

Electric Injection Molding Machine MEIII Series



Mitsubishi Heavy Industries Plastic Technology Co., Ltd.

The mid-sized electric injection molding machine product line of Mitsubishi Heavy Industries Plastic Technology Co., Ltd. (MHIPT) came onto the market with the ME series in 2000. The ME series evolved into the MEII series in 2004, to which several improvements were added. In this way, our mid-sized electric injection molding machines have been highly evaluated in the market for more than 10 years. Today, it is well known that electric injection molding machines have an advantage over hydraulic injection molding machines in molding stability and energy efficiency. What is in demand now is further enhancement in the accuracy of the molding process.

Responding to such demands, Mitsubishi Heavy Industries Plastic Technology Co., Ltd. (MHI-PT) developed the MAC-IX controller that enables high-precision and real-time integrated control of the molding process and applied it to the new MEIII series electric injection molding machine (mold clamping force of 550 tf to 850 tf). This paper presents the features of the developed machine.

1. Specifications of MEIII Series

Table 1 shows the specifications of the new MEIII series electric injection molding machine.

Table 1 Specifications (Part 1)

| Model | | | 550MEIII | | | | | | 650MEIII | | | | | | | |
|---------------------|----------------------------------|---------------------------------|------------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|--------------|------------|--------------|
| | | | 50 | | 70 | | 100 | | 70 | | 100 | | 160 | | 200 | |
| | | | Increased pressure | Standard | Increased pressure | Standard | Increased pressure | Standard | Increased pressure | Standard | Increased pressure | Standard | Increased pressure | Standard | Standard | |
| Injection unit | Screw diameter | | mm | 62 | 70 | 70 | 80 | 80 | 90 | 70 | 80 | 80 | 90 | 90 | 105 | 115 |
| | Theoretical injection volume | | cm ³ | 1055 | 1345 | 1540 | 2010 | 2260 | 2860 | 1540 | 2010 | 2260 | 2860 | 3340 | 4540 | 5450 |
| | Injection shot weight | PS | g | 970 | 1240 | 1410 | 1845 | 2080 | 2630 | 1410 | 1845 | 2080 | 2630 | 3070 | 4180 | 5010 |
| | | PE | | 780 | 995 | 1140 | 1490 | 1670 | 2120 | 1140 | 1490 | 1670 | 2120 | 2470 | 3360 | 4030 |
| | Maximum injection pressure | | MPa | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 147 (1500) |
| | Maximum holding pressure | | (kgf/cm ²) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 123 (1250) |
| | Injection rate | Standard (S) 125 mm/sec | cm ³ /s | 375 | 480 | 480 | 630 | 630 | 795 | 480 | 630 | 630 | 795 | — | — | — |
| | | High speed (H) 160 mm/sec | | 485 | 615 | 615 | 805 | 805 | 1015 | 615 | 805 | 805 | 1015 | 1015 | 1385 | 1660 |
| | | Ultra-high speed (U) 250 mm/sec | | 755 | 960 | — | — | — | — | — | — | — | — | — | — | — |
| | Plasticizing capacity | PS | kg/hr | 180 | 250 | 230 | 320 | 350 | 470 | 230 | 320 | 350 | 470 | 445 | 630 | 610 |
| | | PP | | 105 | 150 | 135 | 190 | 210 | 285 | 135 | 190 | 210 | 285 | 270 | 380 | 370 |
| Maximum screw speed | | | rpm | 210 | | 200 | | 160 | | 200 | | 160 | | 152 | | 113 |
| Clamp unit | Mold clamping force | | kN(tf) | 5390 (550) | | | | | | 6370 (650) | | | | | | |
| | Platen size (H×V) | | mm | 1330×1330 | | | | | | 1530×1410 | | | | | | |
| | Clearance between tie bars (H×V) | | mm | 900×900 | | | | | | 1070×970 | | | | | | |
| | Maximum clamp stroke | | mm | 900 | | | | | | 1000 | | | | | | |
| | Maximum daylight | | mm | 1700 | | | | | | 2000 | | | | | | |
| | Mold thickness | | mm | 400~800 | | | | | | 400~1000 | | | | | | |
| | Ejector | Ejector force | kN(tf) | 127 (13.0) | | | | | | 196 (20.0) | | | | | | |
| | | Ejector stroke | mm | 180 | | | | | | 200 | | | | | | |
| General | Heater capacity | | kw | 15.5 | | 19.7 | | 25.1 | | 19.7 | | 25.1 | | 35.3 | | 38.6 |
| | Overall dimensions (L×W×H) | | m | 8.5×2.3×2.2 | | 8.8×2.3×2.2 | | 9.6×2.3×2.3 | | 9.4×2.6×2.4 | | 10.2×2.6×2.4 | | 10.7×2.6×2.4 | | 10.9×2.6×2.4 |
| | Weight | | t | 29 | | 31 | | 35 | | 36 | | 40 | | 44 | | 44 |

Table 1 Specifications (Part 2)

| Model | | | 850MEIII | | | | | 850MEIIIW | | | | | |
|----------------------------------|------------------------------|------------------------------------|------------------------|---------------|--------------------|---------------|---------------|--------------------|---------------|--------------------|---------------|---------------|---------------|
| | | | 100 | | 160 | | 200 | 100 | | 160 | | 200 | |
| | | | Increased pressure | Standard | Increased pressure | Standard | Standard | Increased pressure | Standard | Increased pressure | Standard | Standard | |
| Injection unit | Screw diameter | | mm | 80 | 90 | 90 | 105 | 115 | 80 | 90 | 90 | 105 | 115 |
| | Theoretical injection volume | | cm ³ | 2260 | 2860 | 3340 | 4540 | 5450 | 2260 | 2860 | 3340 | 4540 | 5450 |
| | Injection shot weight | PS | g | 2080 | 2630 | 3070 | 4180 | 5010 | 2080 | 2630 | 3070 | 4180 | 5010 |
| | | PE | | 1670 | 2120 | 2470 | 3360 | 4030 | 1670 | 2120 | 2470 | 3360 | 4030 |
| | Maximum injection pressure | | MPa | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 147 (1500) | 206 (2100) | 177 (1800) | 206 (2100) | 177 (1800) | 147 (1500) |
| | Maximum holding pressure | | (kgf/cm ³) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 123 (1250) | 177 (1800) | 147 (1500) | 177 (1800) | 147 (1500) | 123 (1250) |
| | Injection rate | Standard (S) 125 mm/sec | cm ³ /s | 630 | 795 | — | — | — | 630 | 795 | — | — | — |
| | | High speed (H) 160 mm/sec | | 805 | 1015 | 1015 | 1385 | 1660 | 805 | 1015 | 1015 | 1385 | 1660 |
| | | Ultra-high speed (U) 250 mm/sec | | — | — | — | — | — | — | — | — | — | — |
| | Plasticizing capacity | PS | kg/hr | 350 | 470 | 445 | 630 | 610 | 350 | 470 | 445 | 630 | 610 |
| | | PP | | 210 | 285 | 270 | 380 | 370 | 210 | 285 | 270 | 380 | 370 |
| Maximum screw speed | | rpm | 160 | | 152 | | 113 | 160 | | 152 | | 113 | |
| Mold clamping force | | kN(tf) | 8335 (850) | | | | | 8335 (850) | | | | | |
| Platen size (H×V) | | mm | 1590×1590 | | | | | 1900×1900 | | | | | |
| Clearance between tie bars (H×V) | | mm | 1070×1070 | | | | | 1320×1320 | | | | | |
| Maximum clamp stroke | | mm | 1200 | | | | | 1200 | | | | | |
| Maximum daylight | | mm | 2300 | | | | | 2300 | | | | | |
| Mold thickness | | mm | 500~1100 | | | | | 500~1100 | | | | | |
| Ejector | Ejector force | kN(tf) | 196 (20.0) | | | | | 196 (20.0) | | | | | |
| | Ejector stroke | mm | 200 | | | | | 200 | | | | | |
| General | Heater capacity | | kw | 25.1 | | 35.3 | | 38.6 | 25.1 | | 35.3 | | 38.6 |
| | Overall dimensions (L×W×H) | | m | 10.9×2.6×2.6 | | 11.4×2.6×2.6 | | 11.6×2.6×2.6 | 10.9×2.9×2.6 | | 11.4×2.9×2.6 | | 11.6×2.9×2.6 |
| | Weight | | t | 50 | | 53 | | 53 | 55 | | 59 | | 59 |

Note:

1. The above values are subject to change due to modification without prior notice.
2. The values for plasticizing capacity are taken from our standard testing conditions.
3. Injection shot weight, injection rate and plasticizing capacity depend on molding conditions and the resin used. Please consult with us if the machine is operated at maximum capacity.

2. Features of MEIII Series

As shown in **Figure 1**, the MEIII series machines are a new mid-sized electric injection molding machines that enable high-precision and real-time integrated control of the molding process using (1) a wide platen, (2) a fast-response injection DD (direct drive) servo motor, (3) a UB (double flight) screw, (4) the new MAC-IX controller and other advanced technologies including a built-in hydraulic unit for the hydraulic core and gate valve, and an electric regeneration servo amplifier.

(1) Wide platen

Our mid-sized electric injection molding machines are equipped with a toggle type clamping system. As resin molding products have become larger and more complex in recent years, molds have also become larger. To meet this need, the developed machine achieved higher rigidity by adopting a wider and box-shaped platen. In comparison to existing machines, all models of the developed machine with 650-tf mold clamping force are equipped with the wider platen, and a model equipped with the wider platen has been added to the lineup of the developed machine with 850-tf mold clamping force.

(2) Fast-response injection DD servo motor

To ensure stable molding accuracy, high-response injection control in increasing the injection speed, switching from filling to holding pressure and sudden decelerating to stop, as well as high repeating accuracy of metering (holding of plasticization completion position) and injection speed/pressure is required. Because of the required specifications, fast-response and high-precision electric injection control is important.

To realize a fast response, it is necessary to reduce the inertia of the injection ball screw driving part. The developed machine uses a proprietary low-speed, high-torque and large-capacity DD (direct drive) servo motor for the injection unit. This low-inertia DD servo

motor causes no overshoot or springback during sudden deceleration of the injection speed in thin wall molding and can reduce molding failure. In addition, the adoption of the DD servo motor eliminates influences from the elongation of the timing belt and the displacement of the synchronization belt, and also reduces noise. As a further advantage, belt maintenance tasks such as replacement and tension adjustment become unnecessary and the injection accuracy is stabilized for long periods.

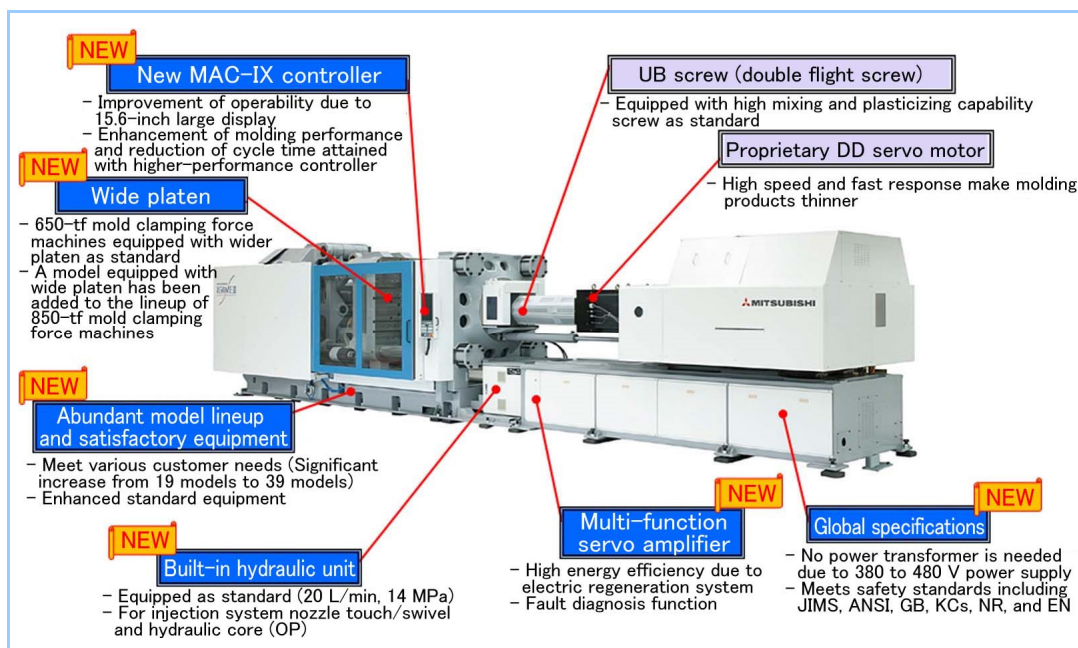


Figure 1 Features of MEIII series

(3) UB screw

Ahead of its competitors, MHI-PT adopted a double flight (long barrier zone) type UB screw as the standard screw in order to attain high plasticization capability, high mixing and high dispersion simultaneously, and has gained a good reputation over a long period of time. MHI-PT's UB screw realizes complete melting without leaving unmelted resin, while maintaining a high plasticization capability due to a closed dam with a dam clearance taper, and therefore has the characteristic of small variations in resin temperature distribution.

(4) New MAC-IX controller

The newly developed MAC-IX controller, while essentially inheriting the operation method of the MAC-VIII controller consisting of a large LCD screen, a touch panel and a simple graphical interface design that pursued viewability, realizes further ease of operation and improved visibility. **Figure 2** shows the MAC-IX controller.

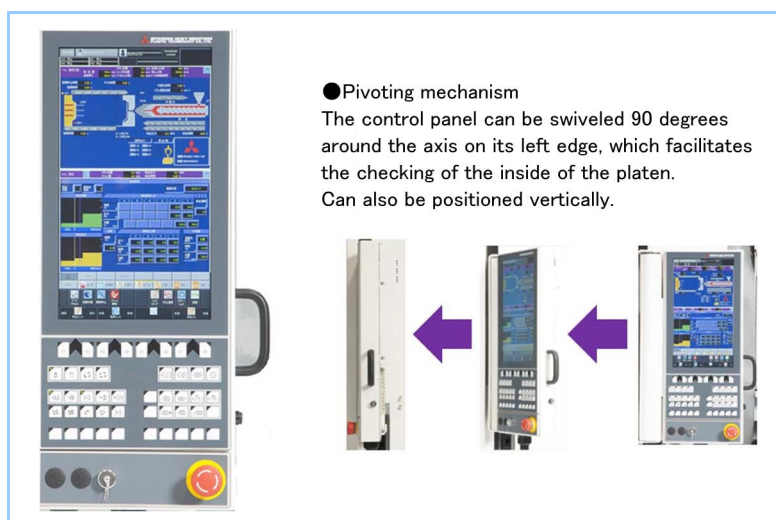


Figure 2 MAC-IX controller

3. Details of MAC-IX Series

The details of the further enhanced, new MAC-IX controller are described below.

(1) Improvement of operability

Higher operability such as a reduction in the screen switching frequency is achieved due to the adoption of a 15.6-inch display with two separate screens as noted below. (Figure 3)

- [1] Molding parameters can be displayed on two screens simultaneously.
(Example 1: Injection screen and mold clamp/unclamp screen, etc.)
- [2] Molding parameters can be set while reviewing the process monitor.
(Example 2: Setting the gate valve opening position while reviewing the injection graph)
- [3] With the long vertical screen, 30 shots can be displayed in the trend list screen in comparison to the existing 15 shots.
(Parameter setting that required two screens can be reduced to one screen.)
- [4] Injection waveform memory
 - The waveform of good items can be memorized and stored as molding parameters.
 - The waveform of a failed molding can be compared with that of a good item.

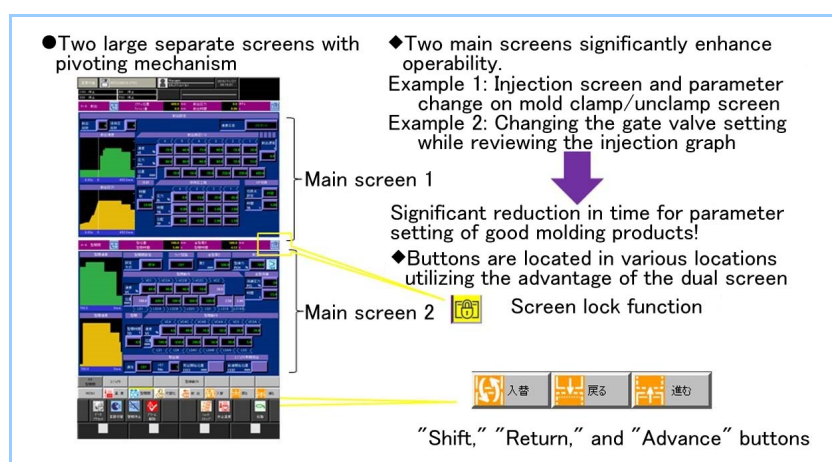


Figure 3 Molding parameters displayed on two screens simultaneously

(2) High-precision molding through real-time, high-speed and high-precision integrated control of molding process

Using an FA-PC equipped with a high-speed CPU, a software system that can control the control modules for high-speed EtherCAT communication, panel control, servo motion control, temperature control and sequence control in a real-time, integrated manner has been realized. In addition, the machine can support web services.

High-precision molding as noted below can be attained by the high-speed control of the fast-response DD servo motor.

[Molding test result of 650MEIII-100H]

Injection time: 11.92+/-0.00 seconds

Maximum injection pressure: 38.8+/-0.02 MPa

Variation in mass of mold product (max. to min.): 0.041% on average

Figure 4 shows the trend of the molding process of the MEIII series in terms of maximum injection pressure, VP switching position, VP switching pressure and cushion amount.

(3) Fastest temperature increase without overshooting through rapid convergence temperature control

By controlling the cylinder heater temperature based on an analysis of the heating characteristics in molding process, overshoot on temperature increase can be significantly reduced, and the time necessary to attain the target temperature is reduced by half.

Figure 5 shows examples of the reduction in overshoot on temperature rise and the time necessary to attain the target temperature.

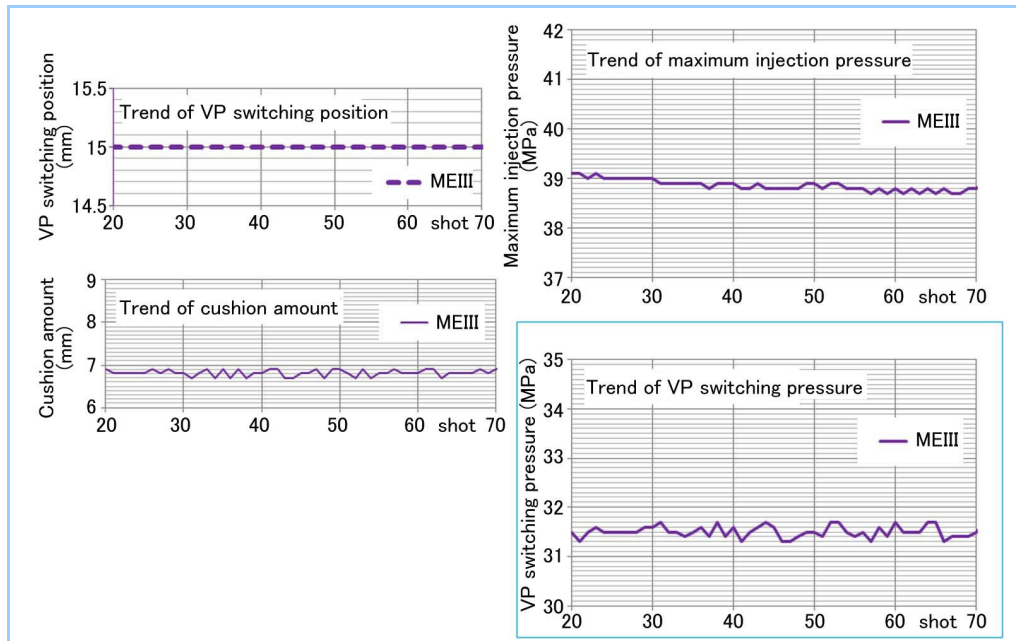


Figure 4 MEIII molding process trends

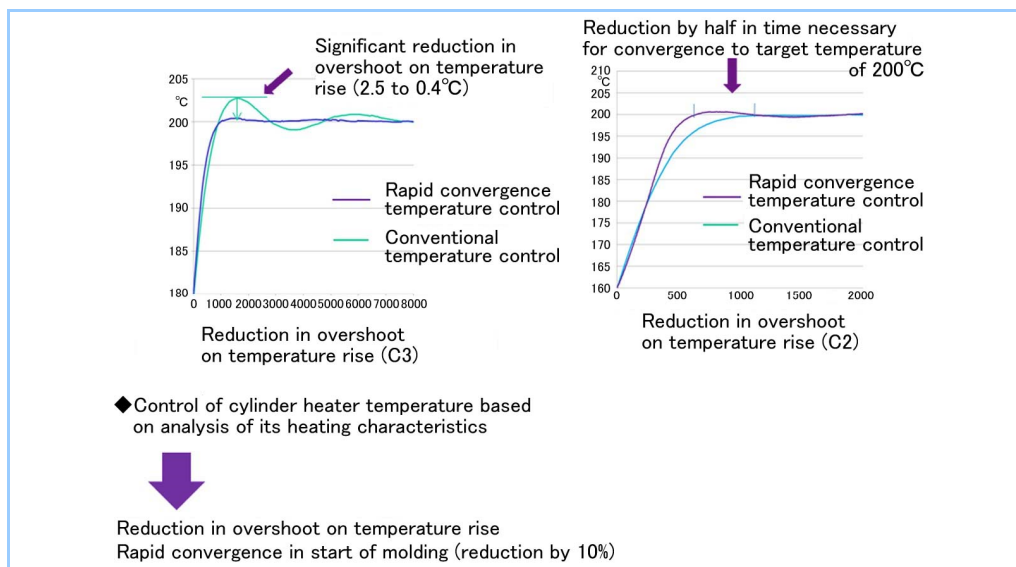


Figure 5 Rapid convergence temperature control

(4) Global reliability

A global man-machine interface is supported as noted below:

[1] Security function

- Login by ID card which can identify administrators and operators
- 3 levels of access control
- Easy traceability management with traceable operation records

[2] User support

- Alarm guidance using a flow chart
- e-manual (can be viewed on screen)
- With a drive recorder, input-output data is automatically stored on a large-capacity HDD when a problem occurs, and the amount of time required for troubleshooting can be reduced by analyzing the stored data.

[3] Global specifications

- UPS (uninterruptable power supply) and surge suppressor are standard equipment
- Multi-language selection (including Japanese, English, Chinese, Spanish, Thai and 8 other languages)
- Pictographic switches (ISO-compliant)
- IEC61131-3 compliant sequence ladder