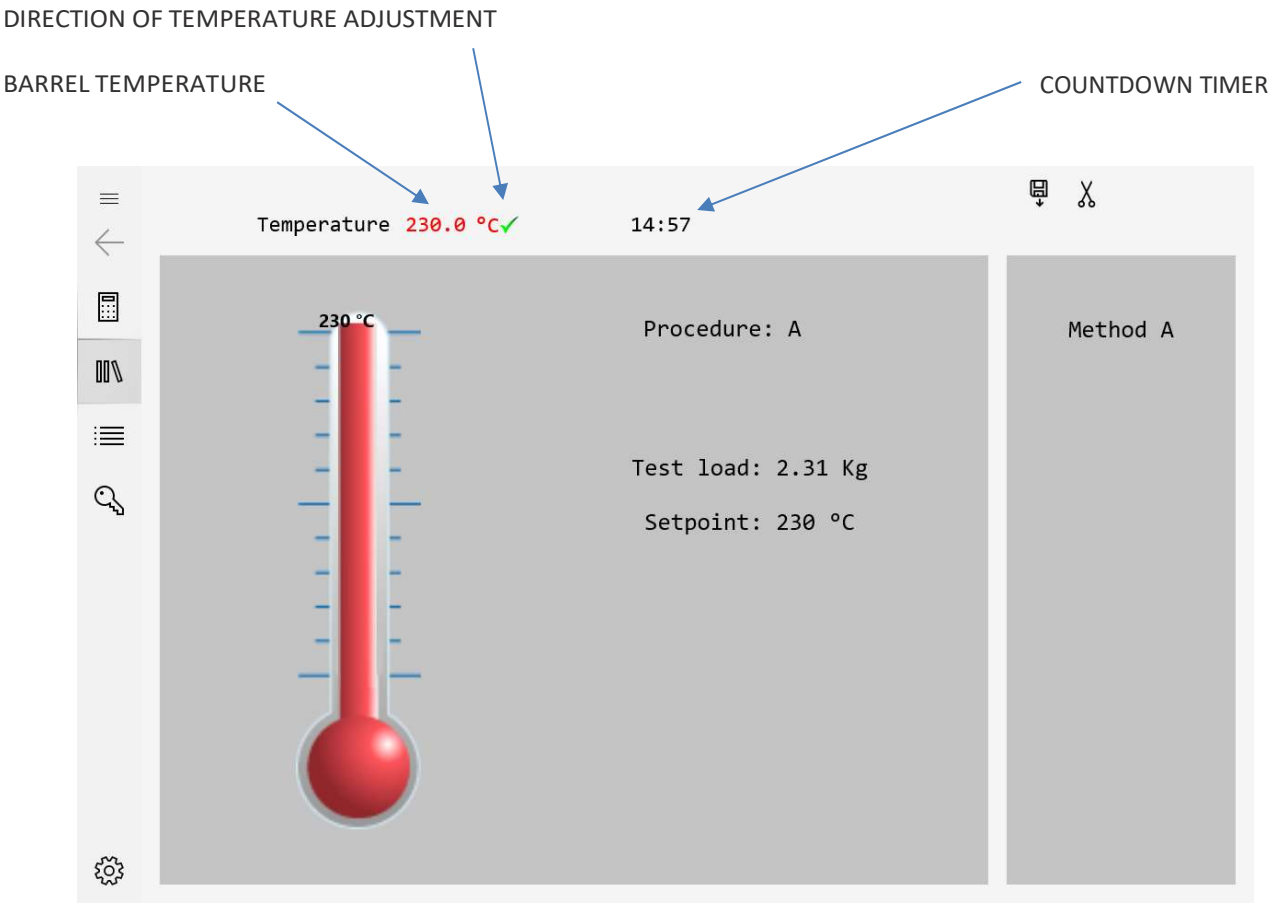
When all fields are complete, press the recipe button again to return to the main recipe screen.

The LMI is now ready to run the test.

When you turn on the machine, the last recipe run will be loaded into memory and the barrel will heat to its setpoint.

STARTING THE TEST

Press the Run Recipe button, and the screen below will appear.

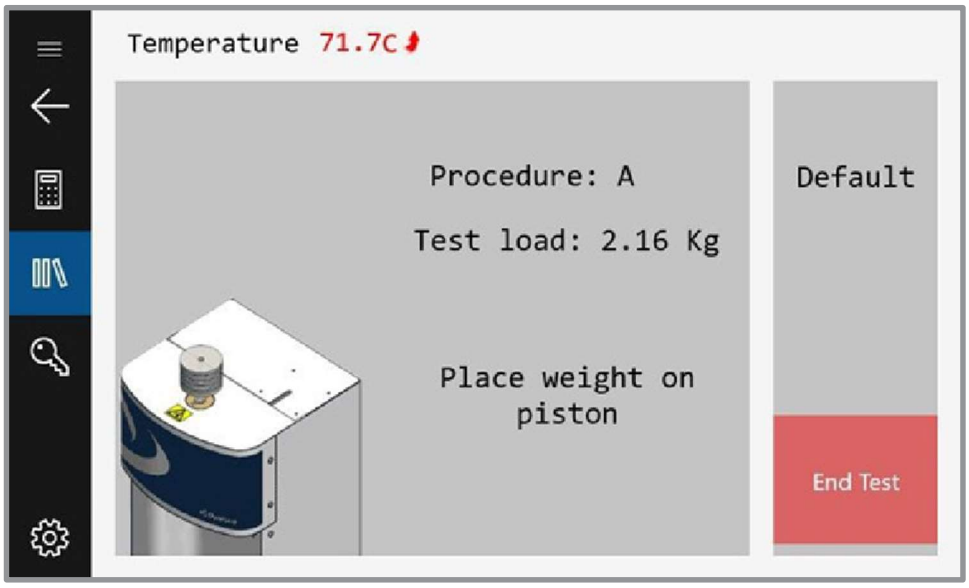


RECIPE NAME

Once the LMI is at the setpoint temperature, a 15-minute count-down timer will start. Ensure that the piston and die are in the unit. After this timer expires, the LMI will be ready to load with material as shown below:

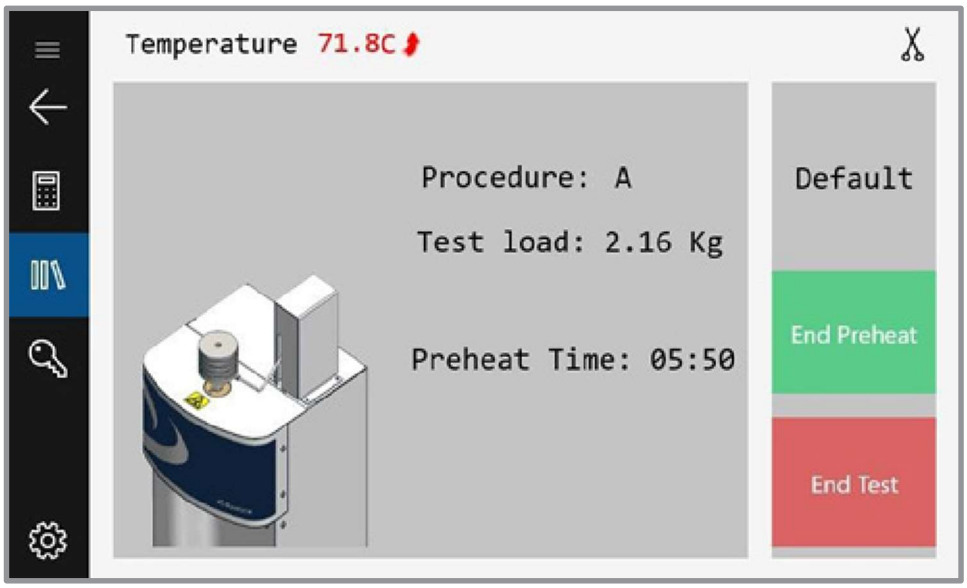
LOADING THE SAMPLE

Load the sample as described in test techniques on page 35. After loading the material, press the screen. The LMI will prompt you to insert the piston and add the weight to the LMI.



PREHEAT

Press the screen again when this is complete. The Preheat time will be displayed on the screen as shown below:

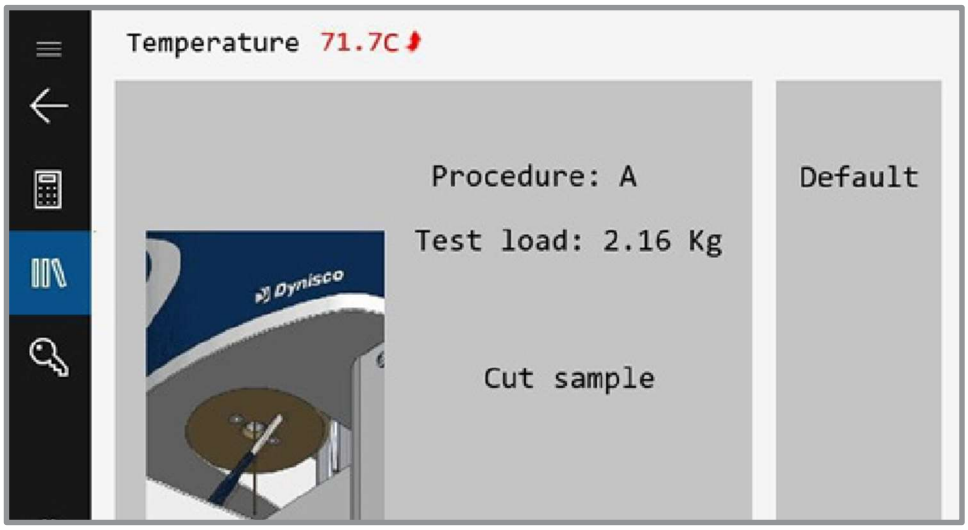

Temperature 71.8C
Procedure: A
Test load: 2.16 Kg
Preheat Time: 05:50
Default
End Preheat
End Test

COLLECT SAMPLES

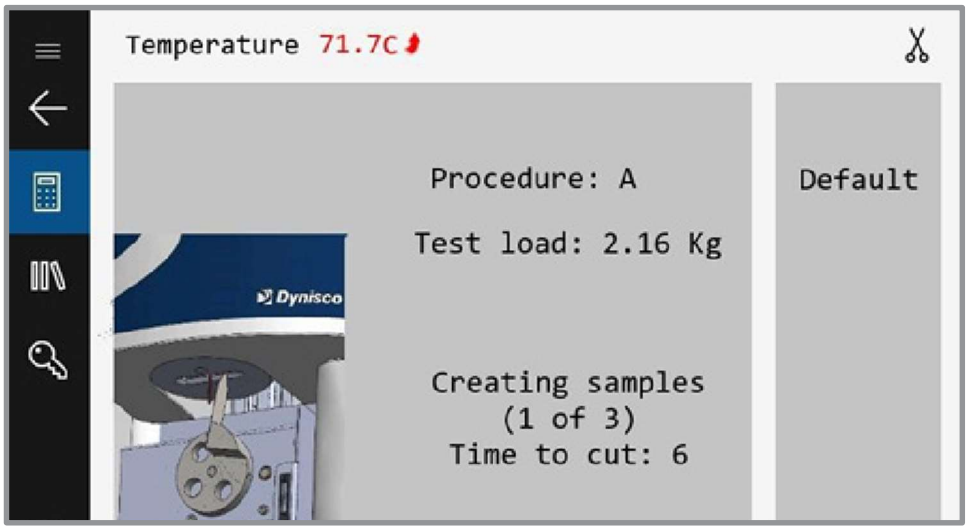
A measurement may start when the 1st scribe mark has lined up with the top of the guide bushing. The run MUST start before the 2nd scribe mark lines up with the top of the guide bushing. After melt time (pre-heat) is completed, and after the piston lowers into the “run area” as denoted by the scribe marks on the piston assembly, the extrudate formed during preheat must be removed. If an autocutter is not installed the LMI will prompt the user to cut the material. If manually cutting the sample, you MUST touch the screen as the extrudate is being cut. It is critical that the cut and touch are simultaneous to get accurate timing.

With the autocutter, the preheat extrudate will be cut automatically. Discard the pre-heat extrudate.

See page 38 for more on how to cut extrudate.

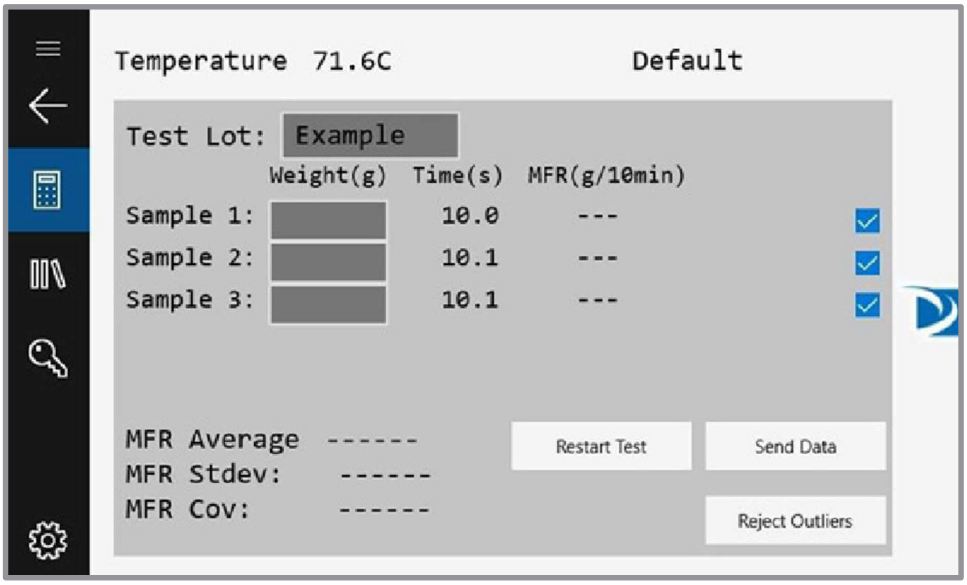


For each sample cut, the LMI will either cut (or prompt the user to cut) the sample after the sample time interval has elapsed. Ensure that the samples are moved away from the landing area, so samples don’t fuse together.



RESULTS

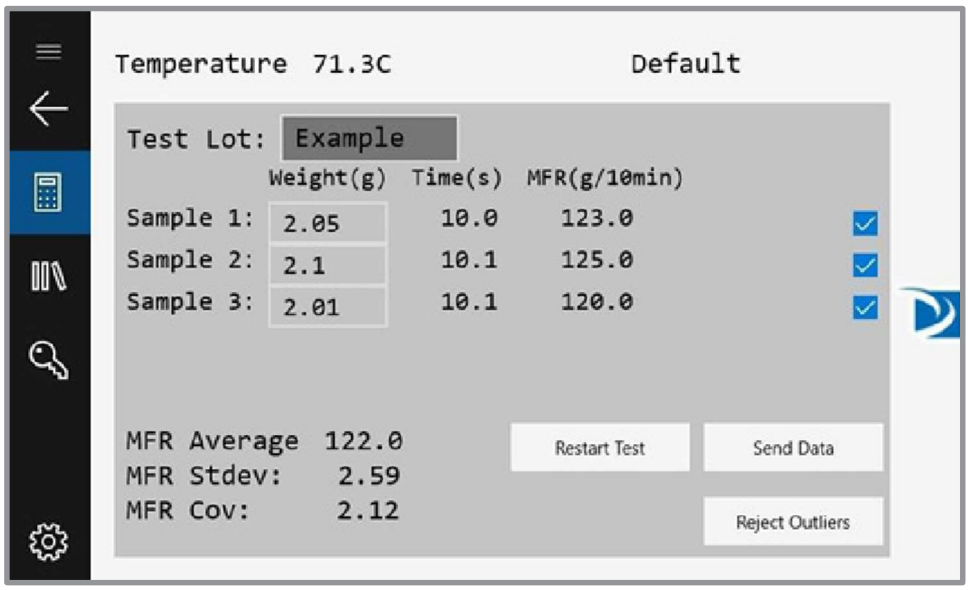
After the final cut has been performed, the results screen will appear:



WEIGH THE SAMPLES

Weigh the sample and enter the weight in grams using the touch panel. (A precision balance is needed to obtain precise flow rate measurements) The flow rate will be immediately calculated and displayed. An extrudate weight of about 1.0 gram or more will reduce weighing errors, adjust the cut time as needed to get at least 0.5 grams of material. If a sample needs to be excluded from the results, uncheck the checkbox to the right of the data point to be excluded. The data point will not be used in the calculations.

If the scale option has been purchased, the weights can be entered automatically. With the scale connected to USB, place the sample of the scale and wait until the measurement is stable. When stable, press the button is the upper right corner of the screen on the scale (the printed page icon). The scale will insert the weight into the currently selected text field.



When all the sample weights have been entered, the user has the option of restarting the test or saving the data. When the “Save Data” button is pressed, the data can go to up to two places. If a USB flash drive in attached to the LMI, a report will be generated and stored on the flash drive. If cloud connectivity is enabled, the data will also be sent to the cloud, accessible via DYNISCO’s cloud platform.

Next perform the steps outlined in the section titled “AFTER A TEST” on page 90.

Press the restart test button to perform another test.

THE METHOD A/B TEST

SECTION 3: TESTING WITH THE LMI6000

THE METHOD A/B TEST

GENERAL DESCRIPTION

In a Method A/B test, both a Method A test and Method B test are performed on the same charge of material. The melt flow rate, derived from Method A, is equated to the Method B flow equation and solved for apparent melt density. The value in doing this test is obtaining a valid apparent melt density which can later be used in a sole Method B test (no manual cuts of extrudate nor weighing) to achieve results equivalent to Method A (operator must make manual cuts and weigh samples).

CALCULATIONS, METHOD A/B

Calculations for the Method A/B test incorporate formulas from both Method A and Method B, as well as an additional formula to correlate the results and determine apparent melt density.

METHOD A FORMULA

$$MFR = \frac{M600}{T_A}$$

M is the mass in grams of material collected over time T, in seconds.
T_A is the time in seconds it takes to traverse the Method A flag length.

METHOD B FORMULA

$$MVR\rho = MFR = \frac{\pi R^2 L\, \rho 600}{T_B}$$

R is the radius of the piston, in centimeters.
L is the flag length, in millimeters.
ρ is the apparent melt density, in g/cc, obtained through A/B testing.
T_B is the time in seconds to traverse the Method B distance L.

METHOD A/B FORMULA

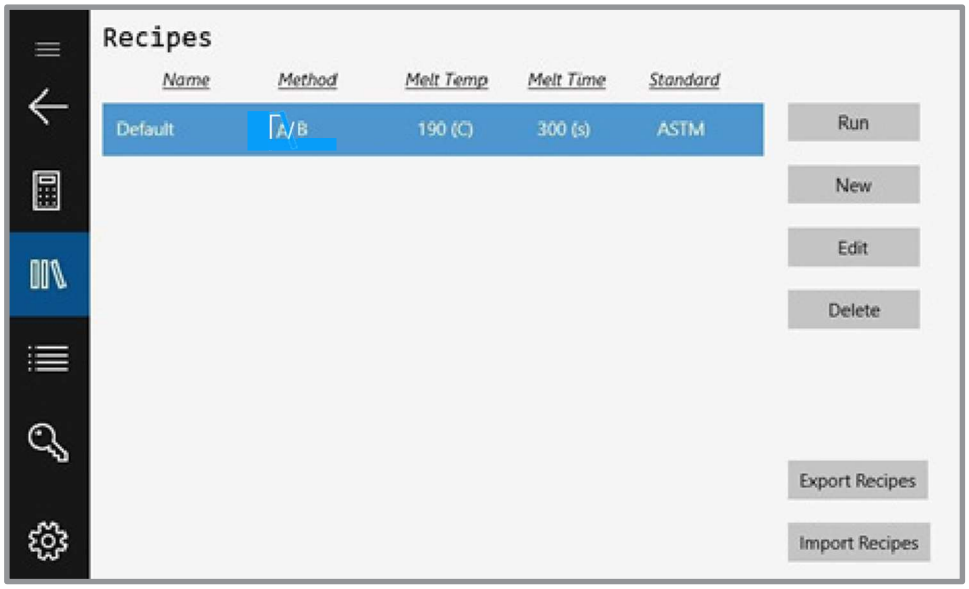
$$\rho = \frac{MT_B}{\pi L R^2 T}$$

See term definitions above.

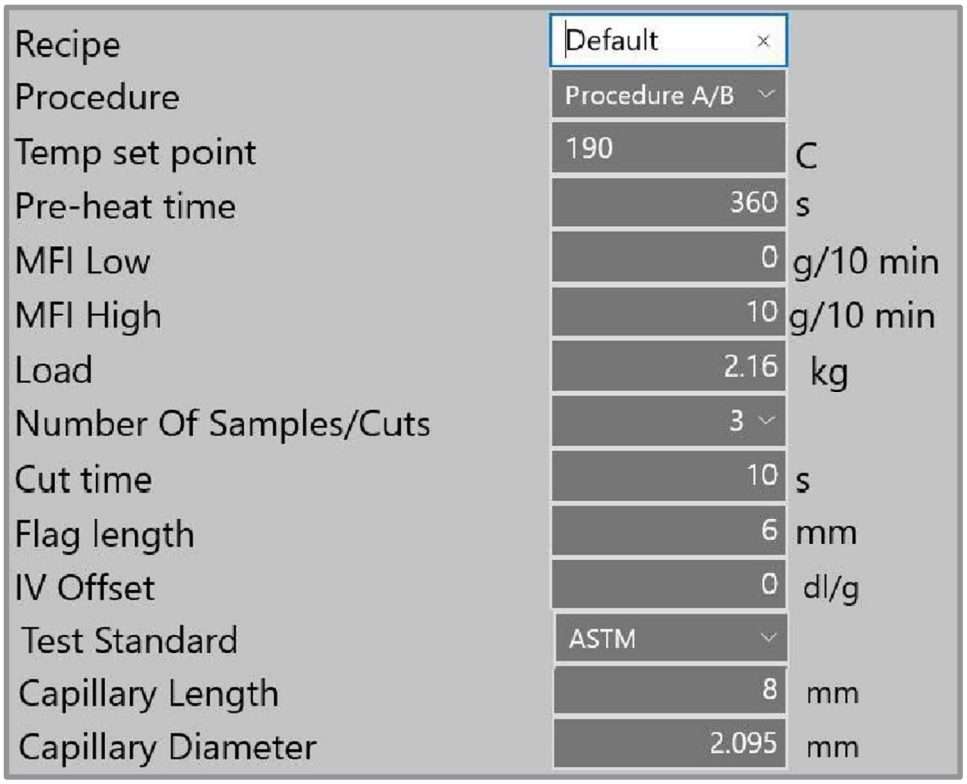
This apparent melt density definition forces the two test methods to agree. DYNISCO recommends taking an average of apparent melt densities from at least 5 separate A/B tests on representative samples of polymer. This average apparent melt density can then be used for Method B tests to get Method A values without having to make cuts! It is called an “apparent melt density” because it is a correlation coefficient that forces Method A and Method B to agree. If there were no leakage past the plunger tip and the extrudate were bubble free and few other minor factors were taken into consideration, then a true melt density could be assessed. All lengths are in mm.

CREATING A PROCEDURE A/B RECIPE

To perform a Procedure A/B test, you must first create a recipe if one doesn't already exist for the material to be tested. This is accomplished by going to the Recipe screen and pressing the "New Recipe" button.



Upon pressing the "New Recipe" button, the following screen will appear:



PROCEDURE A RECIPE PARAMETERS	
RECIPE	Name of recipe.
PROCEDURE	Configures type of test to be run, can be A, B, A/B, C, or D
PRE-HEAT TIME	Amount of time material must be at temperature before test can start.
MFI LOW	Lower limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
MFI HIGH	Higher limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
LOAD	The appropriate weight to be applied to the sample. The load is the combination of the piston and weight.
NUMBER OF SAMPLES	The number of samples to be generated during the test. Valid range is 1-10. This applies to both the Procedure A and Procedure B part of the test.
CUT TIME	The amount of time allocated for each sample in the Procedure A portion of the test.
FLAG LENGTH	The distance of piston travel over which the sample time is acquired in the Procedure B portion of the test.
IV OFFSET	A value entered by the user to offset the IV measurement, if desired.
TEST STANDARD	Allows user to select whether the test is performed to ISO or ASTM standards.
CAPILLARY LENGTH	Length of the capillary that is being used for the test.
CAPILLARY DIAMETER	Diameter of the capillary that is being used for the test.

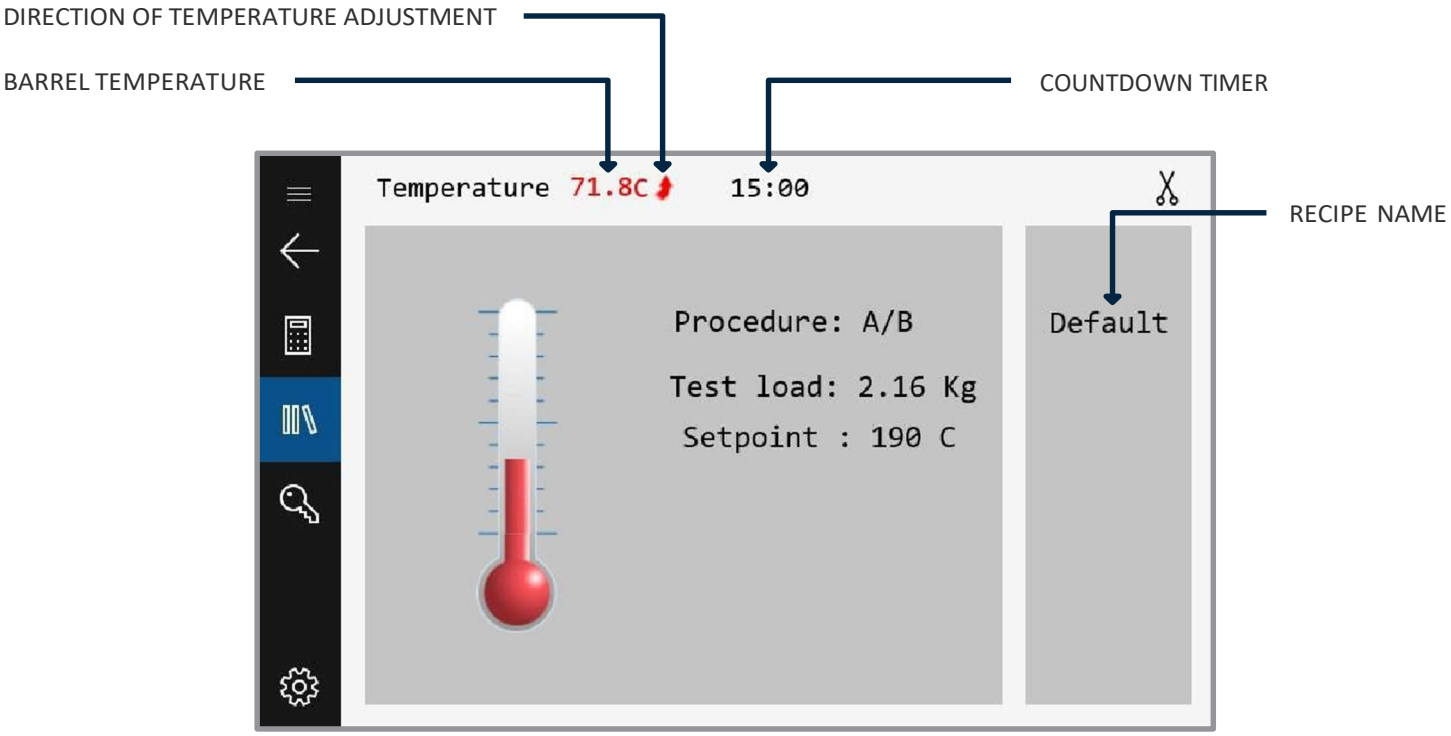
When all fields are complete, press the recipe button again to return to the main recipe screen.

The LMI is now ready to run the test.

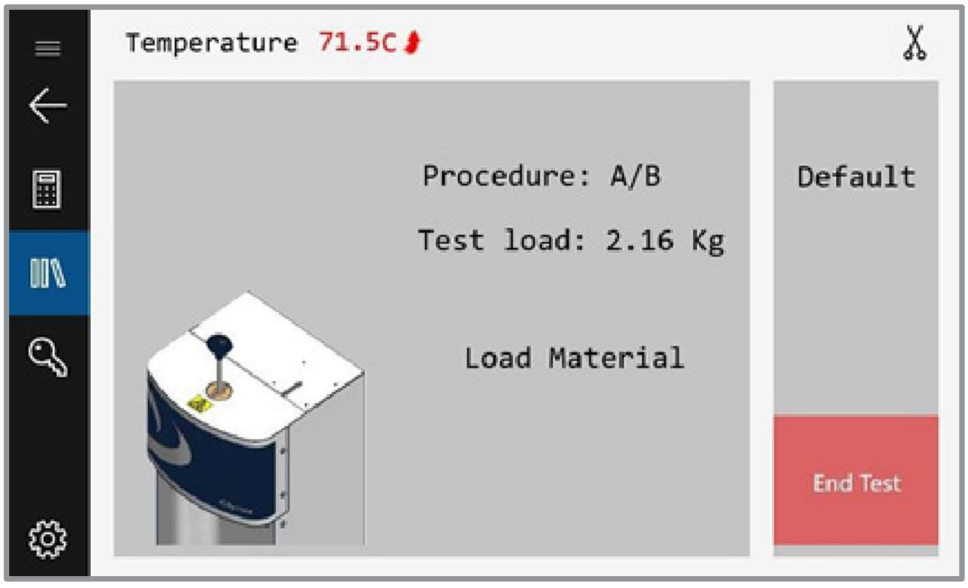
When you turn on the machine, the last recipe run will be loaded into memory and the barrel will heat to its setpoint.

STARTING THE TEST

Press the Run Recipe button, and the screen below will appear.

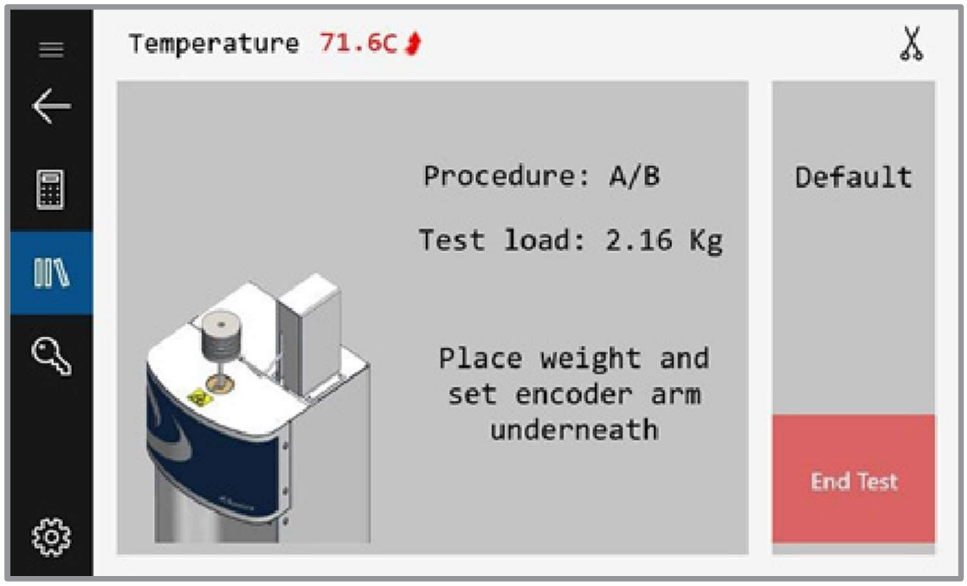


Once the LMI is at the setpoint temperature, a 15 minute count-down timer will start. Ensure that the piston and die are in the unit. After this timer expires, the LMI will be ready to load with material as shown below:



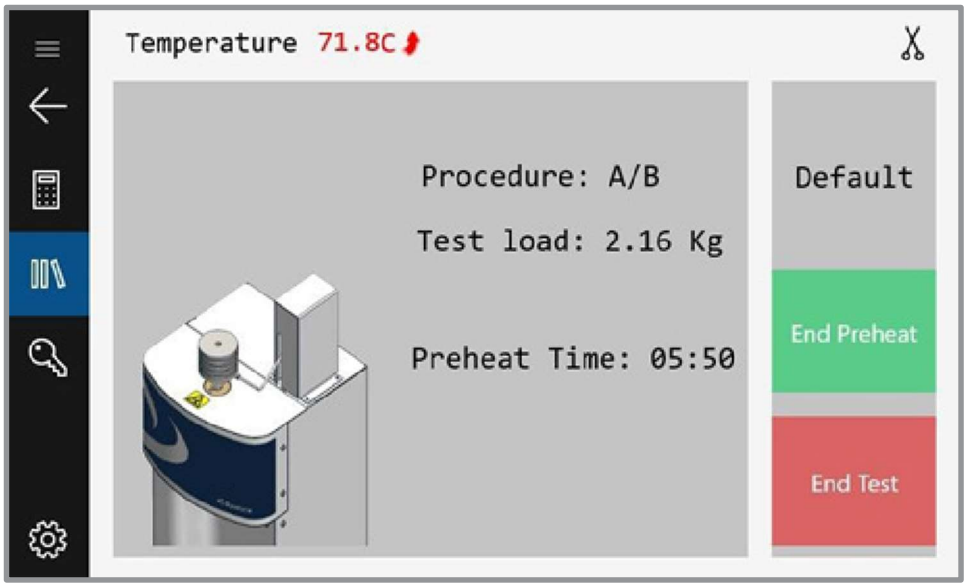
LOADING THE SAMPLE

Load the sample as described in test techniques on page 35. After loading the material, press the screen. The LMI will prompt you to insert the piston and add the weight to the LMI. The encoder arm must also be placed underneath the weight.



PREHEAT

Press the screen again when this is complete. The Preheat time will be displayed on the screen as shown below:

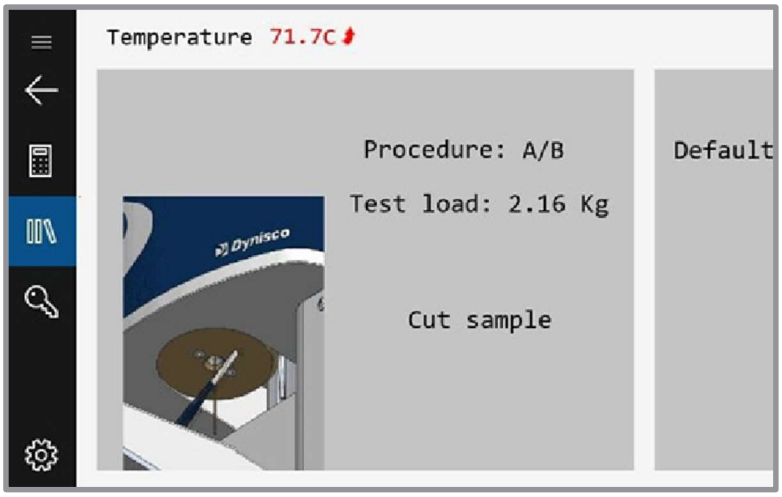


COLLECT SAMPLES

A measurement may start when the 1st scribe mark has lined up with the top of the guide bushing. The run MUST start before the 2nd scribe mark lines up with the top of the guide bushing. After melt time (pre-heat) is completed, and after the piston lowers into the “run area” as denoted by the scribe marks on the piston assembly, the extrudate formed during preheat must be removed. If an Autocutter is not installed the LMI will prompt the user to cut the material. If manually cutting the sample, you MUST touch the screen as the extrudate is being cut. It is critical that the cut and touch are simultaneous to get accurate timing.

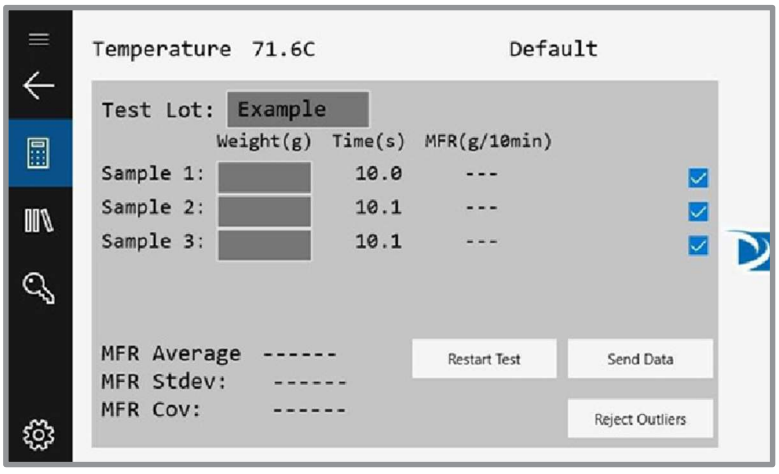
With the Autocutter, the preheat extrudate will be cut automatically. Discard the pre-heat extrudate.

See page 38 for more on how to cut extrudate.



RESULTS

After the final cut has been performed and the piston has traveled the total distance required in the test, the results screen will appear. Note that there are two results screens, one displaying the A portion of the test and one displaying the B portion.

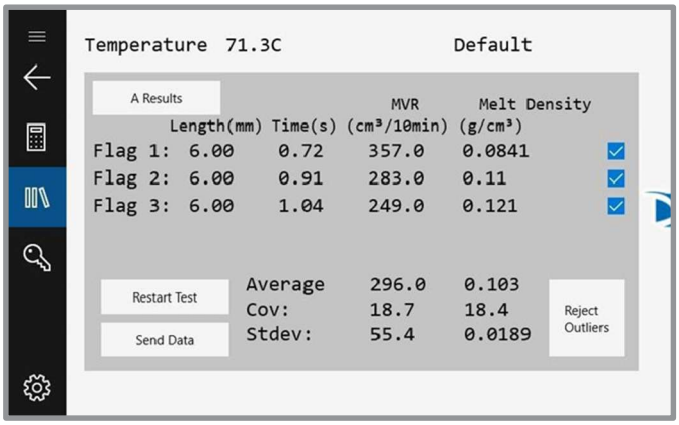


WEIGH THE SAMPLES

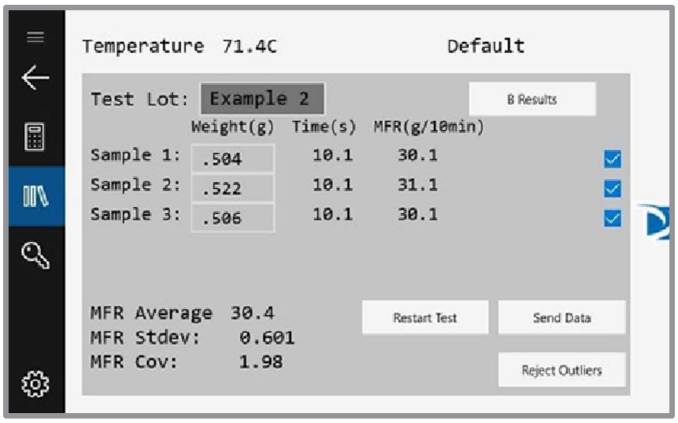
Weigh the sample and enter the weight in grams using the touch panel. (A precision balance is needed to obtain precise flow rate measurements) The flow rate will be immediately calculated and displayed. An extrudate weight of about 1.0 gram or more will reduce weighing errors, adjust the cut time as needed to get at least 0.5 grams of material. If a sample needs to be excluded from the results, uncheck the checkbox to the right of the data point to be excluded. The data point will not be used in the calculations.

If the scale option has been purchased, the weights can be entered automatically. With the scale connected to USB, place the sample of the scale and wait until the measurement is stable. When stable, press the button is the upper right corner of the screen on the scale (the printed page icon). The scale will insert the weight into the currently selected text field.

METHOD A RESULTS



METHOD B RESULTS



When all the sample weights have been entered, the user has the option of restarting the test or saving the data. When the “Save Data” button is pressed, the data can go to up to two places. If a USB flash drive is attached to the LMI, a report will be generated and stored on the flash drive. If cloud connectivity is enabled, the data will also be sent to the cloud, accessible via DYNISCO’s cloud platform.

Next perform the steps outlined in the section titled “AFTER A TEST” on page 90.

Press the restart test button to perform another test.

THE METHOD B TEST

SECTION 3: TESTING WITH THE LMI6000

THE METHOD B TEST

GENERAL DESCRIPTION

Method B is an assessment of a material's flow characteristics based on the volumetric displacement rather than weight of extrudate with time as in Method A. Unlike Method A, no cutting and weighing of the extrudate is required to perform a Method B test. Results from Method B test can be expressed directly as Melt Volumetric Flow Rate (MVR) in cc/10 min. To relate the results of a Method B run back to Method A, the apparent melt density must be known.

The determination of the apparent density is illustrated in the previous section using Method A/B. Without the apparent melt density MFR cannot be calculated using Method B. Some companies use MVR directly without ever determining MFR.

The piston's downward travel time is determined from a counter initiated by an optical sensor or digital encoder. The encoder system makes it possible to get as many as 10 results from one run.

CALCULATIONS, METHOD B

Flow rate for Method B is computed according to the following formula.

METHOD B FORMULA

$$MVR\rho = MFR = \frac{\pi R^2 L \rho 600}{T_B}$$

R is the radius of the piston, in centimeters.
L is the flag length, in millimeters.
ρ is the apparent melt density, in g/cc, obtained through A/B testing.
T_B is the time, in seconds, it takes to traverse the Method B distance L.

You should determine the melt densities for your material using your own melt indexer. Variations in technique and difference in material grades can cause differences from user to user. The following table of melt densities can be used as a general guide. If you get values which differ by more than 10% from these, it is likely that some part of the test is being performed incorrectly. Fillers, reinforcing agents, etc. tend to increase the melt density of the material.

Notice that apparent melt density is a function of temperature. In general, the solid-state density is a very poor estimate of the melt density and should not be used.

TYPICAL MELT DENSITIES

TEMPERATURE, °C	LDPE	HDPE	POLYBUTENE-1	POLYPROPYLENE
120 °C	0.797		0.806	0.880
130 °C	0.791		0.800	0.872
140 °C	0.785		0.794	0.864
150 °C	0.780	0.780	0.787	0.852
160 °C	0.777	0.777	0.780	0.840
170 °C	0.770	0.770	0.774	0.819
180 °C	0.765	0.765	0.767	0.758
190 °C	0.760	0.760	0.760	0.754
200 °C	0.755	0.755	0.754	0.750
210 °C	0.748	0.748	0.746	0.746
220 °C	0.744	0.738	0.740	0.742
230 °C	0.738	0.378	0.733	0.738
240 °C	0.733	0.733	0.726	0.734
250 °C	0.737	0.727	0.719	0.730

Any inaccuracies in the melt density will be propagated proportionally along to the MFR values. Thus a 1% error in the melt density means a 1% accuracy error in the MFR the value.

Method B is an assessment of a material's flow characteristics based on the volumetric displacement rather than weight of extrudate with time as in Method A. Unlike Method A, no cutting and weighing of the extrudate is required to perform a Method B test. Results from Method B test can be expressed directly as Melt Volumetric Flow Rate (MVR) in ml/10 min. To relate the results of a Method B test to Method A, the apparent melt density must be known.

The determination of the apparent density is illustrated in the previous section using Method A/B. Without the apparent melt density MFR cannot be calculated using Method B. Some laboratories use MVR directly without ever determining MFR.

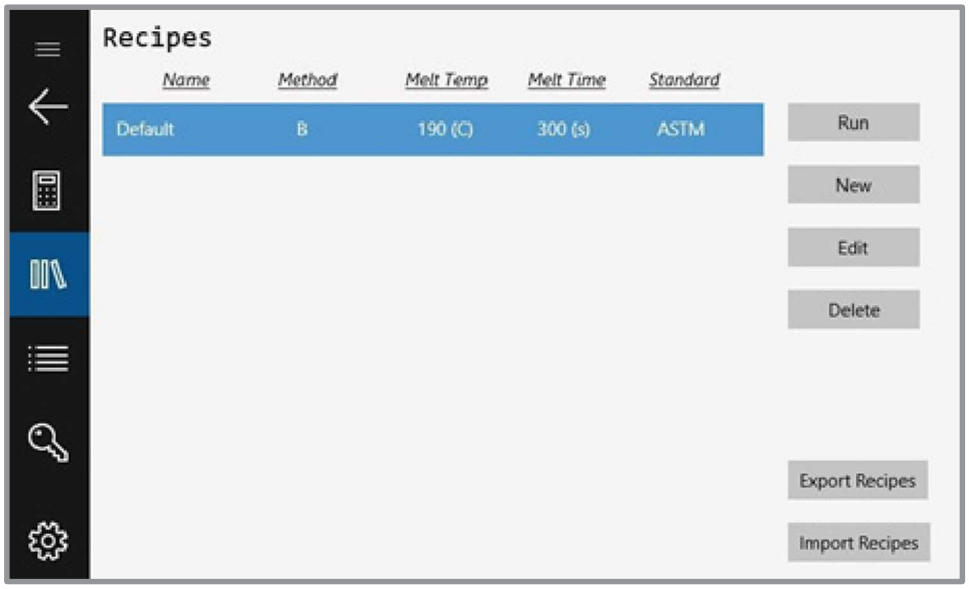
The piston's downward travel time is determined from a counter initiated by a digital encoder. The encoder senses distance traveled by following the bottom of the test weight(s) which are at the top of the piston. With all DYNISCO Systems flags, Method A and B start in the same place. Flags may be any length desired, and a test can have any number as long as the total distance of flags is no longer than the distance from the start point and where the piston would land on the top of the die (≈25.4mm). Balance flag length with the expected MFR of the material. Small flag lengths with high MFI material might have reduced accuracy. Recently, Method B has become the more common test because it is simpler to run (hands free after material load) and more precise for routine analysis. In addition, the encoder system makes it possible to get more from one run.

You should determine the melt densities for your material using your melt indexer. Variations in technique and difference in material grades can cause differences from user to user. The table of melt densities can be used as a general guide if you get values which differ by more than 10% from these, most likely, something is being done incorrectly. Fillers, reinforcing agents etc. tend to increase the melt density of the material. Notice that apparent melt density is a function of temperature.

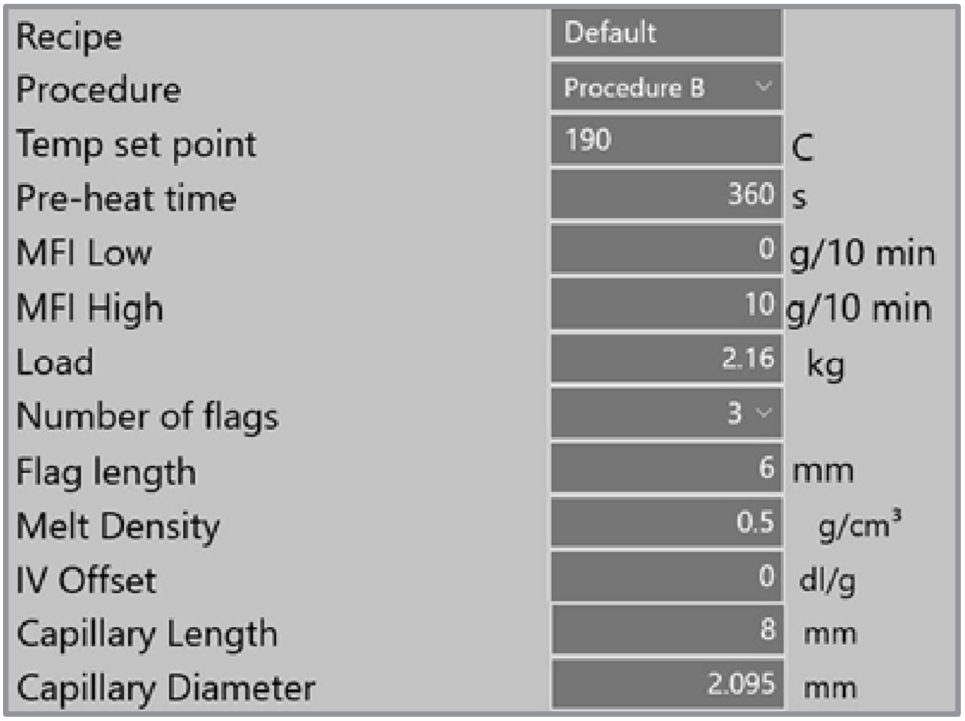
In general, solid-state density is a very poor estimate of melt density, and should not be used.

CREATING A PROCEDURE B RECIPE

A test is performed by running a recipe. You must create a recipe if one doesn't already exist for the material to be tested. This is accomplished by pressing  to go to the Recipe screen and pressing the "New" button.



Upon pressing the "New Recipe" button, the following screen will appear:



PROCEDURE B RECIPE PARAMETERS	
RECIPE	Name of recipe.
PROCEDURE	Configures type of test to be run, can be A, B, A/B, C, or D
PRE-HEAT TIME	Amount of time material must be at temperature before test can start. Generally, choose between 5 and 7 minutes based on your national standard for thermally stable materials.
MFI LOW	Lower limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
MFI HIGH	Higher limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
LOAD	The appropriate weight to be applied to the sample. The load is the combination of the piston and weight.
NUMBER OF FLAGS	The number of flags to be measured during the test. Valid range is 1-10.
FLAG LENGTH	The distance interval over which the sample is timed.
MELT DENSITY	Melt density of test material. Used in MFR calculation.
IV OFFSET	A value entered by the user to offset the IV measurement if desired.
CAPILLARY LENGTH	Length of the capillary that is being used for the test.
CAPILLARY DIAMETER	Diameter of the capillary that is being used for the test.

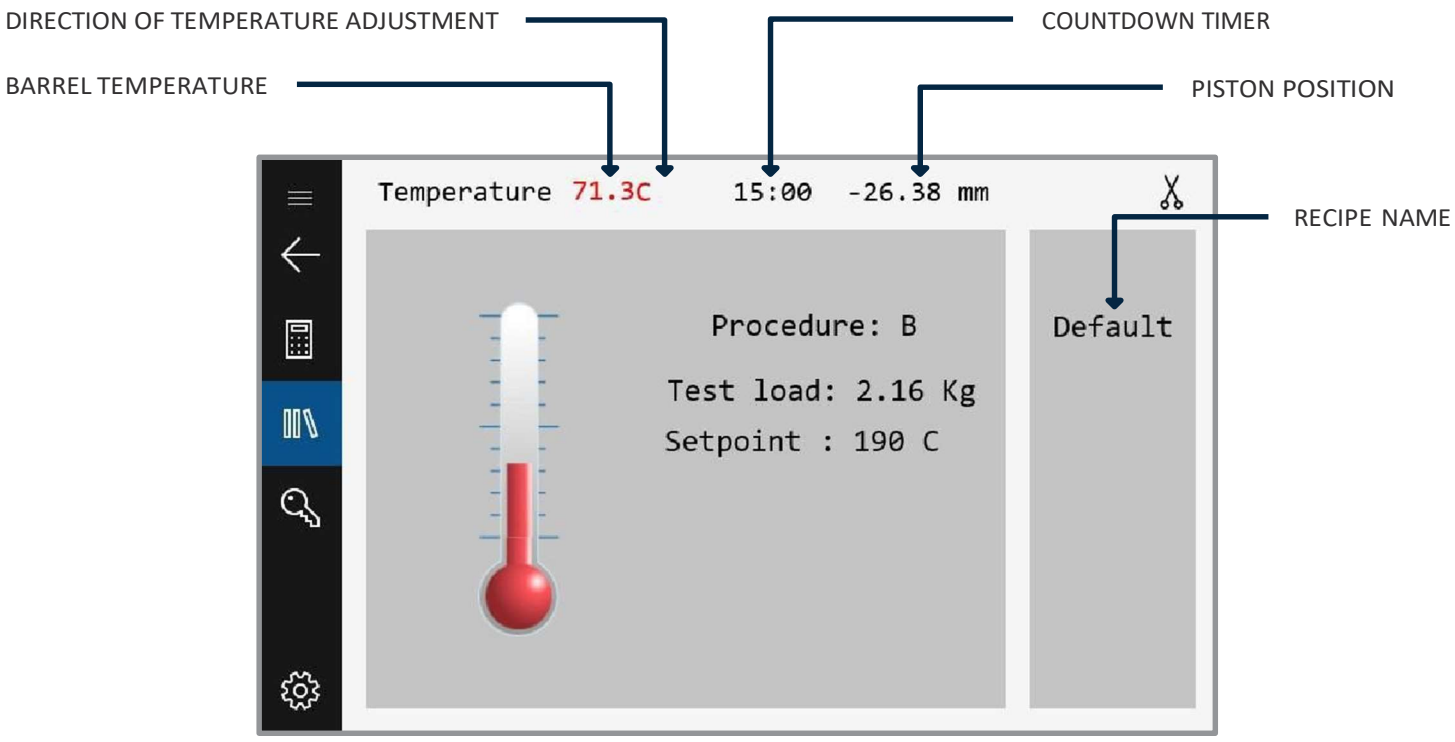
When all fields are complete, press the recipe button again to return to the main recipe screen.

The LMI is now ready to run the test.

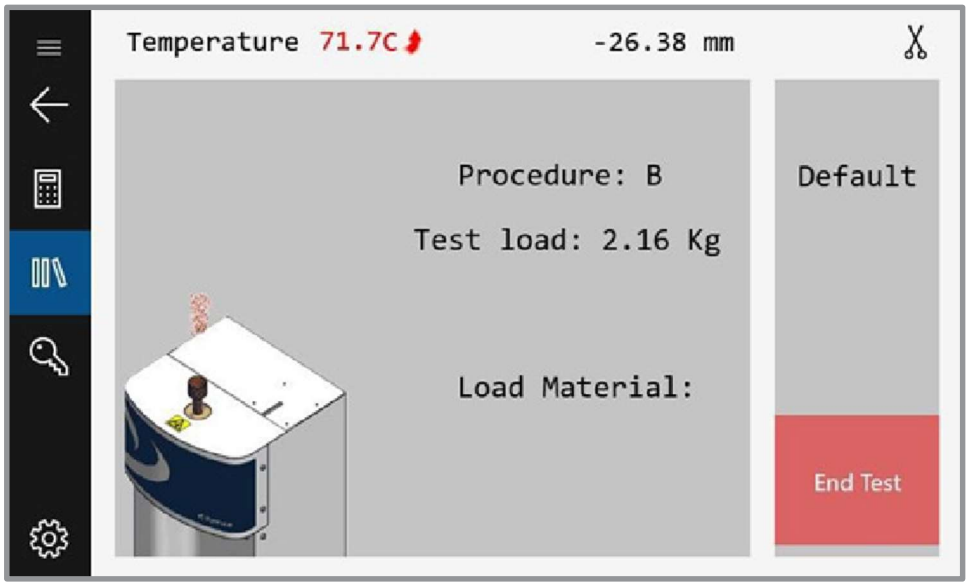
When you turn on the machine, the last recipe run will be loaded into memory and the barrel will heat to its setpoint.

STARTING THE TEST

Press the Run Recipe button, and the screen below will appear.

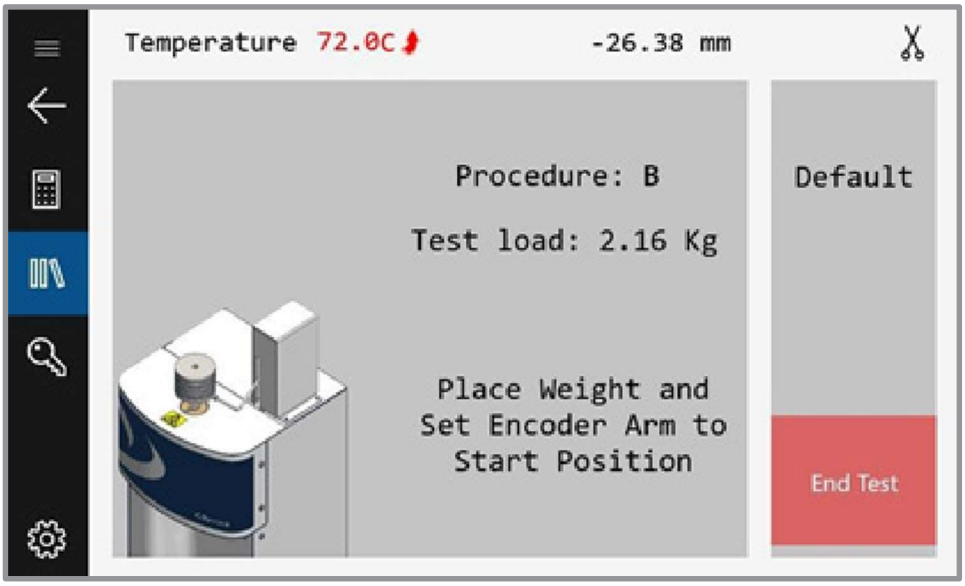


Once the LMI is at the setpoint temperature, a 15 minute count-down timer will start. Ensure that the piston and die are in the unit. After this timer expires, the LMI will be ready to load with material as shown below:



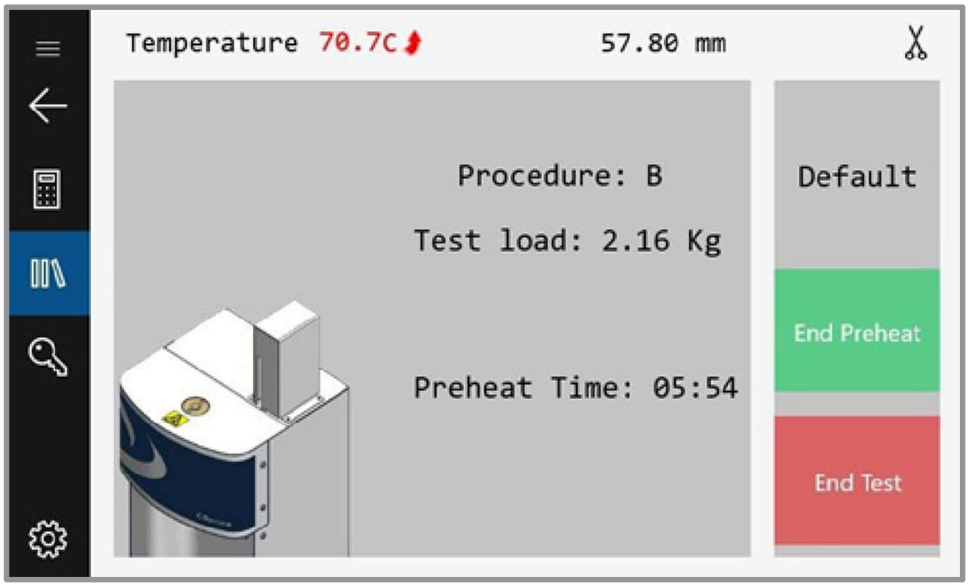
LOADING THE SAMPLE

Load the sample as described in test techniques on page 35. After loading the material, press the screen. The LMI will prompt you to insert the piston and add the weight to the LMI. The encoder arm must also be placed underneath the weight.



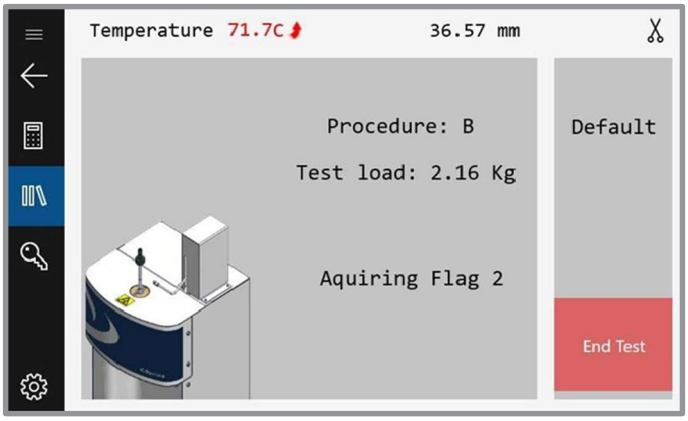
PREHEAT

Press the screen again when this is complete. The Preheat time will be displayed on the screen as shown below:



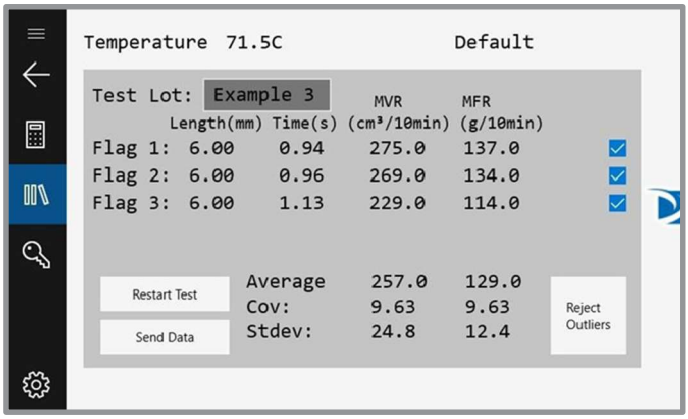
COLLECT SAMPLES

Measurements will start when the 1st scribe mark has lined up with the top of the guide bushing. For each flag length, the LMI will measure the sample time interval that has elapsed.



RESULTS

After the final flag time has been captured, the results screen will appear:



When the results screen is displayed, the user has the option of restarting the test or saving the data. When the "Save Data" button is pressed, the data can go to up to two places. If a USB flash drive in attached to the LMI, a report will be generated and stored on the flash drive. If cloud connectivity is enabled, the data will also be sent to the cloud, accessible via DYNISCO's cloud platform.

Next perform the steps outlined in the section titled "AFTER A TEST" on page 90.

Press the restart test button to perform another test.

THE METHOD C TEST

SECTION 3: TESTING WITH THE LMI6000

THE METHOD C TEST

GENERAL DESCRIPTION

Method C is a variation of a method B test where a half height die is used. This die has half the height, and half the diameter of the standard die used in the other methods. It's generally used as an alternative to the standard method B test when the material's MFR is greater than 75 g/10 min. Even though the results are like the results of the method B test, the results using method C should not assumed to be half the results of a standard method B test. One other difference of note is that the test starts at 50mm above the die rather than 46mm used in the standard method B test.

CALCULATIONS, METHOD C

Flow rate for Method B is computed according to the following formula.

METHOD B FORMULA

$$MVR\rho = MFR = \frac{\pi R^2 L \rho 600}{T_B}$$

R is the radius of the piston, in centimeters.
L is the flag length, in millimeters.
ρ is the apparent melt density, in g/cc, obtained through A/B testing.
T_B is the time, in seconds, it takes to traverse the Method C distance L.

You should determine the melt densities for your material using your own melt indexer. Variations in technique and difference in material grades can cause differences from user to user. The following table of melt densities can be used as a general guide. If you get values which differ by more than 10% from these, it is likely that some part of the test is being performed incorrectly. Fillers, reinforcing agents, etc. tend to increase the melt density of the material.

Notice that apparent melt density is a function of temperature. In general, the solid-state density is a very poor estimate of the melt density and should not be used.

TYPICAL MELT DENSITIES

TEMPERATURE, °C	LDPE	HDPE	POLYBUTENE-1	POLYPROPYLENE
120 °C	0.797		0.806	0.880
130 °C	0.791		0.800	0.872
140 °C	0.785		0.794	0.864
150 °C	0.780	0.780	0.787	0.852
160 °C	0.777	0.777	0.780	0.840
170 °C	0.770	0.770	0.774	0.819
180 °C	0.765	0.765	0.767	0.758
190 °C	0.760	0.760	0.760	0.754
200 °C	0.755	0.755	0.754	0.750
210 °C	0.748	0.748	0.746	0.746
220 °C	0.744	0.738	0.740	0.742
230 °C	0.738	0.378	0.733	0.738
240 °C	0.733	0.733	0.726	0.734
250 °C	0.737	0.727	0.719	0.730

Any inaccuracies in the melt density will be propagated proportionally along to the MFR values. Thus a 1% error in the melt density means a 1% accuracy error in the MFR the value.

Method C is an assessment of a material's flow characteristics based on the volumetric displacement rather than weight of extrudate with time as in Method A. Unlike Method A, no cutting and weighing of the extrudate is required to perform a Method B test. Results from Method C test can be expressed directly as Melt Volumetric Flow Rate (MVR) in ml/10 min. To relate the results of a Method C test to Method A, the apparent melt density must be known.

The determination of the apparent density is illustrated in the previous section using Method A/B. Without the apparent melt density MFR cannot be calculated using Method C. Some laboratories use MVR directly without ever determining MFR.

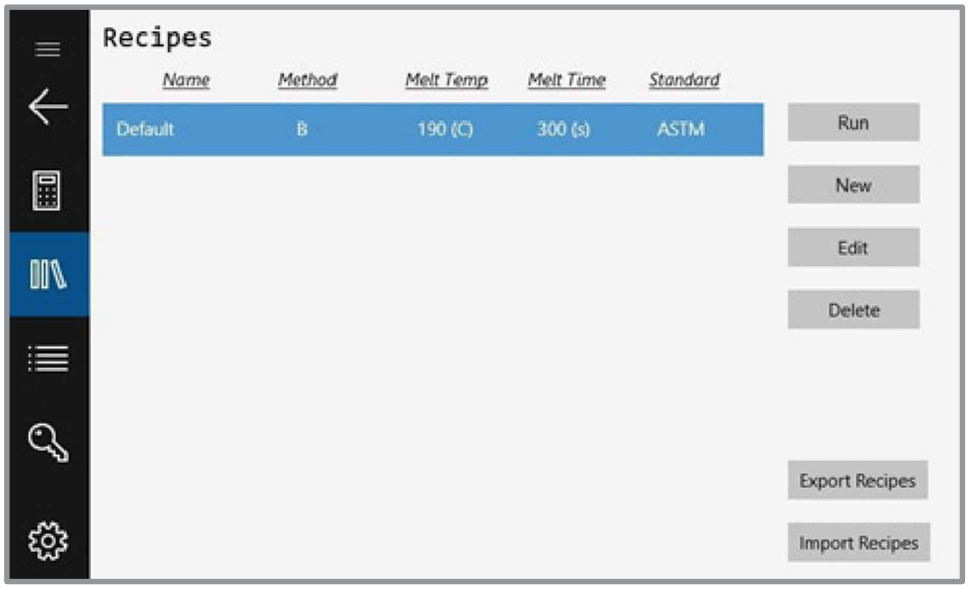
The piston's downward travel time is determined from a counter initiated by a digital encoder. The encoder senses distance traveled by following the bottom of the test weight(s) which are at the top of the piston. Flags may be any length desired, and a test can have any number as long as the total distance of flags is no longer than the distance from the start point and where the piston would land on the top of the die (≈25.4mm).

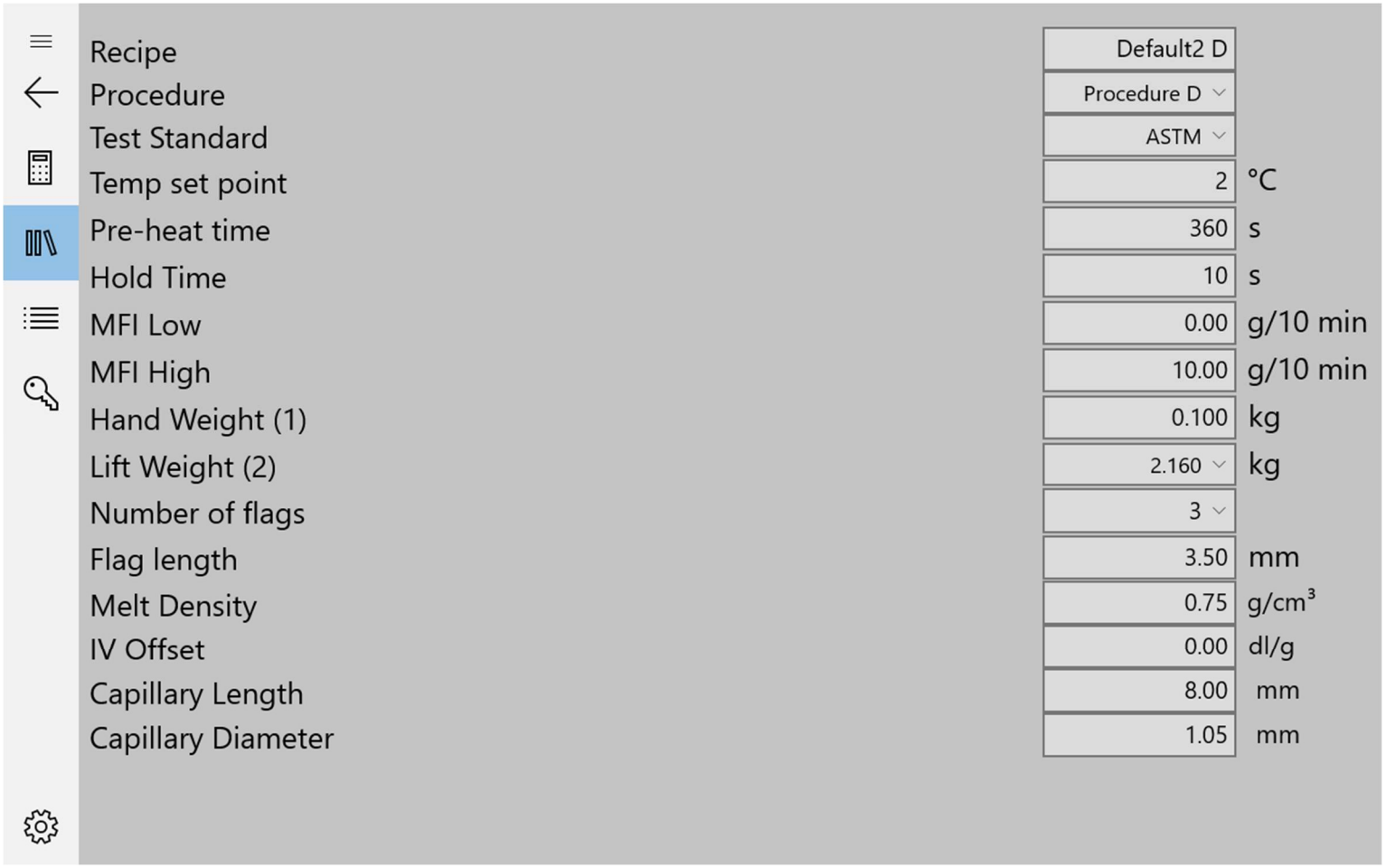
You should determine the melt densities for your material using your melt indexer. Variations in technique and difference in material grades can cause differences from user to user. The table of melt densities can be used as a general guide if you get values which differ by more than 10% from these, most likely, something is being done incorrectly. Fillers, reinforcing agents etc. tend to increase the melt density of the material. Notice that apparent melt density is a function of temperature.

In general, solid-state density is a very poor estimate of melt density and should not be used.

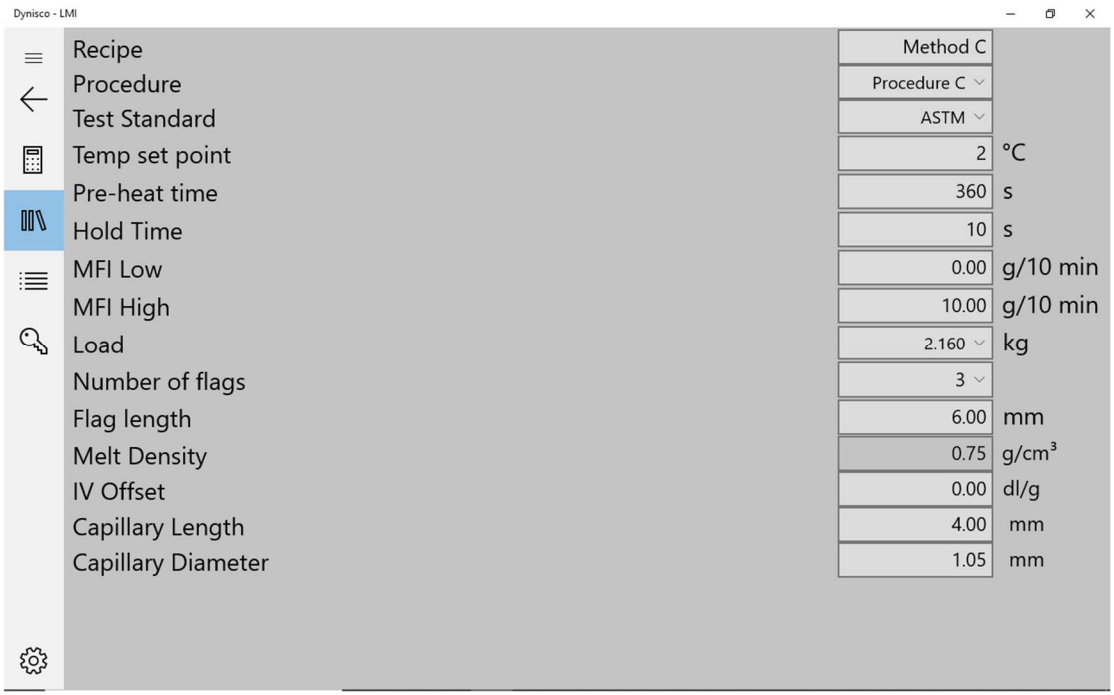
CREATING A PROCEDURE C RECIPE

A test is performed by running a recipe. You must create a recipe if one doesn't already exist for the material to be tested. This is accomplished by pressing to go to the Recipe screen and pressing the "New" button.





Upon pressing the “New Recipe” button, the following screen will appear:



PROCEDURE C RECIPE PARAMETERS	
RECIPE	Name of recipe.
PROCEDURE	Configures type of test to be run, can be A, B, A/B, C, or D
PRE-HEAT TIME	The amount of time material must be at temperature before test can start. Generally, choose between 5 and 7 minutes based on your national standard for thermally stable materials.
MFI LOW	Lower limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
MFI HIGH	Higher limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
LOAD	The appropriate weight to be applied to the sample. The load is the combination of the piston and weight.
NUMBER OF FLAGS	The number of flags to be measured during the test. Valid range is 1-5.
FLAG LENGTH	The distance interval over which the sample is timed.
MELT DENSITY	Melt density of test material. Used in MFR calculation.
IV OFFSET	A value entered by the user to offset the IV measurement if desired.
CAPILLARY LENGTH	Length of the capillary that is being used for the test.
CAPILLARY DIAMETER	Diameter of the capillary that is being used for the test.

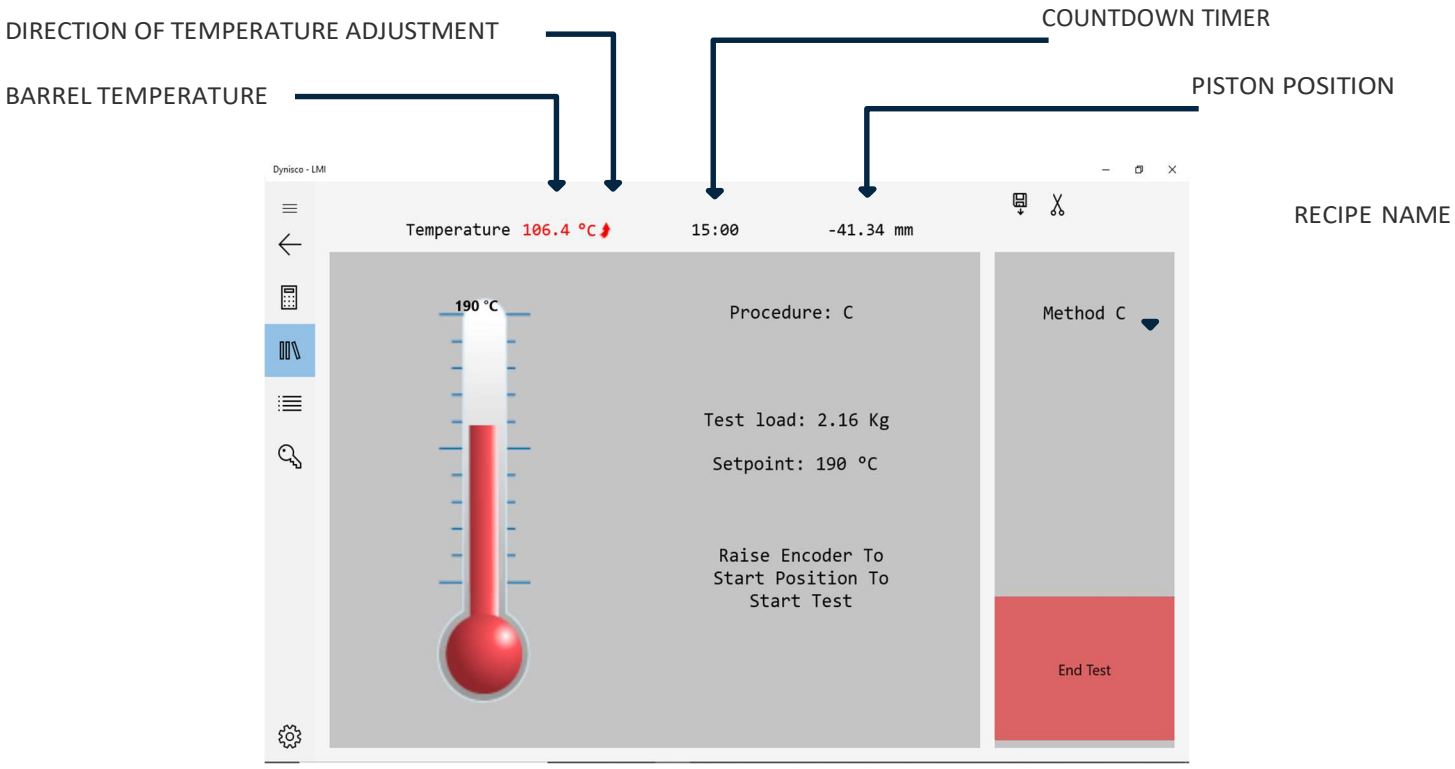
When all fields are complete, press the recipe button again to return to the main recipe screen.

The LMI is now ready to run the test.

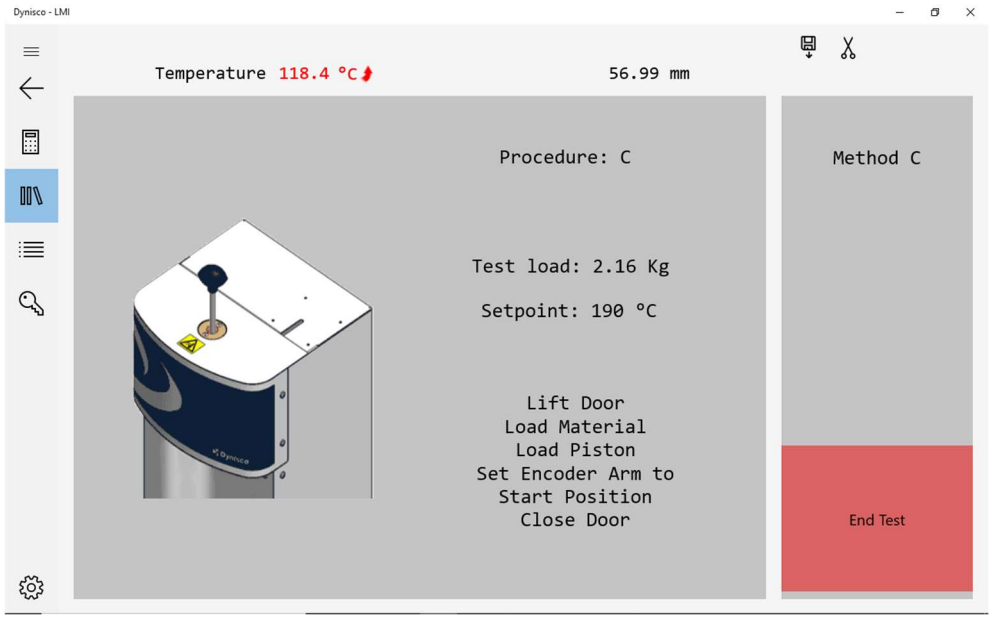
When you turn on the machine, the last recipe run will be loaded into memory and the barrel will heat to its setpoint.

STARTING THE TEST

Press the Run Recipe button, and the screen below will appear.



Once the LMI is at the setpoint temperature, a 15-minute count-down timer will start. Ensure that the piston and die are in the unit. After this timer expires, the LMI will be ready to load with material as shown below:

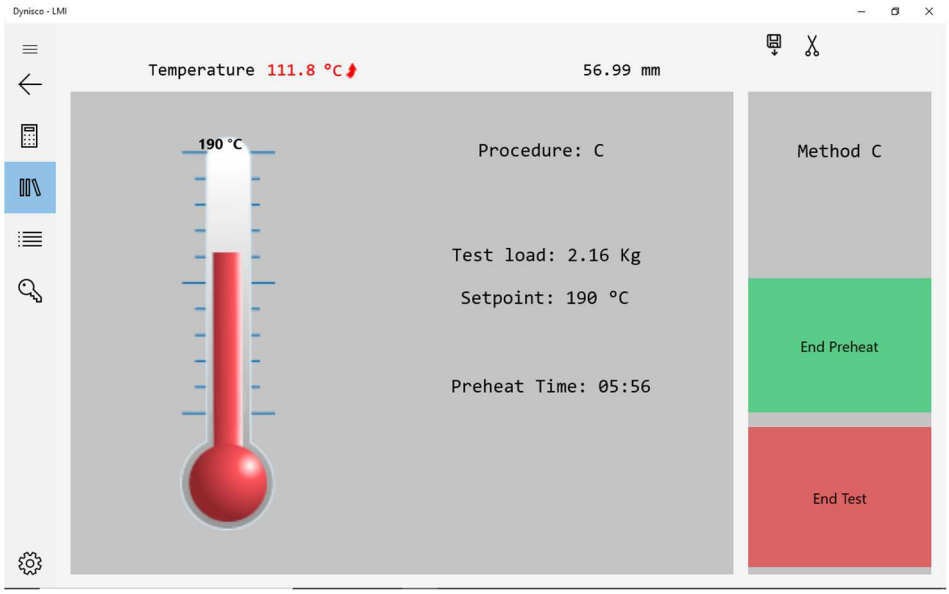


LOADING THE SAMPLE

Open the door to load the sample. Replace the piston and close the door. After the door is closed, press the screen and the test will proceed by lowering the previously specified weight onto the piston. The test will now proceed to the preheat (melt) stage.

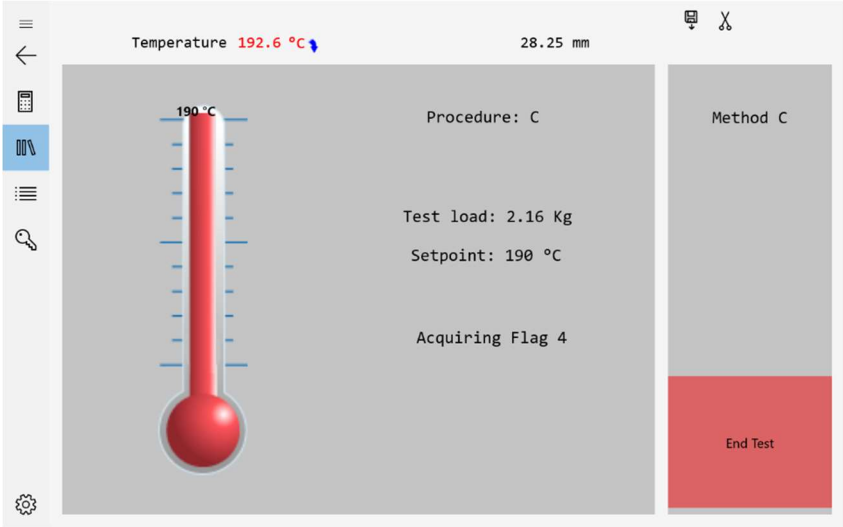
PREHEAT

Press the screen again when this is complete. The Preheat time will be displayed on the screen as shown below:



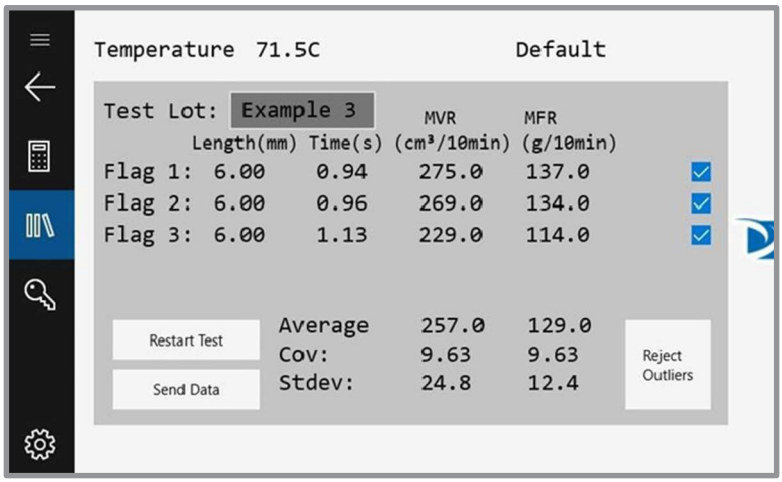
COLLECT SAMPLES

Measurements will start when the 1st scribe mark has lined up with the top of the guide bushing. For each flag length, the LMI will measure the sample time interval that has elapsed.



RESULTS

After the final flag time has been captured, the results screen will appear:



When the results screen is displayed, the user has the option of restarting the test or saving the data. When the "Save Data" button is pressed, the data can go to up to fourplaces. If a USB flash drive in attached to the LMI, a report will be generated and stored on the flash drive. If cloud connectivity is enabled, the data will also be sent to the cloud, accessible via DYNISCO's cloud platform. The LMI will store the last 25 tests locally on the device. Another option is to have the LMI store results in a network location.

Next perform the steps outlined in the section titled "AFTER A TEST" on page 90.

Press the restart test button to perform another test.

THE METHOD D TEST

SECTION 3: TESTING WITH THE LMI6000

THE METHOD D TEST

GENERAL DESCRIPTION

A Method D test is a multi-weight test commonly referred to as a “Flow Rate Ratio” test. MFRs can be calculated using two different test loads on one charge of material. The FRR is calculated by dividing the MFR of the higher test load by the MFR of the lower test load.

CALCULATIONS, METHOD D

Calculations for the Method D test incorporate formulas from both Method A and Method B, as well as an additional formula to correlate the results and determine apparent melt density.

METHOD D FORMULA (For each load)

$$MVR_\rho = MFR = \frac{\pi R^2 L \rho 600}{T_B}$$

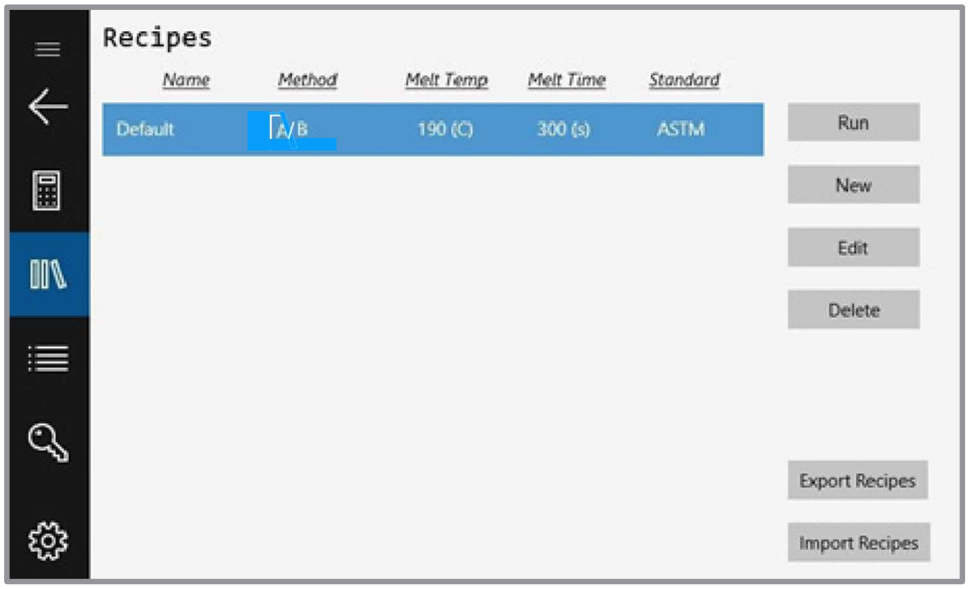
R is the radius of the piston, in centimeters.
L is the flag length, in millimeters.
ρ is the apparent melt density, in g/cc, obtained through A/B testing.
T_B is the time in seconds to traverse the Method B distance L.

FRR FORMULA

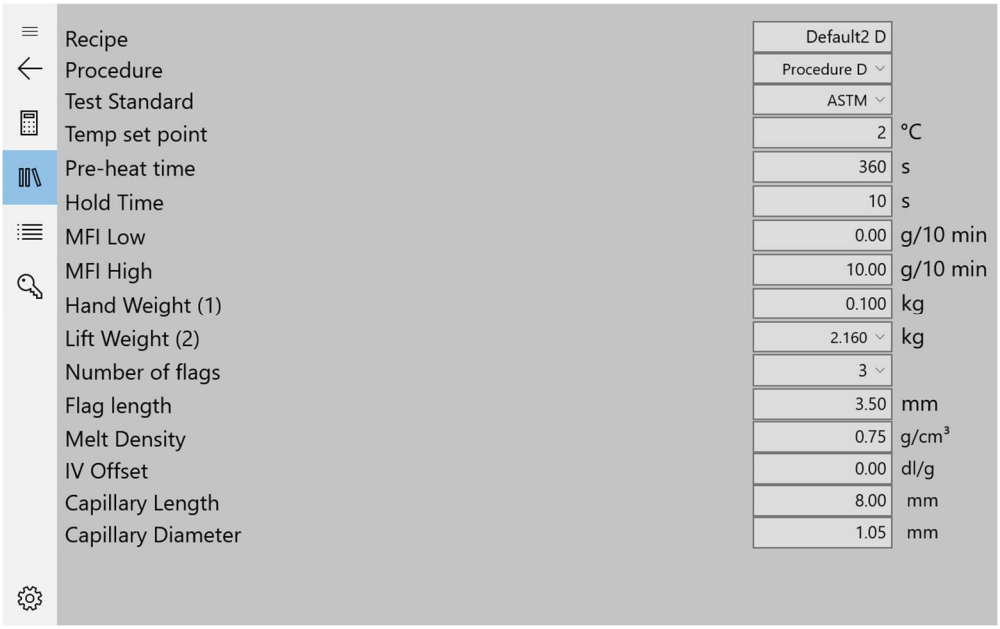
$$FRR = \frac{MFR_H}{MFR_L}$$

CREATING A PROCEDURE D RECIPE

To perform a Procedure D test, you must first create a recipe if one doesn't already exist for the material to be tested. This is accomplished by going to the Recipe screen and pressing the "New Recipe" button.



Upon pressing the "New Recipe" button, the following screen will appear:



PROCEDURE D RECIPE PARAMETERS	
RECIPE	Name of recipe.
PROCEDURE	Configures type of test to be run, can be A, B, A/B, C, or D
TEST STANDARD	Allows user to select whether the test is performed to ISO or ASTM standards.
PRE-HEAT TIME	Amount of time material must be at temperature before test can start.
MFI LOW	Lower limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
MFI HIGH	Higher limit that controls the color that the MFI is displayed in on the results screen. Black is within the limits and red is outside the limits.
Hand Weight (1)	The first weight used in the method D test. This is a hand weight placed after material is loaded.
Lift Weight (2)	The second weight used in the test. This weight is placed by the lift system.
NUMBER OF FLAGS	The number of flags to be generated for each load during the test. The valid range is 1-3. Each weight will have this number of flags.
FLAG LENGTH	The distance of piston travel over which the sample time is acquired.
MELT DENSITY	Used in calculating MFR from MVR.
CAPILLARY LENGTH	Length of the capillary that is being used for the test.
CAPILLARY DIAMETER	Diameter of the capillary that is being used for the test.

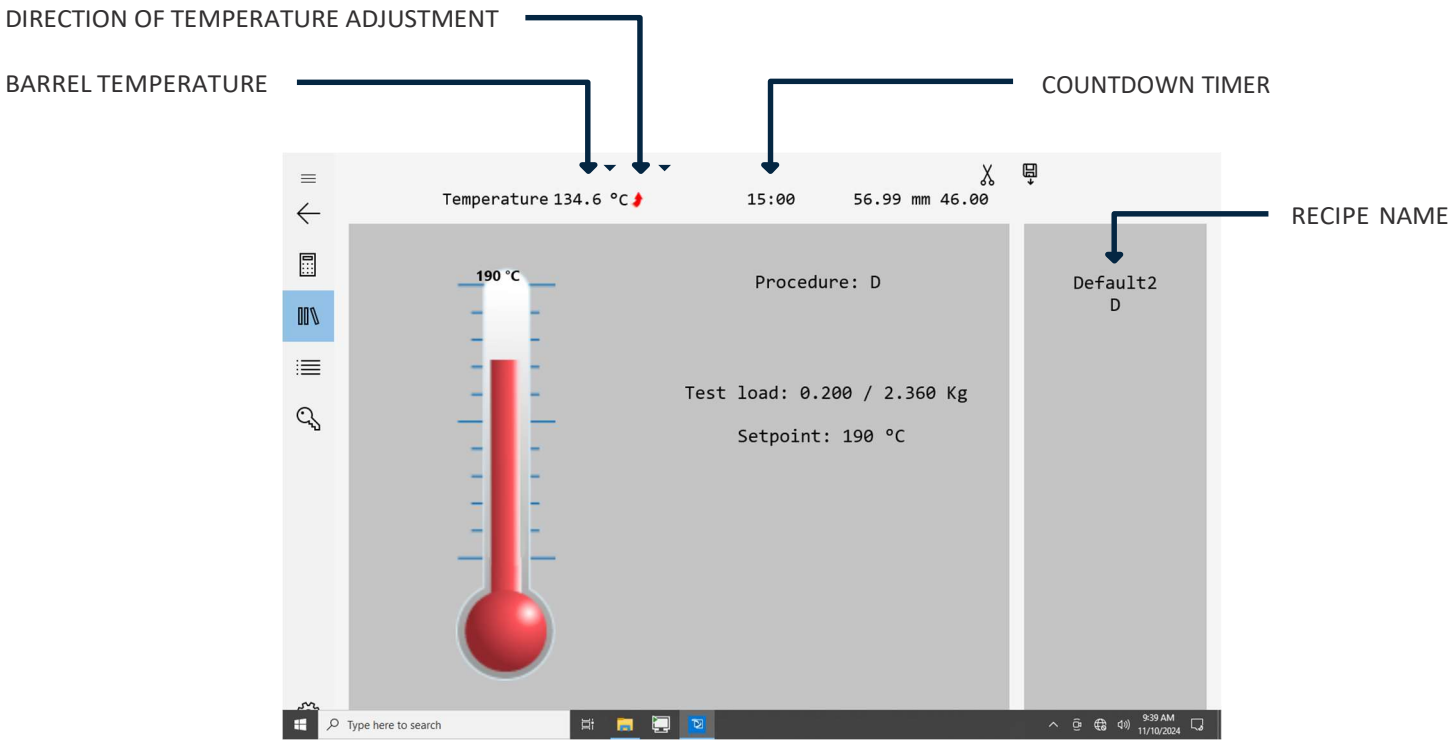
When all fields are complete, press the recipe button again to return to the main recipe screen.

The LMI is now ready to run the test.

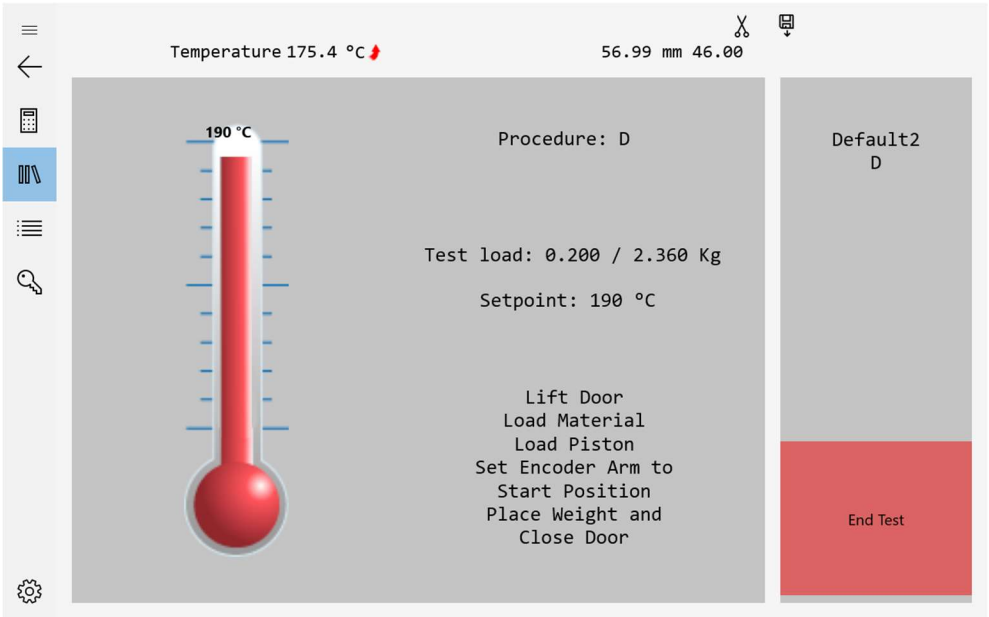
When you turn on the machine, the last recipe run will be loaded into memory and the barrel will heat to its setpoint.

STARTING THE TEST

Press the Run Recipe button, and the screen below will appear.



Once the LMI is at the setpoint temperature, a 15-minute count-down timer will start. Ensure that the piston and die are in the unit. After this timer expires, the LMI will be ready to load with material as shown below:

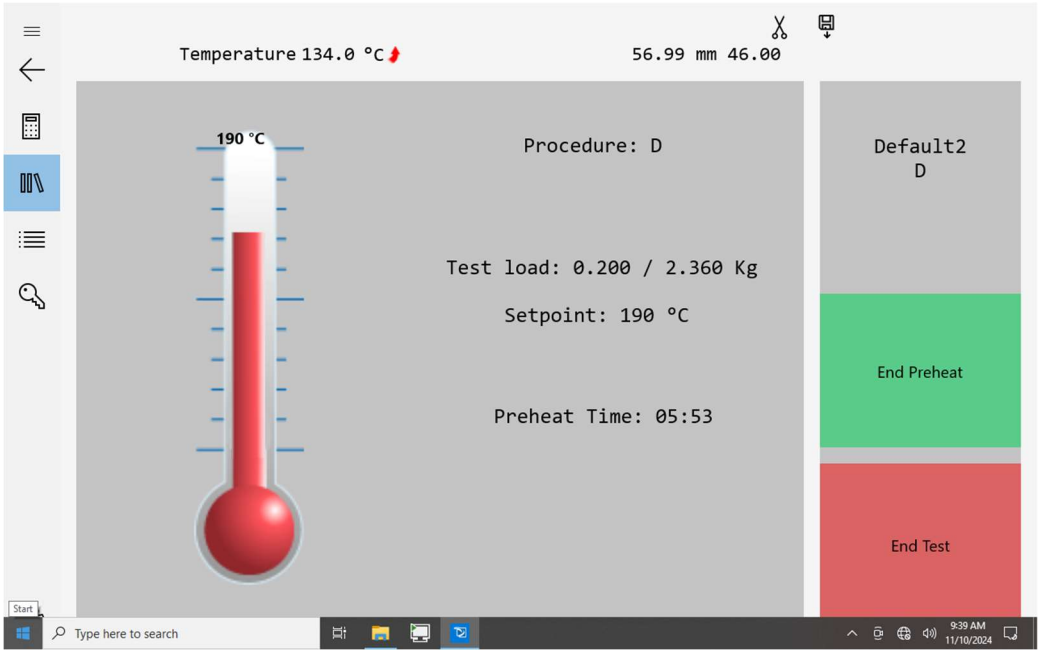


LOADING THE SAMPLE

Load the sample as described in test techniques on page 35. After loading the material, press the screen. The LMI will prompt you to insert the piston and add the hand weight to the LMI. The encoder arm must also be placed underneath the weight.

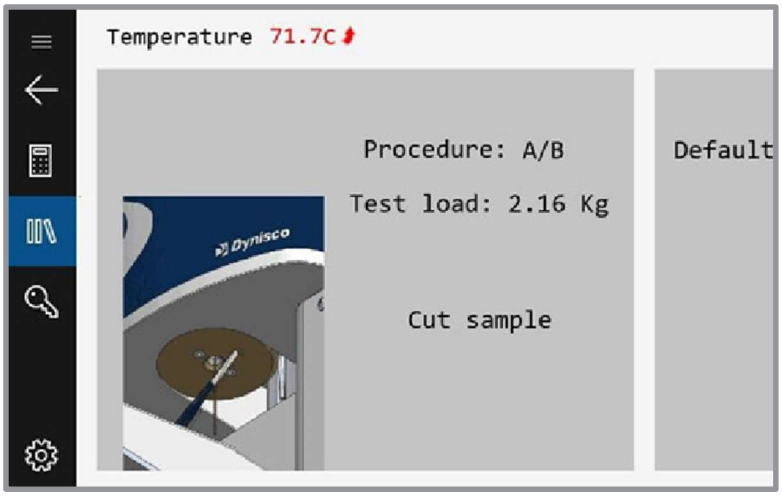
PREHEAT

Press the screen again when this is complete. The Preheat time will be displayed on the screen as shown below:



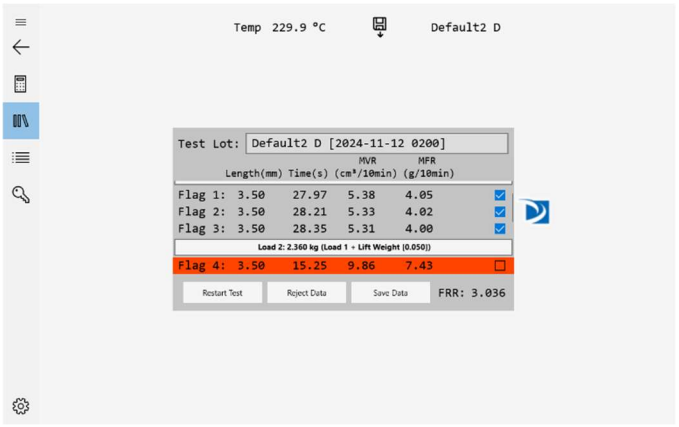
COLLECT SAMPLES

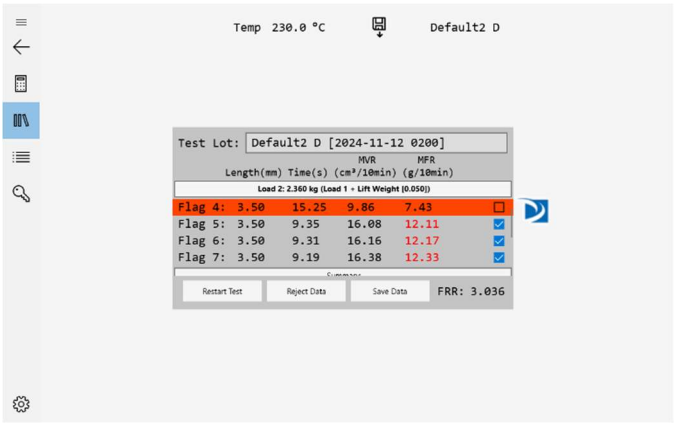
Measurements will start when the 1st scribe mark has lined up with the top of the guide bushing. For each flag length, the LMI will measure the sample time interval that has elapsed. After the first set of flags is captured, the lift system will lower the second weight onto the piston. The second set of flags will be captured.

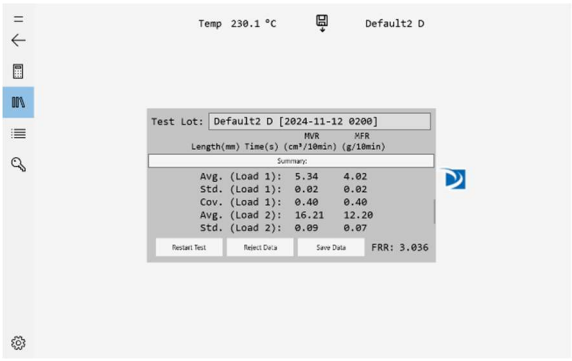


RESULTS

After the final cut has been performed and the piston has traveled the total distance required in the test, the results screen will appear. The results screen outlined below:







DESCRIPTION OF RESULTS

In the example shown above the test consists of two tests of three flags each separated by a transition flag. During the transition flag the second load is being lowered by the weight system onto the hand weight. The average MFR from each phase of the test is used in calculating the value of the FRR. With the MFR of the higher load being divided by the MFR of the lower load.

When the test is complete, the user has the option of restarting the test or saving the data. When the “Save Data” button is pressed, the data can go to up to two places. If a USB flash drive is attached to the LMI, a report will be generated and stored on the flash drive. If cloud connectivity is enabled, the data will also be sent to the cloud, accessible via DYNISCO’s cloud platform.

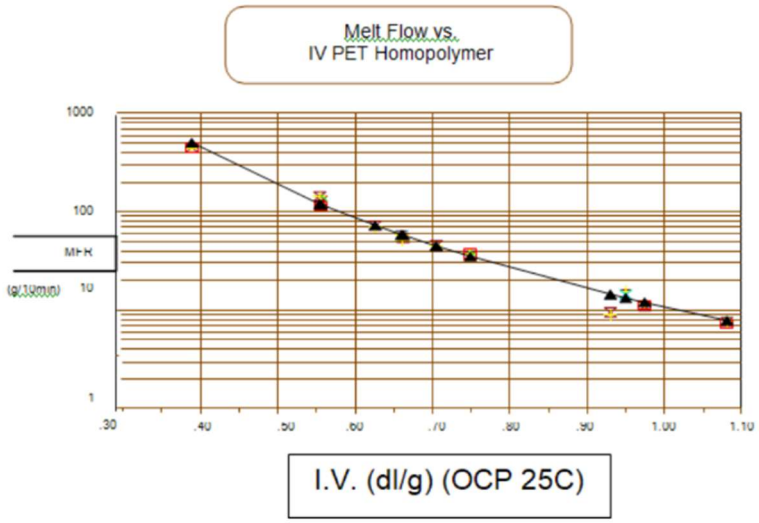
Next perform the steps outlined in the section titled “AFTER A TEST” on page 90.

Press the restart test button to perform another test.

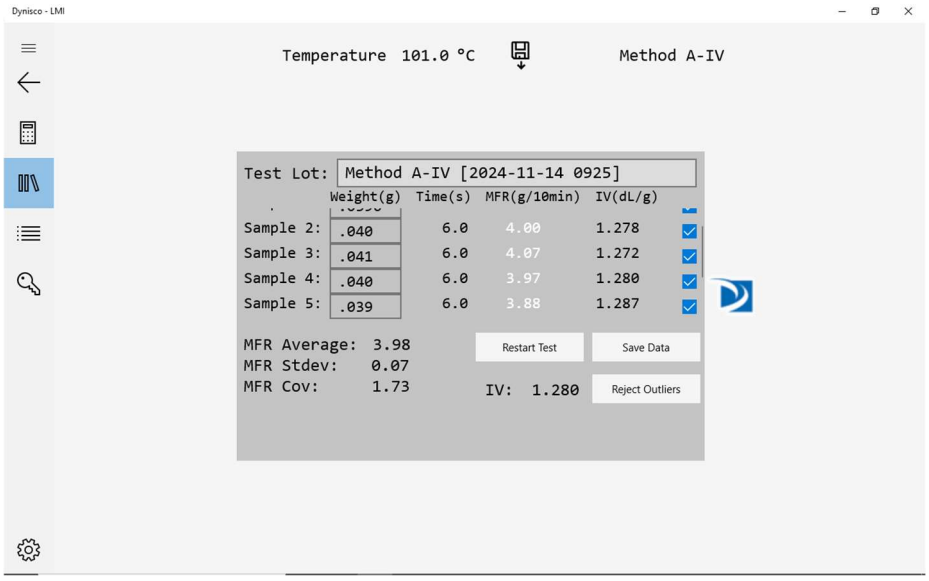
INTRINSIC VISCOSITY

SECTION 3: TESTING WITH THE LMI6000

This feature allows the Melt Indexer to correlate Melt Flow Rate (g/10 min.) to Intrinsic Viscosity (dl/g). Intrinsic Viscosity (IV, ASTM D3835) is a “wet chemistry” technique used to assess the specific volume of an isolated polymer chain, when dissolved in a good solvent. This value is directly related to the molecular weight of the polymer. Melt Viscosity or MFI measurement is another, empirical (non-absolute like I.V.), way to assess molecular weight. Melt Viscosity and Intrinsic Viscosity are related in such a way that IV can be directly calculated from Melt Index values. This is described in greater detail in the applications brief, “Correlating Melt Rheology of PET to Solution Intrinsic Viscosity” by J. Reilly and P. Limbach, available from DYNISCO on request.



When a test temperature is set to 285C, intrinsic viscosity results will be displayed as show below:



MAINTAINING YOUR LMI

SECTION 4: MAINTAINING THE LMI6000

AFTER A TEST

SECURE THE ENCODER ARM

- Always place the encoder arm into the lowered and locked position before cleaning and the end of the day. This prevents damage and ensures that the encoder arm will be in the proper position upon power up.
- Never place any severe force against the side of the arm.
- The real-time flow during the test is an approximate value and should not be used as an absolute value. Fractional flows below 1.0 MFI will appear to change by larger steps due to resolution of sample time.
- The encoder absolute resolution is 0.015 mm overall accuracy, ± 0.0254 mm error.

CLEANING UP

Push down slowly on the weight and purge any material remaining in the barrel through the die and out of the barrel. Remove the piston rod by twisting it clockwise to break the seal created by the molten plastic then pull straight up.

If you pull the rod out too quickly, you may cause a suction that pulls the die out along with the rod, which may lead to a very hot die coming off and traveling through the air, onto the floor, or some other undesired location.

While wearing protective gloves, wipe the piston rod with a cotton rag. Remove the die with the die removal tool. Put two cleaning patches directly over the barrel about 1/2 way overlapped and, using the cleaning tool, push the patch down into the barrel. Run the patch up and down several times and then repeat the process. A minimum of two sets of patches are generally needed to clean the barrel properly, however, some materials are harder to clean than others. Repeat the process until used patches come out clean.

When the system is clean, put the die and piston plunger back into the barrel. This allows the piston plunger and the die to reheat before the next test.

With materials that are thermally stable (less than 5% viscosity change over 1/2 hour of heat exposure) we recommend only cleaning the barrel between every second run. For materials that degrade or are moisture sensitive it is recommended that both the barrel and the die be cleaned completely between each test.

To clean the die, use the die removal rod and push the die up from the bottom of the barrel and out the top. Wipe it with a cotton rag and clean it by running the drill bit through it several times. Remove material that collects in the grooves of the drill bit and repeat until the drill passes easily through the die. Scrape the die with the sample cutting knife if needed to clean the top and bottom faces. For materials that crystallize quickly you can clean the die by first running a drill bit up into the die while it is hot and in the indexer. This will make it much easier to get the cleaning drill bit inserted when the die is removed and the material starts to solidify.

Also, while the die is out of the barrel, look down the barrel bore to be sure it is clean (use safety glasses when looking down the barrel and beware of noxious fumes that may come from heated material inside!). Ensure the inside surface of the barrel is smooth and shiny when completely clean.

Experienced users often listen for a double bounce of the die when they drop it back into the barrel to know that the barrel is clean. If the barrel is dirty, the die hangs up and will not bounce when it hits the bottom of the barrel.

If you don't use gloves, you will eventually get burned.

If you are using PVC die (D3364 for unstable materials), be sure to get the material out of the conical top section. Standard dies have a flat entrance and exit.

When the die is out of the barrel, it cools down quickly. The longer the die is out of the LMI, the longer the wait for the temperature to stabilize will be. Minimizing the time the die stays out of the machine will increase the number of tests you can run in a given time interval. When the temperature on the front display is within 0.2°C of the set point, you can begin the next test. Loading material will cause a small temperature to change even if the temperature set point is locked in. A sufficient melt time, (360 seconds, for example) will allow ample time to get the temperature to the set point and stabilize before the first data point is collected.

Always leave the machine clean. If it is going to sit at room temperature for an extended period of time, you may wish to coat the barrel with a light machine oil to prevent rusting. The oil will need to be cleaned with cleaning patches from the machine before accurate data can be obtained.

Do not heat the barrel back to elevated temperatures before cleaning the machine oil from the barrel. If not cleaned before heating, the heated barrel risks a starting a fire and / or emitting noxious fumes.

For materials that are extremely hard to clean (Polystyrene, EVA and elastomers, etc.) solvents may be required. Never use flammable solvents on a HOT barrel. In general, however, DYNISCO does not recommend using solvents for health, safety, and environmental reasons.

CLEANING TOUGH POLYMER RESIDUE WITH SOLVENTS

Oven cleaner (Easy-Off) sprayed onto a cold plunger and left overnight will do an excellent job of cleaning degraded material off of the shaft, the outside of the die and the die retainer plate. Be careful not to inhale oven cleaner vapors.

MAINTENANCE AND SERVICING

DYNISCO certifies that at the time of shipment, this instrument met all dimensional, temperature control, and performance specifications of the applicable local standard specified at time of order (such as ASTM D1238.)

DYNISCO recommends verification of calibration at least once a year to ensure that the instrument continues to meet the standard. Contact DYNISCO's Field Service Department at (508) 541-9400 or contact your local Sales & Service Representative to schedule an appointment.

INSTRUMENT RECOMMENDED MAINTENANCE SCHEDULE

REGULAR MAINTENANCE	
DAILY	Remove the orifice and clean thoroughly with brush and precision drill bit. Clean your indexer barrel with cotton patches when hot. Piston should spin easily when placed into a clean barrel.
WEEKLY	Give it a good cleaning with a brass brush. Use oven cleaner to clean the piston rod exposed metal and orifice.
CALIBRATION INTERVAL	Depending on your company policy, a calibration or calibration check may be needed on a monthly, quarterly, or yearly basis. It is a recommended that a repetitive maintenance schedule be created for your instrument.
LONG TERM MAINTENANCE	
THOROUGH CLEANING	Clean the dust and dirt with clean air every six months to one year, more often in dirty environments. Remove the orifice and clean thoroughly. Clean your barrel. Use oven cleaner to clean the piston rod assembly and orifice.
MECHANICAL TOLERANCE	All dimensions and tolerances per ASTM D1238 and ISO 1133-1. Piston Tip Diameter = 0.3730"/ 9.474mm ± 0.0003"/0.0076mm; Piston Tip Length = 0.2500"/ 6.35mm ± 0.0050"/0.127mm. Assembled piston rod weighs 100 grams. GO/NO-GO gage works properly on the orifice. Orifice length = 0.3150"/8mm ± 0.0010"/0.0254mm. Weights still weigh correctly. Digital Encoder calibration. Gages can be purchased from DYNISCO. At the time of manufacture
BARREL DIAMETER	Once the barrel is extremely clean, all dimensional measurements are to be made at room temperature it can be checked using a bore gage. Gage can be purchased from DYNISCO. The barrel center bore measures 0.3760"/ 9.55mm ± 0.0002"/0.00508mm at the time of manufacture. All dimensions and tolerances per ASTM D1238 and ISO 1133-1.

ASK FOR HELP

Call DYNISCO directly at (508) 541-9400 or visit www.dynisco.com and ask for technical support. To help us handle your questions as quickly as possible, have the following items ready before you call:

- Instrument name and model number (on back panel)
- Instrument serial number (on back panel)
- Current version of instrument software and firmware (See page 28 for retrieving this information)

ADDITIONAL SUPPORT

SECTION 4: MAINTAINING THE LMI6000

SPARES & CONSUMABLES

ITEM	PART NUMBER	QTY. (EACH)
ORIFICE INSULATOR, MICA (LOWER)	0051-14MA	1
SCREWS FOR LOWER INSULATOR	S0980	2
PISTON ASSEMBLY (PISTON, ROD, INSULATOR, BUSHING)	0051-30	1
DIE REMOVAL TOOL	0051-35	1
POLYMER PACKING HAND TOOL	0051-36	1
ORIFICE CLEANING DRILL WITH PIN VISE	0051-38	1
ORIFICE CLEANING DRILLS (#45)	0051-39	1
BARREL CLEANING TOOL (USED WITH PATCHES)	0051-40	1
PISTON TIP	0051-41	1
PISTON TIP, HASTELLOY	0051-41H	1
PISTON ROD INSULATOR WITHOUT SPOKE	0051-42	1
PISTON ROD INSULATOR WITH SPOKE	0051-42A	1
PISTON ROD ONLY	0051-43	1
PISTON GUIDE BUSHING	0051-44	1
FILL FUNNEL	0051-45	1
ORIFICE (D1238 TUNGSTEN CARBIDE) STANDARD 8MM HEIGHT	0051-46	1
ORIFICE (D1238 HASTELLOY)	0051-46H	1
DIE / ORIFICE (HALF-DIE 4MM HEIGHT HALF DIAMETER)	0051-46S	1
ORIFICE (D1238 STAINLESS STEEL)	0051-46SS	1
ORIFICE (D3364, TUNGSTEN CARBIDE FOR PVC) (VINYL)	0051-46V	1
BRONZE BRUSH ROD (HANDLE)	0051-47	1

KNIFE, PALETTE (FOR CUTTING METHOD A)	0051-53	1
LEVEL	0051-54	1
GO / NO-GO GAUGE	0051-55	1
FUNNER, POLYMER CHARGE	0051-80	1
FILL FUNNEL (NITROGEN PURGE)	0051-80NP	1
HIGH FLOW MELT PLUG	0051-83	1
MIRROR, LMI6000	1196030	1
FUSE, 3A	1196051	1
INSULATOR, TOP MICA (DIE ENTRY POINT)	4051-20MA	1
SCREWS FOR TOP INSULATOR	AS490	2
TOOL RACK	6052-16	1
PISTON ASSEMBLY (TIP, PISTON, WEIGHT TOP)	7051-72	1
PISTON ASSEMBLY [DIGITAL ENCODER] PISTON, ROD, INSULATOR, BUSHING	7051-72	1
BARREL CLEANING BRUSH	B0555	1
BARREL CLEANING PATCHES	GP0103	1 bag (1,000 ea.)
BARREL CLEANING PATCHES	GP0104	1 bag (100 ea.)
LOADING BEAKER	GP0300	1
ORIFICE CLEANING BRUSH	GP0310	1

SUPPORT VENDORS

NIST STANDARD REFERENCE MATERIALS (SRM)

For example: Standard Material 1476 is a branched polyethylene with a MFR of 1.19 ± 0.01. As of 2013, cost was $870 / U.S. for 12 grams.

TROUBLESHOOTING

GETTING WRONG OR NON-REPEATABLE TEST VALUES

- Thoroughly clean the barrel and piston to remove potential test contaminants.
- Inspect the die to ensure that the orifice is clean and the diameter length is correct and within specification.
- If running a Method B test, is the density value correct?
- Check tip diameter (> 0.3727)to ensure it remains within specification.
- Ensure that the LMI6000 is properly leveled on the workbench.
- Is the LMI6000 due for its annual calibration to remain in specification?
- Inspect the weights used. Are they within ±0.5% of the original weight rating?
- Check the balance / scale used to weigh the extrudate to ensure it is accurate.
- Inspect the piston rod assembly to ensure that it is not bent.
- Place the die into the barrel and closely inspect it. Does the die get to the bottom of the barrel?
- When manually cutting a sample, ensure to synchronize tapping the screen with making the cut.

AUTOCUTTER DOES NOT OPERATE

- Is the door of the LMI6000 shut?
- Is the autocutter enabled in the machine settings?
- If the autocutter is making a noise and is jammed with the blade against the barrel?
- Has the material been qualified to cut with the cutter?
- Is the blade properly adjusted? (Adjust the screws that secure the blade to the wheel.)
- If it is making noise when the blade is not in contact with the barrel, then the gears might be binding. Contact DYNISCO Field Service.
- If you wish to cut manually and the LMI doesn't prompt you, verify that the Autocutter is disabled on the Machine settings screen. (See page 28.)

GLOSSARY OF TERMS

SECTION 5: APPENDICES

GLOSSARY OF TERMS

ITEM	QTY. (EACH)
DIE / ORIFICE / CAPILLARY	A metal item with an opening of typically around 2 mm diameter that is inserted into the apparatus.
DIGITAL FLAG / DIGITAL ENCODER	A device used to measure piston travel.
FIRMWARE	Software embedded into the instrument's hardware. Sometimes you may receive firmware upgrades.
FLOW RATE	A measure of polymer's mass flow rate (grams extruded in 10 minutes) using a particular orifice under specified conditions of temperature and load.
INTRINSIC VISCOSITY	Often used in process and quality control for specification of polymers such as PVC, Nylon and PETA, I.V. is a theoretical reduced or inherent viscosity achieved when the concentration of polymer in a polymer- solvent solution approaches zero. (It is related to the size of the molecules and thus to their molecular weight.)
MELT FLOW INDEXER	An instrument used to perform ASTM D-1238 testing of molten plastics and other polymers.
MELT DENSITY	The density of the polymer in the molten state. It is not the same as the standard or bulk density that is typically reported on polymer data sheets.
METHOD A	Measurement of the amount of extrudate accumulated for a given amount of time. The test is completely manual and is sometimes called the "cut-n-weigh" Method.
METHOD A / B	This test measures the amount of material extruded over time and volume extruded over a distance. A means of measuring travel is employed. To run a method B test, an A/B run MUST be run first to determine the polymer's melt density.
METHOD B	Measurement of the volume of material that extrudes over time. Can be conducted only after an A/B experiment is conducted. This is a "no- cuts," automated test that is the most convenient for busy laboratories.
METHOD C	Like a Method B test, but uses a half-height die. This test is used for materials that have a melt flow rate greater than 75 g/10 min.

METHOD D	Performs an MVR test at two different loads. Used to calculate a Flow Rate Ratio (FRR) for a given material.
MVI	Material is forced through an orifice at a specific temperature using a specific weight. The volume extruded in a 10-minute period is an MVI, in cm/10 min.
RTD	Resistance Temperature Detector - A component that senses temperature and changes in temperature.

APPENDIX I

SECTION 5: APPENDICES

APPENDIX I

TEST CONDITIONS FOR EXTRUSION PLASTOMETER (MELT INDEXER)

POLYMER TYPE	ASTM CONDITIONS PER ASTM D1238	REQUIRED WEIGHTS & ITEMS
ACETALS	[190 / 2.16] and [190 / 1.05]	950gm [WT950P] 2060gm [WT2060P]
ACRYLICS	[230 / 1.2] and [230 / 3.8]	1100gm [WT1100P] 3700gm [WT2060P]
ACRYLONITRILE BUTADIENE STYRENE [ABS]	[200 / 1.2] and [230 / 3.8]	3700gm [WT3700P] 4900gm [WT4900L] 5000gm [WT5000L]
ABS / PC BLENDS	[230 / 3.8], [250 / 1.2], [265 / 3.8] and [265 / 5.0]	1100gm [WT1100P] 3700gm [WT3700P] 4900gm [WT4900L]
CELLULOSE ESTERS	[190 / 0.325], [190 / 2.16], [190 / 21.6] and [265 / 5.0]	225gm [WT225P] 2060gm [WT2060P] 4900gm [WT4900L] 16600gm [WT16600L]
FLUOROPLASTIC [E-CTFE] PER ASTM D3275	[271.5 / 2.16]	2060gm [WT2060P] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]
FLUOROPOLYMER [ETFE] TYPES I, II, & III PER ASTM D3159	[297 / 5.0]	4900gm [WT4900L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]
NYLON	[275 / 0.325], [235 / 1.0], [235 / 2.16], [235 / 5.0], and [275 / 5.0]	225gm [WT225P] 900gm [WT900P] 2060gm [WT2060P] 4900gm [WT4900L]
FLUOROCARBON [FEP] PER ASTM D2116	[375 / 5.0]	4900gm [WT4900L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]
FLUOROCARBON [PFA] PER ASTM D3307	[372 / 5.0]	4900gm [WT4900L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]
POLYCHLOROTRIFLUOROETHYLENE	[265 / 12.5]	3700gm [WT3700P] x 2 5000gm [WT5000L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]

POLYETHYLENE	[125 / 0.325], [125 / 2.16], [190 / 0.325], [190 / 2.16], [190 / 21.6], and [190 / 10.0]	225gm [WT225P] 2060gm [WT2060P] 4900gm [WT4900L] 5000gm [WT5000L] 16600gm [WT16600L]
ADDITIONAL ITEMS FOR USE WITH SPECIAL POLYETHYLENE	[310 / 12.5]	3700gm [WT3700P] x 2 5000gm [WT5000L]
POLYCARBONATE	[300 / 1.2]	1100gm [WT1100P]
POLYMONOCHLOROTRIFLUOROETHYLENE	[265 / 21.6]	4900gm [WT4900L] 16600gm [WT16600L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825" ID x .315" L) [0051-46H]
POLYPROPYLENE	[230 / 2.16]	2060gm [WT2060P]
POLYSTYRENE	[200 / 5.0], [230 / 1.2], [230 / 3.8], and [190 / 5.0]	1100gm [WT1100P] 3700gm [WT3700P] 4900gm [WT4900L]
POLYVINYL ACETAL	[150 / 21.6]	4900gm [WT4900L] 16600gm [WT16600L]
POLYVINYLIDENE FLUORIDE	[230 / 21.6] and [230 / 5.0]	4900gm [WT4900L] 16600gm [WT16600L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825" ID x .315" L) [0051-46H]
POLYPHENYLENE-SULPHIDE	[315 / 5.0]	4900gm [WT4900L]
STYRENE-ACRYLONITRILE (SAN)	[230 / 3.8], [220 / 10.0], and [230 / 10.0]	1600gm [WT1600L] 3700gm [WT3700P] 4900gm [WT4900L] 5000gm [WT5000L]
STYRENIC THERMOPLASTIC ELASTOMER	[190 / 2.16] and [200 / 5.0]	2060gm [WT2060P] 4900gm [WT4900L]
THERMOPLASTIC ELASTOMER ETHER-ESTER (TEEE)	[190 / 2.16], [220 / 2.16], [230 / 2.16], [240 / 2.16], and [250 / 2.16]	400gm [WT400P] 2060gm [WT2060P]
THERMOPLASTIC ELASTOMERS (TEO)	[230 / 2.16]	2060gm [WT2060P]
VINYLIDENE FLUORIDE COPOLYMERS	[230 / 2.16], [230 / 5.0], [120 / 5.0], and [120 / 21.6]	4900gm [WT4900L] 5000gm [WT5000L] 16600gm [WT16600L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825" ID x .315" L) [0051-46H]

* ASTM Conditions above are identified by the currently recommended temperature in degrees Celsius, and load in Kg (designations are listed in brackets).

† DYNISCO part numbers for Required Weights & Items are listed in brackets. Dimensions are denoted in parentheses.

POLYMER TYPE	ASTM CONDITIONS OTHER THAN ASTM D1238	REQUIRED WEIGHTS & ITEMS
POLYVINYLCHLORIDE (PVC) PER ASTM D3365 FOR NON-RIGID AND SEMI-RIGID	[190 / 2.16] and [190 / 1.05]	950gm [WT950P] 2060gm [WT2060P]
ADDITIONAL ITEMS FOR USE WITH RIGID PVC	[230 / 1.2] and [230 / 3.8]	1100gm [WT1100P] 3700gm [WT2060P]
POLYBUTYLENE (PB) PER ASTM D2581	[200 / 1.2] and [230 / 3.8]	3700gm [WT3700P] 4900gm [WT4900L] 5000gm [WT5000L]
THERMOPLASTIC POLYESTER (PBT + PET, PBT + TEEE) PER ASTM D5927	[230 / 3.8], [250 / 1.2], [265 / 3.8] and [265 / 5.0]	1100gm [WT1100P] 3700gm [WT3700P] 4900gm [WT4900L]
POLYETHER - IMIDE (PEI) PER ASTM D5205	[190 / 0.325], [190 / 2.16], [190 / 21.6] and [265 / 5.0]	225gm [WT225P] 2060gm [WT2060P] 4900gm [WT4900L] 16600gm [WT16600L]
POLYMETHYL METHACRYLATE (PMMA) PER ASTM D788	[271.5 / 2.16]	2060gm [WT2060P] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]
POLYKEYTONE (PK) PER ASTM D5990	[297 / 5.0]	4900gm [WT4900L] Corrosion Resistant Hastelloy Barrel [4051-25HA] Hastelloy Piston Tip [0051-41H] Hastelloy Orifice (.0825” ID x .315” L) [0051-46H]

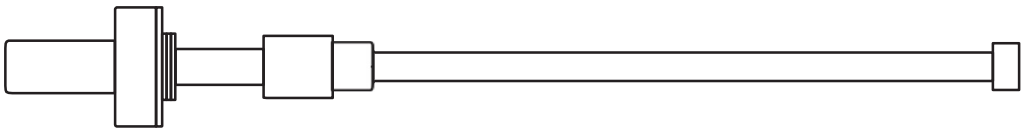
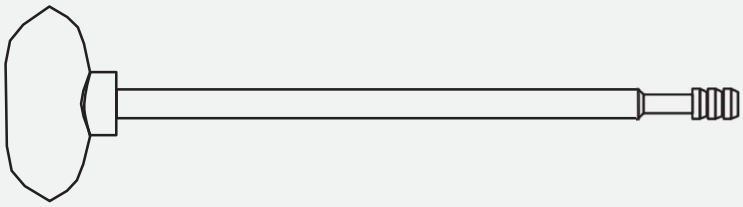
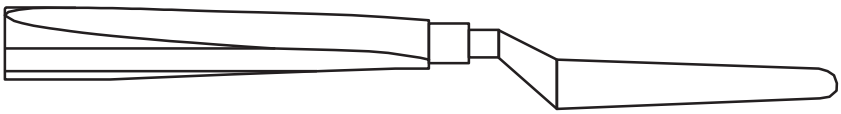
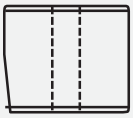
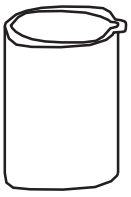
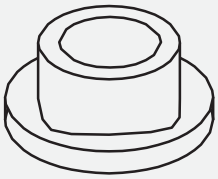
* Conditions above are identified by the currently recommended temperature in degrees Celsius, and load in Kg (designations are listed in brackets).

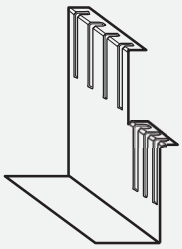
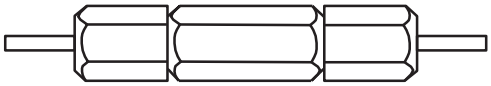
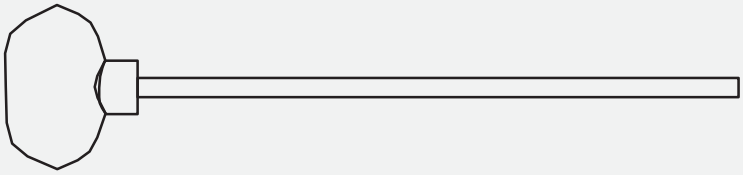
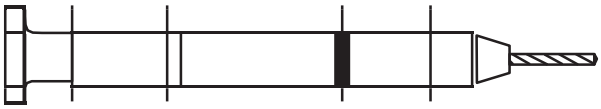
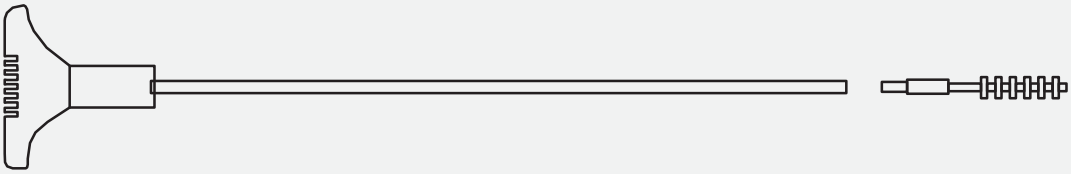
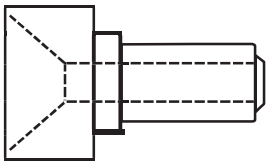
† In cases where more than one condition is listed for a polymer type not all conditions may be required for testing a particular grade of that polymer. Consult the material specification sheet or your supplier to determine the applicable test conditions for your specific material.

APPENDIX II

SECTION 5: APPENDICES

APPENDIX II

	PISTON ASSY 0051-30
	PATCH CLEANING ROD 0051-40
	PALLETTE KNIFE 0051-53
	CARBIDE ORIFICE 0051-46
	BEAKER GP0300
	LEVEL 0051-54

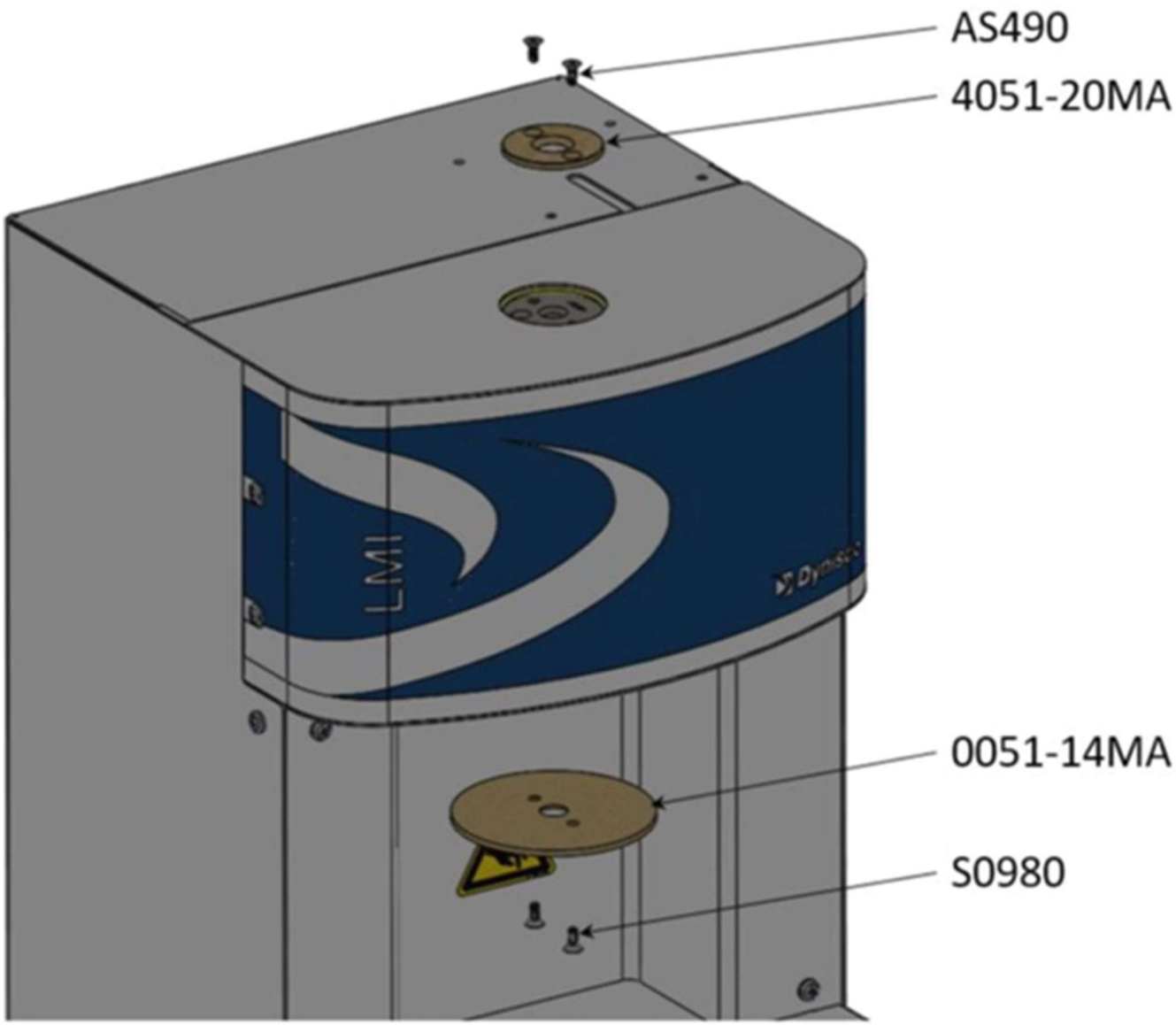
	TOOL RACK 6052-16
	GO / NO-GO GAUGE 0051-55
	ORIFICE REMOVER 0051-35
	PIN VISE 0051-38
	CLEANING ROD WITH BRUSH AND HANDLE 0051-47
	FILL FUNNEL 0051-45

APPENDIX III

SECTION 5: APPENDICES

APPENDIX III

REPLACEMENT MICA INSULATORS



The parts identified above can be replaced by the user. Exercise caution when replacing these parts. First turn off the unit, disconnect the power cable, and allow the unit to cool to room temperature before replacing.