LME - Laboratory Mixing Extruder

Instruction Manual

P/N: 14213600 | Rev: 112017 | ECO: n/a

GENERAL EQUIPMENT SPECIFICATIONS

This page is a record of your equipment specifications. This information is found on the stamped nameplate of your instrument. Please fill in the blanks below when you receive your Dynisco unit. When contacting the sales or service department to order parts or obtain information, refer to this page. This will allow us to respond quickly and accurately to your request.

MODEL NO. ______________________________

SERIAL NO. ______________________________

WIRING DIAGRAM (See drawing at back of manual)

MAIN FUSE ____________________ **Amperes**

SINGLE PHAZE ___________________ **Volts AC**

MODEL _______________ **LME** ___________________

TYPE Laboratory Mixing Extruder

Dynisco Polymer Test - Product Warranty

Dynisco Polymer Test warrants to the original buyer only, that all products and services furnished hereunder shall be free from defects in material and workmanship. This warranty is subject to the following terms and conditions.

1. This warranty shall remain in effect for a period of one (1) year from date of start-up or fifteen (15) months from date of shipment whichever is earlier; provided however that notice of any such defect is reported to Dynisco Polymer Test within thirty (30) days following its discovery.
2. Parts that normally contact the material under test shall have a warranty period of three (3) months from start-up or five (5) months from date of shipment whichever comes first; provided however that notice of any such defect is reported to Dynisco Polymer Test within then (10) days following its discovery.
3. This warranty not applicable to the fiber optic image bundle. This item to be warranted for thirty days, and not to exceed the OEM warranty.
4. The start-up date for parts sold as "spare parts" will be considered the date of shipment for purposes of this warrantee only.
5. Consumables such as heat elements, light sources, infrared sources, printer ribbons and the like shall be considered expendable and will only be warranted to be functional at time of shipment.
6. In the event any material or workmanship shall be determined defective by Dynisco Polymer Test, Dynisco Polymer Test's liability hereunder is limited to the repair or replacement, at Dynisco Polymer Test's option, of the defective part. Dynisco Polymer Test shall have NO liability for the costs of removing, returning, or reinstalling any repaired or replaced part or component.
7. Dynisco Polymer Test shall have no liability whatsoever for any defects which directly or indirectly arise out of or result from accident, abuse, improper use, vandalism, unauthorized repairs, or similar deviations from normal use under Dynisco Polymer Test control.
8. This warranty shall be void and of no effect if the products covered hereby are:
   - A. Installed or moved and reinstalled without the presence of Dynisco Polymer Test's personnel at start-up.
   - B. Not maintained in strict accordance with Dynisco Polymer Test's published maintenance procedures.
   - C. Altered or modified in any way without Dynisco Polymer Test's authorization.

Except as provided above, Dynisco Polymer Test makes no other warranties, expressed or implied, including without limitation, warranties of merchantability, or of fitness for a particular purpose.

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1.0 INTRODUCTION

The Dynisco LME Laboratory Mixing Extruder is a laboratory tool developed to evaluate the processability of a variety of plastics and rubbers from very fine powders to coarse materials prior to production.

The specimen material is placed in a cooled hopper where it falls onto the hot surface of a cylindrical rotor. As the rotor turns, the specimen drags against the inclined surface of the stationary scroll and moves toward the outlet die. As the specimen collects in the radial gap, it is compressed by the converging space between the scroll surface and the end of the header case. The specimen is melted through heat conduction created by the mechanical work of the turning rotor. When sufficiently melted, the specimen moves to the axial gap where it is rotationally sheared between the end of the rotor and the inside of the case. This motion causes a centripetal pumping effect, enabling the specimen to flow to the outlet die and exit through the orifice.

The LME User's Guide for Installation and Operation contains operational procedures and safety precautions. Please read the manual carefully before installing and operating your instrument to ensure its safe use and accurate test results. Dynisco strongly recommends reading this manual and cannot be held responsible for operating the LME in a manner that is inconsistent with the instruction presented.

2.0 SAFETY

This section contains safety symbols that will appear throughout the manual. It also provides a list of operational precautions and guidelines to operate the LME safely.

2.1 Safety Symbols

HIGH VOLTAGE! indicates that ignoring the instructions may lead to electric shock for the operator.

BURN HAZARD! indicates that ignoring instructions may lead to a burn injury when using the equipment.

WARNING! indicates that ignoring the instructions may damage the machine.

NOTE! indicates operational hints and useful information.

2.2 Operational Precautions

Use of this equipment may involve dangerous conditions. It is the responsibility of the purchaser of this equipment to establish and implement safety and health procedures or regulations that will protect the operator from unnecessary risks or hazards.

2.2.1 Shock Hazard

The LME contains internal components that operate at high voltage. There are no user serviceable parts inside the instrument. Attempts at servicing the LME by unqualified personnel can result in exposure to electrical shock. Please contact Dynisco Customer Service to obtain repair and maintenance services by a factory-trained service representative.

2.2.2 Burn Hazard

The LME has accessible parts that are capable of reaching temperatures that could cause injury to the operator. Parts such as the LME's header, hopper, rotor, and case supporting block should never be handles with bare hands after the heating process has been initiated.

2.2.3 Precautions

WARNING! **To prevent damage to the instrument, never turn on the drive switch unless the instrument is hot enough to melt any polymer in it.**

HIGH VOLTAGE! **Never remove the cover unless the instrument is unplugged from electric power.**

3.0 SPECIFICATIONS

PHYSICAL

Width:	49 cm (19 in)
Depth:	61 cm (24 in)
Height:	23 cm (9 in)
Header:	0.3125 cm (1/8 in) diameter orifice (replaceable)
Weight:	54.5 kg (120 lb)

ELECTRIC

230 V, 50/60 Hz, Single Phase

120 V, 50/60 Hz, Single Phase
(Refer to the plate on the instrument for the correct power requirements)

Fuse:
250 V, 10 A
120 V, 5 A

WATER:
Supply and drain: 200 cc per minute tap water (one gallon)

ENVIRONMENTAL
Indoor use
Altitude: up to 2 000 m
Ambient Temperature: 16 to 29 °C (60 to 85 °F)
Relative Humidity: 80% maximum
Mains Supply Voltage Fluctuations: ±10% of the nominal voltage
Overvoltage Category: II
Pollution Degree: 2

Workspace: To operate the instrument and perform routine maintenance, approximately 90 x 60 cm (3 x 2 ft) of workspace is recommended for all models.

4.0 INSTALLATION

4.1 Uncrating the Instrument

The LME is shipped in one crate. The TUS and LEC, if are shipped separately. Before accepting shipment, carefully inspect the crate for damage. If hidden damage is found after the crate is opened, immediately notify the carrier. Notify Dynisco Customer Service as to the nature and extent of the damage.

The packing crate and materials should be saved until the instrument is installed and operating properly.

After uncrating the LME, place the instrument on a smooth, level surface in a room with steady temperature and humidity. (See the product specifications in Section 3.0.)

NOTE! **Dynisco has processed polyethylene or polypropylene through the LME prior to shipping to test the instrument, coat the rotor, and lubricate the rotorscroll interface.**

4.2 Tools and Accessories

The LME is shipped with the following items:

1 Spatula
2 Brass rod
3 Thin wrench (7/16)
4 One set of hex keys
5 Six spare header screws (6-32 x 3/4)

Figure 1
LME Tools and Accessories

4.3 Component Names and Functions

The LME's components are described below starting from the front of the instrument:

Header: Stationary component which includes the standard header plus the 1/8 inch orifice (See Figure 3). The orifice allows easy replacement. Dynisco offers a selection of three optional orifices (1/32", 1/16", & 3/32" – orifice diameter) and four optional headers (ribbon, spinneret or multi-strand, tube, and wiring coating.)

Band Heater: Encircles and heats the header (See Figure 4.)

Case Supporting Block: Supports the case and permits the adjustment of the header to rotor clearance (gap area) through axial movement. It is supported by two threaded rods and two guide rods (See Figure 5.)

Rotor: Rotated heated cylinder that contains an electrical heater (See Figure 4.)

Scroll: Stationary tube between the case and rotor that guides the polymer towards the gap area in response to the rotor's rotation (See Figure 3.)

Hopper: Water-cooled conical aperture on the LME's top into which the operator feeds polymer into the extruder. It must be connected to a 200 cc/min water supply and drain (See Figure 4.)

Gap (Dial) Indicator Gauge: Indicates the clearance between the rotor's surface and the headers inner side (See Figure 4 and 5.)

Gap Adjusting Nuts: Four nuts located in front of and behind the case-supporting block on each side of the two threaded support rods (See Figure 5.)

Control Panel Components:

Power Switch: Provides on/off control to all of the instrument's circuits. When the switch is illuminated, the power is on.
Drive Switch: Provides on/off control of the drive motor. (See Section 2.3.3 Precautions.)
Heat Switches (2): The two switches, one the left for the rotor and one on the right for the header, provide on/off control to a heater circuit. When the switch is on, power is on to the heater.
Heater Controls: The LME has two temperature controllers, one each for the rotor and the header. See Section 4.4 below for operating instructions.
Speed Control: Adjusts the rotor speed.
Fuse: 250V, 10 A (P/N 13433700)
250 V, 5 A (P/N 14179700)

4.4 Temperature Controllers

4.4.1 Front Panel Features

The front panel features on the LME controller are described below (Figure 2).

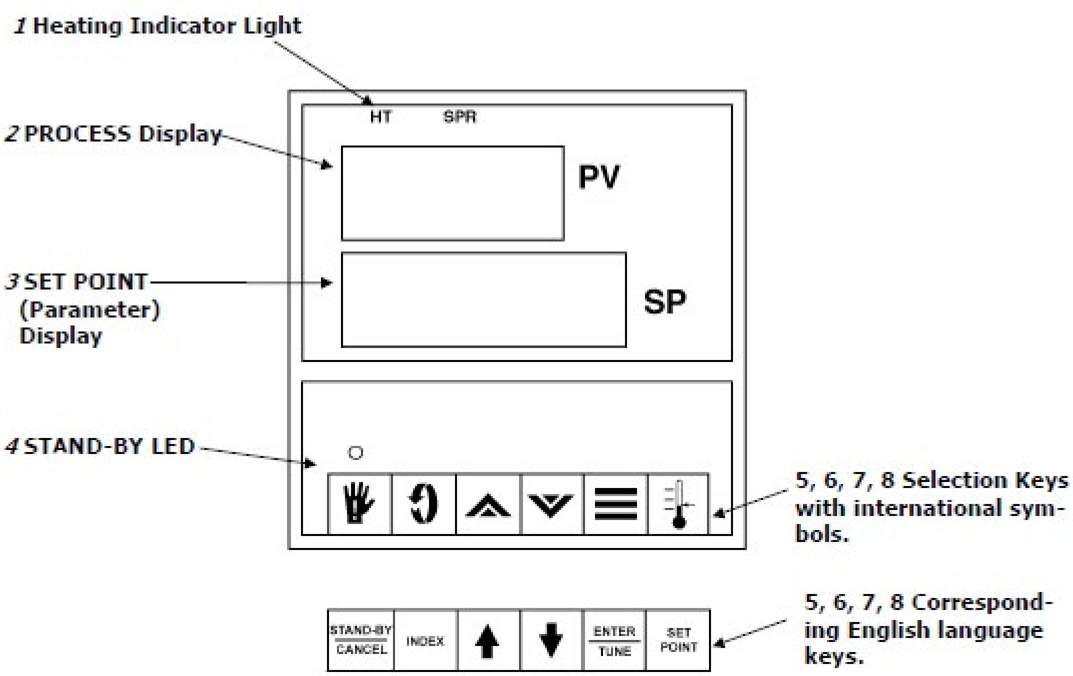

Figure 2
LME Controller Front Panel

1 HT: Lights when heating is initiated

2 The process temperature or parameter code is viewed on the upper display

3 The temperature set point or parameter setting is viewed on the lower display.

4 STAND-BY LED: Light when the STAND-BY key is pressed to

5 Set point key: Used to select the temperature set point

6 ENTER/TUNE key: Used to enter a selected value into non-volatile memory. Also used to auto-tune the controller when used in the correct sequence.

7 Up and down arrow keys.

8 STAND-BY/CANCEL key: Used to disable outputs and put the controller into idle (stand-by) mode. The stand-by position also allows access to auto-tuning. If the key is pressed during auto-tuning, the controller will cancel the procedure and return to the stand-by mode.

4.4.2 Controller Operation

Selecting the Set Point:

To select a new set point, press the up or down arrow keys until the desired temperature appears in the lower display. Press ENTER to store the new set point in memory. Allow 15 minutes for the process temperature to stabilize.

NOTE! **If power is interrupted to the controller before the ENTER key is not pressed to set the store the new set point in memory, the old set point will be displayed.**

Set Point High Limit:

The controller's set point high limit is factory-set to 400 °C. The A1 indicator light will stay on while the heater is operating within the process temperature limit. If the set point is set above 400 °C and the process temperature exceeds the set point, the indicator light and heater will shut off.

Tuning the Controller:

See **Appendix A** for instructions on tuning the controller.

Troubleshooting:

The following table will help you troubleshoot any problems that may occur with the LME controller. Please contact Dynisco Customer Service to obtain repair and maintenance services by a factory-trained service representative.

Problem	***Possible Cause***
The process display shows (- - - -) or HHHH.	The thermocouple needs repair or replacement.
The process display shows LLLL or counts down when the temperature is rising.	The thermocouple may be reversed.
The temperature display is incorrect by approximately 30%.	The wrong thermocouple type is connected or internal range jumper is in the wrong position. Check the controller's serial tag for the sensor type then check the probe.
No heat.	Incorrect heater wiring or output module.
The display blinks or entered values change.	Electromagnetic Interference (EMI). To eliminate high-voltage spikes, the sensor and controller wiring may need to be separated from noisy power lines. Heated devices may need grounding or coils and contacts may need to be suppressed.
The display fails to light up.	No power or blown fuse.

5.0 LME OPERATION

5.1 Start-Up Procedure

NOTE! **It is recommended that the first trials of the instrument be made with an easy to process material such as polyethylene (either high or low density), polystryrene, or polypropylene.**

1. Turn off the switches for the header heater, rotor heater, drive, and main power.

2. Check the plate on the side of the instrument for the correct power requirement. Plug in the power cord to the proper electrical source.

3. Connect the water supply to the hopper. Water jacket fittings are located at the hopper's base. A flow of 200 cc of water per minute is necessary to achieve adequate cooling. A small submersible pump connected to the instrument using Tygon tubing has been found to be satisfactory for this purpose.

4. Turn on only the Main Power, Rotor Temp, and Header Temp switches.

5. Adjust the temperature of the rotor and header to a temperature approximately 20 °C above the material's melting point by pressing the controller's ARROW key until the desired set point temperature appears on the display. Press ENTER to store the setting into memory. (The required temperature settings will depend on the material being processed.)

NOTE! **If ENTER is not pressed after a new set point is displayed, it will revert back to its previous set point when the instrument is turned off. The accuracy of the rotor's sensing temperature requires a nominal normalization period of approximately 15 minutes.**

6. As the instrument heats up, test a pellet of material against the header's outside surface at the outlet to see if it melts. When the pellet starts melting the instrument is hot enough and the header temperature controller (the controller on the right) should be set at the process temperature displayed at that moment. If the pellet melts very quickly the header is too hot and the header controller should be set back.

7. Do the same for the rotor. As the rotor temperature goes up, drop a pellet of material into the hopper and use the brass rod to gently push it against the rotor's surface. Record the rotor temperature (process temperature) at which the pellets start melting and set the rotor controller (controller on the left) at that temperature. If the rotor is hotter than necessary to easily melt the pellet, adjust the temperature controller down.

WARNING! **Rotor temperatures that are unnecessarily high will degrade the material and may damage the rotor.**

8. The LME is now ready for specimen processing: Turn on the drive switch and slowly feed a few pellets into the hopper. As the instrument's working zone fills, the melted specimen will start to extrude from orifice. As the operation stabilizes, the hopper can be filled with pellets for steady-state extrusion. If the pellets are free flowing and the hopper has an adequate supply of cooling water, a continuous steady-state extrusion will result. Occasionally, with non-free flowing pellets, bridging in the hopper may occur requiring gentle prodding with the brass rod.

5.2 Motor Speed

The LME has a variable-speed motor with a sensing control to maintain constant speed under variable load. The original manufacturer's instructions are located near the end of this manual. The table on page shows the corresponding revolutions per minute of the rotor shaft to the dial settings.

Speed Control Dial Setting	Motor RPM
10	16
20	30
30	60
40	90
50	120
60	152
70	180
80	220
90	250
100	270

6.0 INSTRUMENT ADJUSTMENTS

6.1 Axial Gap Size Adjustment

A gap size setting of 0.020 inches is recommended as typical. If greater intensive mixing is desired, decrease the gap size. If greater throughput is desired, increase the gap size.
The gap size is adjusted by loosening the two sets of adjusting nuts in front and back of the case supporting block(See Figure 5) and sliding it towards the LME until the rotor's front surface touches the header's inside surface. Turn the gap size indicator to zero, then move the case supporting block until the gap size indicator gauge displays the desired gap size. Retighten the four adjusting nuts.

6.2 Axial Gap Alignment

NOTE!

To properly set the axial gap between the rotor and header, the inside of the header and the scroll/rotor area should first be cleaned of all polymer so that the case supporting block, which contains the hopper, scroll, and header assembly, can slide freely along the rotor.

1. Loosen the four adjusting nuts on the two threaded rods that position the case supporting block.

2. Move the case supporting block assembly to the left so that the end of the rotor touches the inside of the header for an axial gap of zero.

3. Set the dial indicator to zero.

4. Move the case supporting block to the right to open the gap between the end of the rotor and the inside of the header. Use the two adjustment nuts on the threaded rod in front of the case supporting block to set the gap at 0.020 inches.

5. Rotate the left nut to move the case supporting block to the right. When the dial shows 0.02 inches, tighten the right nut against the block.

6. Check the dial indicator. If the gap setting is not 0.020 inches, loosen the right or left nut and move the case supporting block accordingly.

7. After setting the gap, securely tighten both nuts.

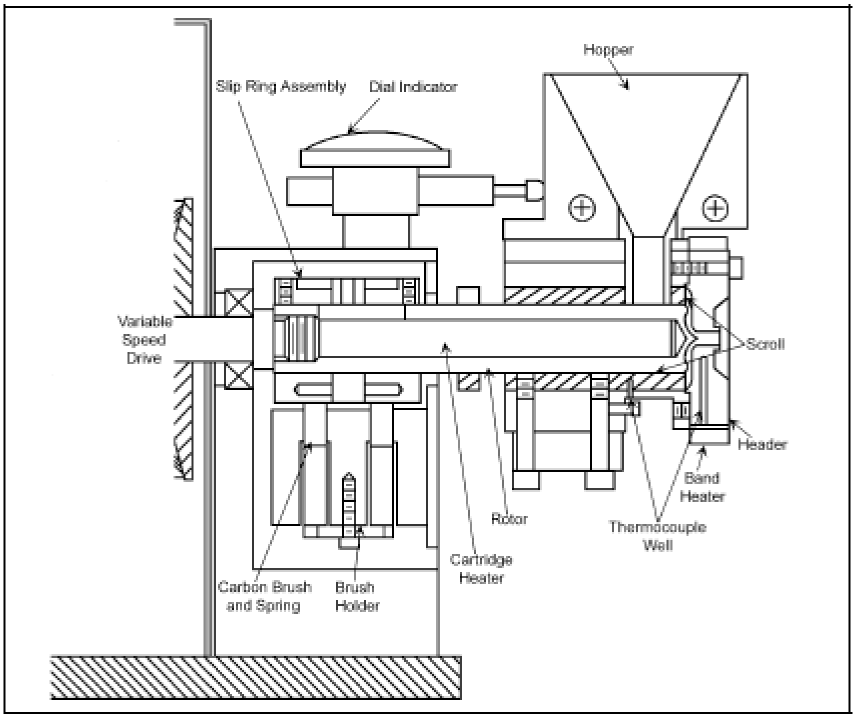

Figure 3
Extruder Assembly

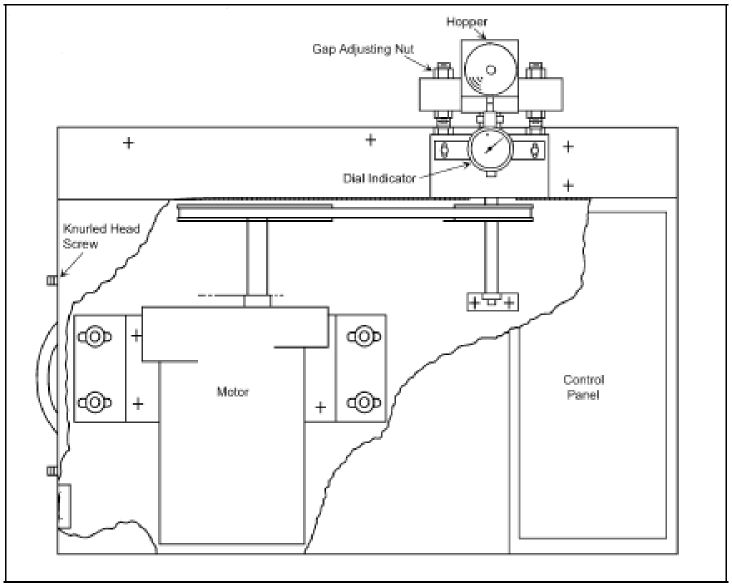

Figure 4
LME Top View

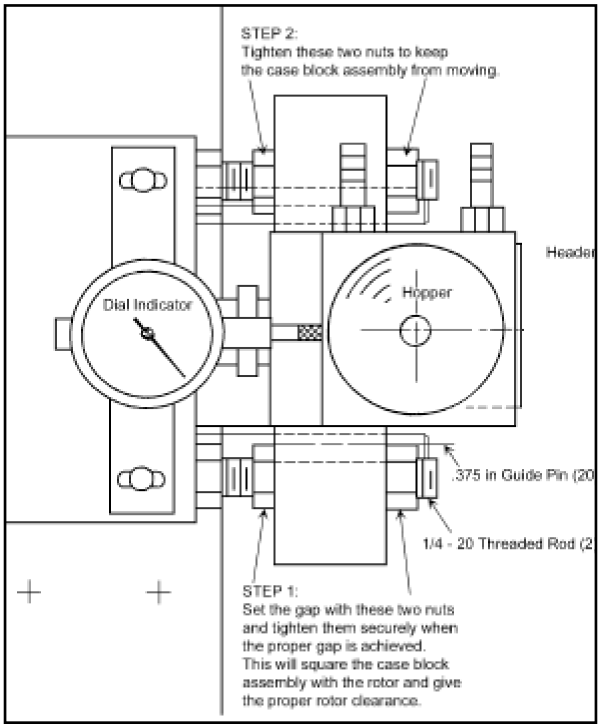

Figure 5
Case Supporting Block Assembly

7.0 CLEANING PROCEDURES

There are several methods for cleaning the LME; the exact procedure will depend on the materials and operating conditions. If there is a plentiful supply of test materials available, the easiest method is to simply stop feeding the old material into the instrument and begin feeding the new material. The old material should be completely flushed from the system after approximately 50 grams of the new material has been processed.

Another method is to feed general-purpose polypropylene into the instrument. When the previous material has been flushed out, stop feeding, turn off the instrument and allow it to cool. Remove the heater band by loosening the screw on the band. Remove the header from the case by removing the six header mounting screws. The remaining polypropylene inside the working zone is now solid and can be removed with a pair of pliers.

When test materials are limited or when a completely clean extruder is desired, follow the procedures below for disassembling and cleaning the scroll, rotor, and header.

BURN HAZARD! **This procedure requires the use of insulated thermal gloves.**

1. While the LME is still hot, turn off the main power and unplug the instrument.

2. Put on insulated thermal gloves and remove the heater band by loosening the screw at the band's base with a flat-head screwdriver and slipping the band off the header. Carefully place the heater band on surface that will not be damaged by the heat. Be careful to not to excessively twist the heater band's wires.

3. Remove the six header screws using the hex keys supplied with your instrument. Be careful not to let the header drop when you remove the last screw. If the header sticks, gently pull it form the case.

4. Wipe the polymer material from the header with a cotton cloth and clean the orifice by pushing a toothpick through it. Place the header on a surface that will not be damaged by the heat.

5. Remove the rotor thermocouple by loosening the cap screw securing it to the case.

6. Remove the cap screw securing the case from the the bottom of the case supporting block. Slide the case from the rotor.

7. Use the brass rod supplied with your instrument to remove excess material from the scroll. Use a stainless steel brush or the supplied spatula to clean the scroll area. Use a stainless steel pad to clean the rotor.

8. If necessary, to thoroughly clean the header and scroll, place them in a high temperature furnace for a short period. Do not exceed 650 °C (1 200 °F). Brush them thoroughly when cool.

9. Reassemble the components in reverse order. Use high-temperature anti-seize lubricant on the threads of all screws to prevent binding caused by high temperatures.

8.0 OPTIONAL EQUIPMENT

8.1 LME Take-Up System

Drawing the material from the LME into fibers, the LME Take-Up System pulls the fibers into smaller diameters, wrapping them around a spindle(250-ft/min maximum speed). The system's speed can be varied to match the extrusion rate to produce the desired fiber diameter. Two lower rollers pull the extrudate from the LME(5.20-ft/min maximum speed) to form a strand that can be cut into pellets with the LME Chopper.

Figure 6
LME Take-Up System

8.1.1 Strand Production

1. Start the LME and establish a steady-state operation.

2. Turn on the take-up system and set it for slow speed (approximately ¼ of the scale).

3. Open the lower pair of rollers by pushing down on the right end of the lever.

4. Pick up the end of the extrudate with tweezers or pliers and pass it through the feed guide and between the rollers and strand guide tube.

NOTE! **The feed guide will only be used with the LME circular orifice header and not with the ribbon or any of the available types of orifice headers.**

5. Lower the upper roller by releasing the lever.

6. Adjust the take-up speed to produce the desired strand diameter.

8.1.2 Melt-Drawn Fiber Production.

1. Start the LME and establish steady-state operation.

2. Place the take-up spool tube on the upper roller and hold it in place by turning the spool drum.

3. Place a small piece of double-sided adhesive tape on the surface of the start-up spool drum.

4. Turn on the take-up system and set it for moderate speed.

5. Pick up the extrudate with tweezers and quickly pull it over the top of the start-up spool drum.

6. When the extrudate catches on the adhesive tape, quickly pull the tweezers down and way.

7. Place the fiber into the upper feed guide, which will automatically move the fiber across the entire length of the spool tube by means of a traverse. Adjust the take-up speed to give the desired diameter of the fiber.

8. Stop the operation when the desired quantity of fiber has been collected on the spool tube.

8.1.3 Take-Up System Cleaning and Maintenance

Since the extruded polymer will not stick to the spools or the feed guide the cleaning of the instrument is not a critical issue.

The gear motor used inside the instrument needs no maintenance, which makes the entire instrument selfmaintained.

8.2 LME Chopper

The LME Chopper was designed to pelletize the extrudate from the LME Laboratory Mixing Extruder. The chopper is self-contained and must be connected to the proper AC source, 50/60 cycles, single phase. The chopper 's indicator light lets the operator know when it is operating.

Pellet size is determined by the speed of the extrudate as it enters the feed inlet located above the discharge.

Figure 7
LME Chopper

8.2.1 Chopper Cleaning and Maintenance

Clean the chopper using only compressed air directed into the clean-out port. The port is located directly behind the feed inlet.

The gearmotor used inside this instrument is oil lubricated. The oil level has to be checked every 4 to 5 months or 600 operating hours – whichever occurs first. Refill the gearhead as needed using a good quality rust and oxidation inhibited oil conforming to AGMA# 5 (SAE# 50 non-detergent) with a viscosity index of 918-1122 SUS @ 100°F, viscosity index of 90 minimum and pour point of 0°F (minus 17.8°C) maximum (Bodine lubricant #LD-38). Do not overfill. Maximum quantity needed is 38cm3.

Appendix A:
Tuning the LME Controller

AUTO-TUNING:

Whenever you install a new programmed controller or heater in the LME Laboratory Mixing Extruder, or want the optimal PID (Proportional Integral Derivative) settings at the most-used temperature set point, you will need to auto-tune both the header and rotor controllers simultaneously. Auto-tuning will automatically calculate the values for Rate/Reset (-rt-), Heat Gain (-HG-), and Cool Gain (-CG-) on both controllers. The following procedure will guide you through the auto-tuning process.

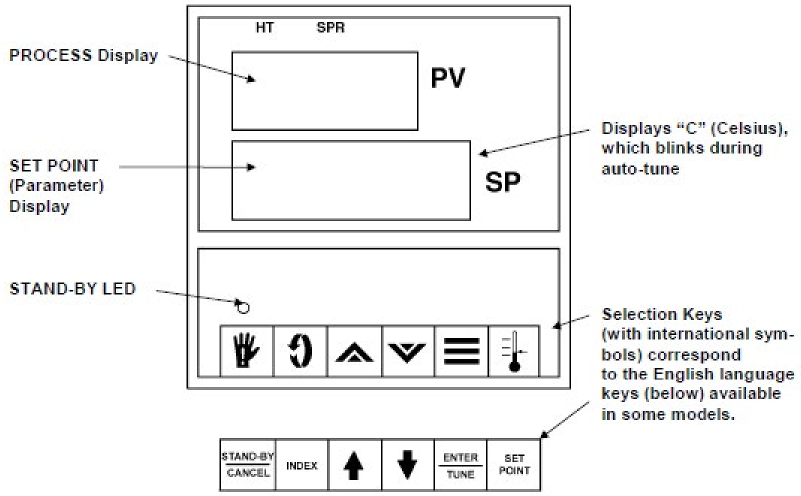

Figure 8
LME Controller Front Panel

NOTE! **The auto-tuning process must always be started at room (ambient) temperature to ensure effective settings.**

1. Turn on the LME's MAIN POWER switch.

2. Select the required temperature on the SET POINT display (see the figure above) with the up or down arrows and press ENTER. (Pressing and holding either arrow key for longer than five seconds increases the scrolling speed.)

NOTE! **The set point you select must be at least 38 °C above room (ambient) temperature to ensure effective settings. The header controller should also be set at least 15 °C higher than the rotor controller.**

3. Press the STAND-BY key. The LED above the key will light and the instrument will be placed in idle mode.

4. Press the INDEX key until the code for parameter #9 (Access Code), -cd-, appears in the PROCESS display. Select configuration code 14 in the SET POINT display with the up or down arrows and press ENTER.

5. Press the INDEX key until the code for parameter #10 (Auto-Tune Damping), -At-, appears in the PROCESS display. Dynisco recommends selecting the High Damping option for the optimal PID settings for your instrument. Use the up or down arrows to select the code for this option, 02 in the SET POINT display, and press ENTER.

6. To start auto-tuning, press the ENTER/TUNE key. The displays will return to process and set point displayed. The C digit, next to the set point temperature, will blink while tuning is in process. (You can stop the auto-tune at any time by pressing STAND-BY/CANCEL.)

7. When auto-tuning is complete, the C digit will stop blinking.

8. Press the STAND-BY key, then press the INDEX key until parameter #9, -cd-, appears in the PROCESS display. Select 01 in the SET POINT display by pressing the down arrow and then ENTER. (This code will allow changes to the set point only; all other parameters will be displayed with lock when you attempt to select them with the INDEX key.)

FINE TUNING (OPTIONAL):

Auto-tuning Rate/Reset (-rt-), Heat Gain (-HG-), and Cool Gain (-CG-) will be adequate for a majority of users. If you want to customize the PID settings for special test requirements, this section will guide you through manually fine-tuning these parameters.

It is important to note that the best rate time, -rt-, is one-eighth (1/8) the time in seconds of one cycle. (A cycle is the time in seconds between the controller's two consecutive picks of temperature overshoot.) For a faster response decrease the value of -rt-; for a slower response increase its value. High values of -rt- are recommended for systems with poor coupling between the heater and the sensor, or systems that have multiple lags. In addition, the -HG- and -CG- values must be kept the same, even if no cooling is used. Lower these to half their previous value if you want to lower the temperature overshoot. (Low values are recommended for systems with poor coupling between the header and the sensor.)

You can adjust all three parameters while the instrument is heating up, but remember that the start-up and running parameters will usually be different. Therefore, you will need to adjust both -HG/-CG- and - rt- ±25% to strike a balance between good start-up and running settings. You may need to spend some time trying different combinations of these parameter values before finding the best setting.

⚠ WARNING!

The LME will not operate properly if some of the initial control parameters are altered; for this reason please consult Dynisco before attempting any such changes. We do not recommend altering any of the control parameters unless you have extensive experience in PID programming.

9. Press the INDEX key until -rt-, -HG-, or -CG- appears in the PROCESS display.

10. Enter the required parameter setting using the up or down arrows. (For -rt- the range is 1 to 255 seconds; for -HG- and -CG-, 1 to 400 seconds.)

11. Press the ENTER key.

Appendix B:

Header Diagrams

• Standard Orifice

• Ribbon

• Multi-Strand

• Tube

• Wiring Coating

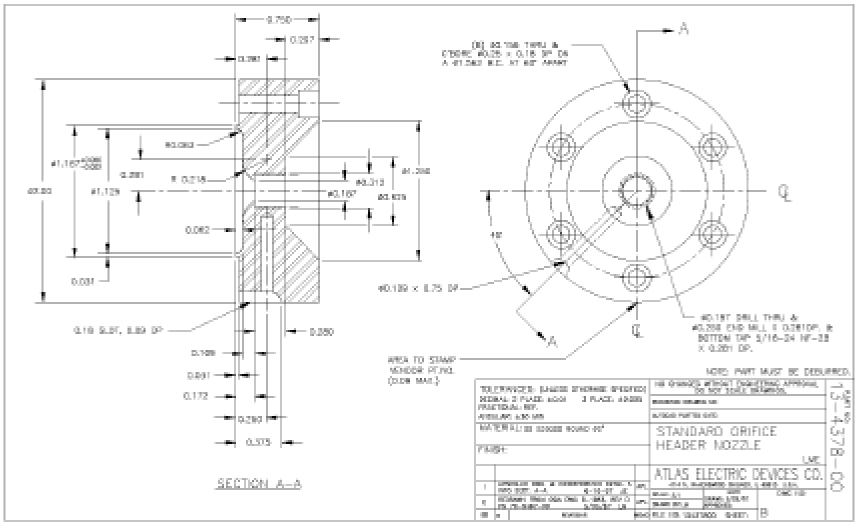

Figure 9
Standard Orifice Header

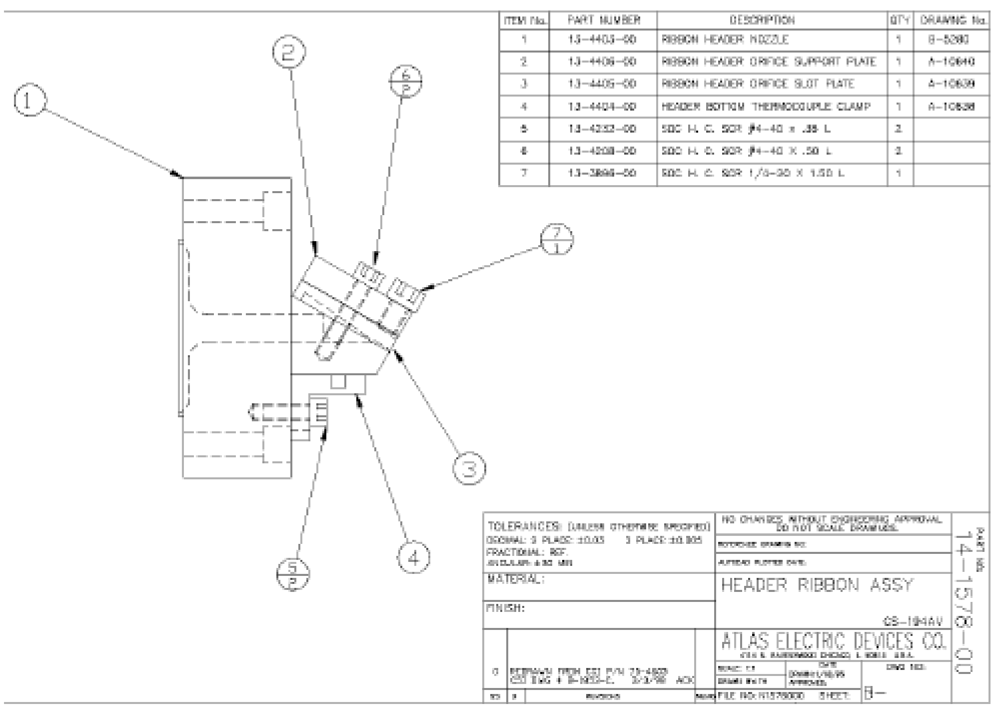

Figure 10
Ribbon Header

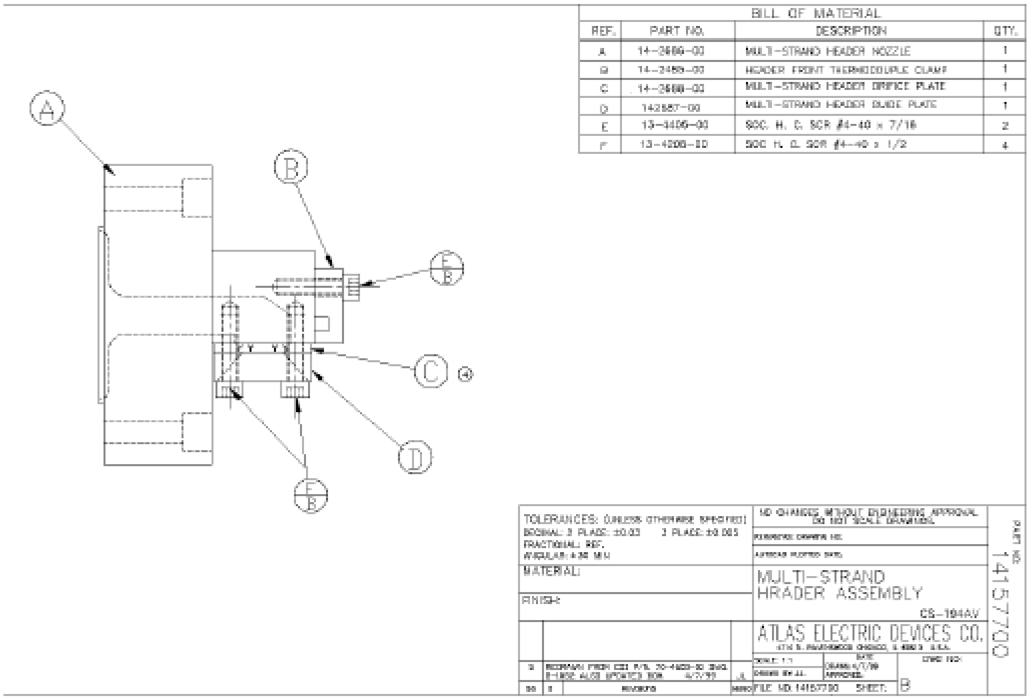

Figure 11
Multi-Strand Header

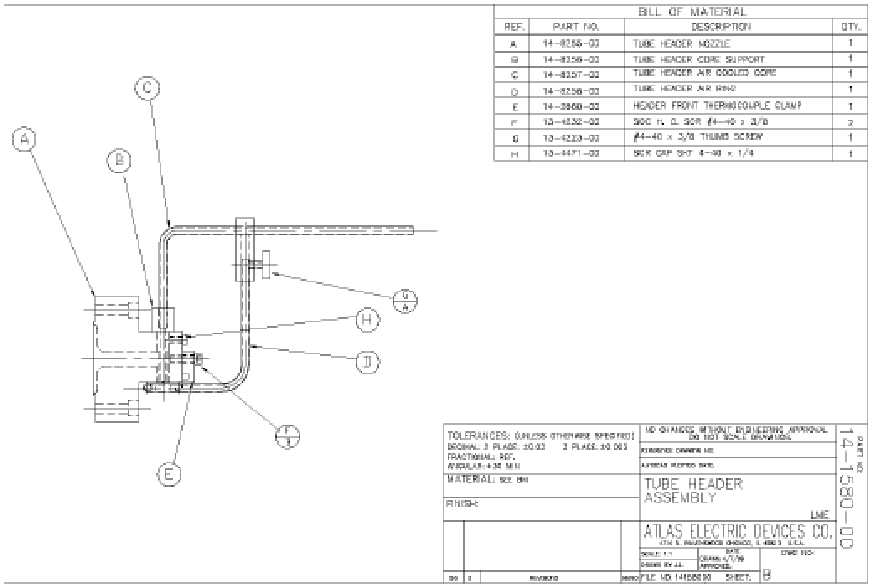

Figure 12
Tube Header

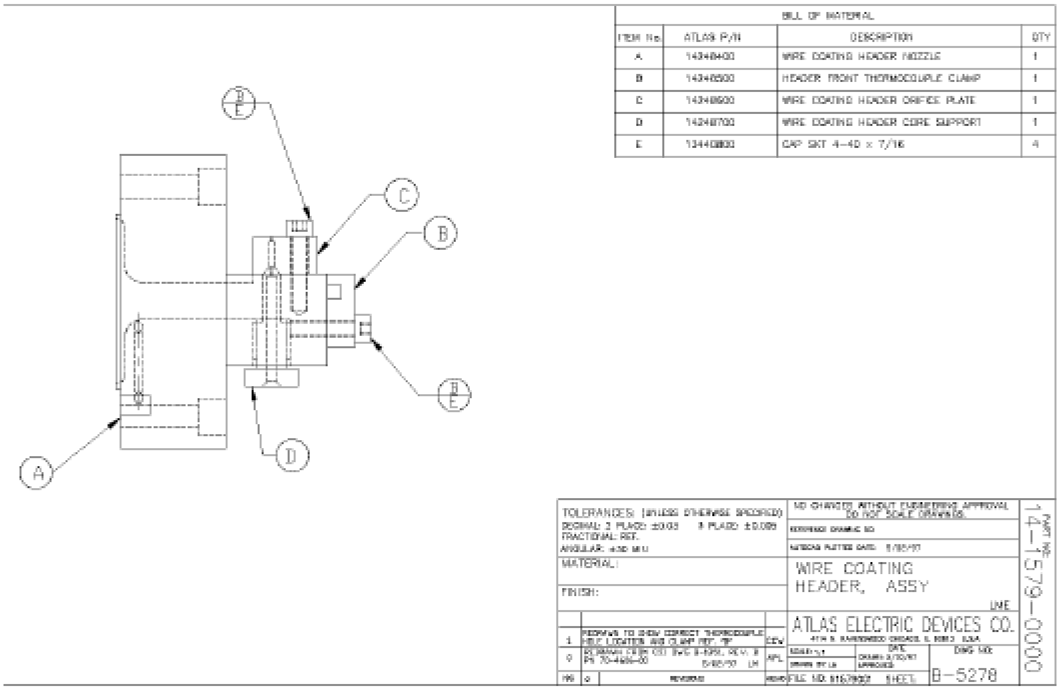

Figure 13
Wiring Coating Header