Fully Electric Injection Molding Machine Si-6

Si-6 series

Small-size models

<table>
<thead>
<tr>
<th>Model</th>
<th>SI-50-6</th>
<th>SI-80-6</th>
<th>SI-100-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI-100-6</td>
<td>SI-130-6</td>
<td>SI-180-6</td>
<td>SI-230-6</td>
</tr>
</tbody>
</table>

Customer's Value Up
SMART MOLDING
Powerful yet Simple Process Control

Si-6series
Based on TOYO's accumulated molding expertise and technical know-how, small models in Si-6 series offer strengthened base performance for value-up of customer's products.

- New control SYSTEM 600
  Easy-to-operate control system including an easy-to-see 15-inch LCD touch panel, high precision mold protection, and versatile trouble diagnosing function.

- Space-efficient design
  Easy factory floor layout or machine replacement thanks to small footprint of the machine.

- Easy maintenance
  Much easier servicing work thanks to one-touch connection of nozzle heater and thermocouple, light toggle cover, and fewer cover-fixing bolts.

- Environmental friendliness
  Reduced and digitally visualized power consumption boosts energy saving activity and evokes eco-consciousness.
Globally-uniformed specifications

Standardized multi-language screen and common safety specifications covering all the destinations of the machine.

Japan (J1001: The Japan Society of Industrial Machinery Manufacturers)
China (GB32590: National Standard)
Europe (CE Mark)
North America (ANSI/SPI)
South Korea (KC Mark)
Brazil (NR-12)

Safety specifications are available to meet the safety standards for each country.

Wide selection of injection units for your specific needs

<table>
<thead>
<tr>
<th>Injection unit</th>
<th>Screw diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Si-50-6</strong></td>
<td>D75D 20 24 28</td>
</tr>
<tr>
<td><strong>Si-80-6</strong></td>
<td>D150HD 24 28</td>
</tr>
<tr>
<td><strong>Si-100-6</strong></td>
<td>DH300D 24 28</td>
</tr>
<tr>
<td><strong>Si-130-6</strong></td>
<td>F200D 28 32 36 40</td>
</tr>
<tr>
<td><strong>Si-180-6</strong></td>
<td>F150D 28 32 36 40</td>
</tr>
<tr>
<td><strong>Si-230-6</strong></td>
<td>H450D 32 36 40 46</td>
</tr>
</tbody>
</table>

Standard injection units and screw diameters

1 Φ6: non-available for Si-80-6 or Si-100-6. 2 Φ60: non-available for Si-180-6.
High precision mold clamping mechanism to produce high grade products (Si-50-6, Si-80-6, Si-100-6)

Combining the proven V-clamp mechanism and a newly designed guide structure, we have realized high precision clamping needed to produce small precision products.

Linear guides for straight mold movement plus strengthened machine frame.
High precision mold clamping mechanism
(Si-50-6, Si-80-6, Si-100-6)

1. Straight mold movement along the entire stroke reduces uneven wear of mold guide pins to a minimum.

2. Alignment and parallelism of the clamping component can be maintained for extensive years.

3. No grease scattering over the mold thanks to eliminated tie-bar guides.

The V-Clamp mold clamping structure realizes ideal clamping

The mold-clamping unit employs the V-shaped toggle mechanism, the V-clamp, and die-plates, both of which have been developed in collaboration with Kyoto University. Owing to the center-press effect, the V-clamp provides well-balanced and uniformed surface pressure over the mold, realizing ideal mold clamping. The die-plates are optimally designed so that they can be slim but have high rigidity.

Extended tie-bar clearance

For the Si-6 models ranging from 50 ton to 130 ton, tie-bar clearance has been extended compared with the equivalent 2013 models in the Si-V series, which facilitates mold replacement work and gives high freedom in designing molds.

Comparison of tie-bar clearances

<table>
<thead>
<tr>
<th>Model</th>
<th>Si-V Tie-bar clearance</th>
<th>Si-6 Tie-bar clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>50ton</td>
<td>360x325mm</td>
<td>360x360mm</td>
</tr>
<tr>
<td>80ton</td>
<td>410x375mm</td>
<td>410x410mm</td>
</tr>
<tr>
<td>100ton</td>
<td>460x410mm</td>
<td>460x460mm</td>
</tr>
<tr>
<td>130ton</td>
<td>510x460mm</td>
<td>510x510mm</td>
</tr>
</tbody>
</table>

* Si-180-6 and Si-230-6 have the same clearances as those of Si-V series.

Extended mold height dimensions

The Si-6 series covers previously optional mold height extension, which gives high freedom in designing molds.

Comparison of max. mold heights

<table>
<thead>
<tr>
<th>Model</th>
<th>Si-V Max. mold height</th>
<th>Si-6 Max. mold height</th>
</tr>
</thead>
<tbody>
<tr>
<td>100ton</td>
<td>450mm</td>
<td>510mm</td>
</tr>
<tr>
<td>130ton</td>
<td>450mm</td>
<td>550mm</td>
</tr>
<tr>
<td>180ton</td>
<td>500mm</td>
<td>600mm</td>
</tr>
<tr>
<td>230ton</td>
<td>580mm</td>
<td>680mm</td>
</tr>
</tbody>
</table>

* 50, 80 tons same as Si-V series.
Injection Mechanism

High precision injection for constant molding of quality products

The Si-6 series offers a wide selection of injection units for your specific molding needs. The proven twin nozzle-touch rods structure secures high molding quality.

Proven "twin nozzle-touch rods" structure
Parallelism of the die plates is kept constant along the entire mold closing stroke, which contributes to precision molding.

Wide selection of injection units
You can choose a standard unit, a high pressure unit, or a high speed unit for your specific molding application.

Molding's weight variation reduced by 20%*

Compared with the previous Si-V series, the Si-6 offers higher quality thanks to its stable injection performance and SYSTEM 600 control system.

<table>
<thead>
<tr>
<th>Item</th>
<th>Si-180V</th>
<th>Si-180-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw diameter</td>
<td>Ø50</td>
<td>Ø55</td>
</tr>
<tr>
<td>Product weight</td>
<td>137.44-137.52g</td>
<td>135.87-135.92g</td>
</tr>
<tr>
<td>R (max-min)</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>X (average)</td>
<td>137.48g</td>
<td>135.89g</td>
</tr>
<tr>
<td>o (standard deviation)</td>
<td>0.0161</td>
<td>0.0127</td>
</tr>
<tr>
<td>R / X</td>
<td>0.0582</td>
<td>0.0368</td>
</tr>
<tr>
<td>3o / X</td>
<td>0.0351</td>
<td>0.0280</td>
</tr>
</tbody>
</table>

* Comparison was made with Si-180V in 2013 model.

Downsizing

Space-efficient design even in small-size models

The new clamping unit structure has reduced the machine length, which contributes to efficient use of the factory floor.

Reduced machine length with increased mold height

The optional mold height extension in the previous model is now standard; but the machine length is reduced. This design contributes to easier handling of larger molds and efficient use of the factory floor.

Max. machine length reduced

104 mm

For Si-80-6, and Si-80-6, the mold height remains the same.

Comparison is made with equivalent 2013 models in Si-V series.
Easier maintenance and improved eco-efficiency

Reflecting desires from users, the Si-6 series is a practically easy machine to maintain. In addition, energy-efficiency and eco-friendliness are greatly increased.

▷ Power consumption display

Visualization of power consumption promotes energy saving activity

Either integrated total power consumption from a preset point or hourly consumption can be displayed by switching. In addition, the consumed power can be displayed in the desired unit such as JPV, US$ or emitted amount of CO₂.

▷ Toyo-developed food-grade grease

In addition to Toyo’s own “PLASTAR GREASE B3 No.2”, which is required only 1/10 the consumption of ordinary grease, a food-grade grease “PLASTAR GREASE H1-2” has been developed.

▷ Extended safety door opening stroke

The safety door-opening stroke is extended so that mold maintenance work can be made easily and safely.

<table>
<thead>
<tr>
<th>Model</th>
<th>Si-V [At min. mold height]</th>
<th>Si-6 [At max. mold height]</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 ton</td>
<td>346 mm</td>
<td>580 mm</td>
</tr>
<tr>
<td>80 ton</td>
<td>376 mm</td>
<td>650 mm</td>
</tr>
<tr>
<td>100 ton</td>
<td>402 mm</td>
<td>750 mm</td>
</tr>
<tr>
<td>130 ton</td>
<td>445 mm</td>
<td>1000 mm</td>
</tr>
<tr>
<td>180 ton</td>
<td>550 mm</td>
<td>1080 mm</td>
</tr>
<tr>
<td>230 ton</td>
<td>672 mm</td>
<td>1250 mm</td>
</tr>
</tbody>
</table>

Easy access to the area behind the movable die-plate

▷ Split toggle cover

The guide bar supporting structure is changed, and the toggle cover is split, for easier maintenance work.
New Control SYSTEM600 Control Unit

Totally new control system New stage of high speed and high response operation

Equipped with an easy-to-operate large touch panel, the latest control system SYSTEM 600 provides a variety of enhanced functions including improved mold protection and operator-supporting functions such as mold condition analyzing and molding navigation.

15-inch touch panel

Having the same setting items and screen layout as before, the gray-tone touch panel has become larger for greater visibility and operability.

HSP mold protection system

High response of SYSTEM 600 control and specially set two torque monitoring areas combined, the HSP (High Sensitive Protection) mold protection system shows greater performance in protecting the mold from damage due to product pinching between mold halves. Mold protection accuracy has been much improved even in high cycle operation, so that cycle time can be shortened without concern for any damage to the mold.

[Example of foreign object detection]

| Condition | In testing the effect of the HSP system, a 5.82 mm-thick molding was placed between the mold halves on the Si-280-6. |

Comparison of crush volume in foreign object detection test

Crush volume (mm)

- Low pressure clamping (conventional)
- HSP mold protection

The HSP system reduced the "crush volume" by 55% at maximum.
Trouble diagnosing support

For quick recovery, data necessary to diagnose a trouble are automatically stored.

The four graphs shown below are automatically stored when any alarm is issued in a certain cycle. This function is particularly useful to solve a trouble at a unmanned night shift or a seldom-reproducible trouble.

- Injection graph
- 1 cycle graph
- Metering graph
- 1 cycle logic graph

These four graphs are automatically stored in a USB memory in a cycle where the machine has stopped due to any alarm.

Molding condition analyzing function

By comparing operator-set molding parameters with the stored reference data*, this analyzing function finds out setting problems and displays advice for correction, so that an operator can set proper molding conditions in a short time.

Automatic identification of setting problems
- Oversight in parameters setting
- Unintended machine motion

Corrective advice on the screen
- Problematic settings are displayed
- Problem visualization leads to quality molding

* Reference data has been established based on Toyo's long standing molding experience.

Other special functions

- Just Pack control
  - High precision holding pressure control
  
  By precisely controlling the holding pressure right after the first injection process, smooth melt filling can be made compared with conventional control. This control suppresses burns and minimizes the residual stress that tends to cause warping.

  Example: Light guide plate (Standard control vs. Just Pack control)
  
  The graph shows the transition of the holding pressure with an upper line by conventional control and a lower line by Just Pack control. The light-blue area is excessive pressure by conventional control.

- V-mode control
  - Response-speed adjusting function
  
  This function automatically controls acceleration and deceleration in injection, mold opening and closing, and ejection. Unlike conventional system, ideal acceleration and deceleration patterns can be set simply by choosing a desired mode.

  Acceleration and deceleration in each mode

  The graph shows acceleration and deceleration curves depending on the V-mode selection.
Proprietary Technology

Toyo's own technologies make otherwise complicated molding process simple

Gas suppression screw

SAG (Screw Against Gas)

Gas-caused defects account for a large part of molding defects.

- Molding defects: silver, discoloring, burn, short shot, flash
- Affects to mold: sticking of grime, clogging of vent

The SAG screw reduces above defects and troubles and increases yield rate.

Cause of gas generation

Main cause: Unbalance between pellets feeding and melting in the heat barrel
- Over-heating due to excessive feeding of pellets
- Local heating due to variation of feed volume or melt adhesion to heat barrel

Advantage of SAG screw

The SAG screw alone can solve the problem.
Thanks to its unique screw design, the SAG screw controls shearing heat during plasticization process so that gas generation can be suppressed. You do not need any other equipment to solve the gas-caused problems.

Automatic melt viscosity control program

meltcon

Melt condition of resin varies when following factors are changed: Production lots of resin, drying conditions, contents of crumbled material, molding machines, plasticizing components. The meltcon automatically controls melt viscosity so that the machine can keep producing quality products despite the changes of above factors.

Feature of meltcon

You set the base melt density at first to produce products with desired quality. After that, the meltcon automatically controls the heat barrel temperature to maintain the preset melt density. Condition adjustment by an operator is not necessary.

Sample case of SAG's effect

Extended span of mold maintenance
Greatly reduced grime adhered to the mold

Material: PC / Product: Battery case / Machine: 100-tonner with φ24 screw / Cycle: 24 ± 24 hours/day

<table>
<thead>
<tr>
<th>Operation condition after one-month operation</th>
<th>Mold maintenance time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional screw</td>
<td>Every two days</td>
</tr>
<tr>
<td>SAG screw</td>
<td>Operation for 90 days</td>
</tr>
<tr>
<td></td>
<td>No maintenance needed even after</td>
</tr>
</tbody>
</table>

Many other effective cases have been reported in processing LCP, PET, PBT, PPS, PVC, etc.

Sample case of meltcon's performance

Product: Spiral flow / Material: PC / Comparison method: The flow length was measured before and after changing material lots without changing any molding parameters.

With meltcon OFF

The flow length was changed

You need to change molding conditions to maintain the same flow length

With meltcon ON

You do not need to adjust molding conditions.
Optional Plasticization Parts

A great variety of plasticizing components to support SMART MOLDING

Special screw lineup
- SAT design: High-mixing sub-flight screw
  - For high-mixing and high cycle molding
- MIT design: High-mixing screw
  - For high-mixing and high color dispersion molding
- LOT design: Screw for high viscosity resin
  - For molding optical products of PMMA, PC, etc.
- MIT design: Special specification screw
  - For low-density Master Batch use
  - For turbulent, high-mixing and color dispersion use

Nozzle lineup
- Small diameter (Heater OD: φ20)
  - Standard: up to φ20
  - Standard: φ24 to φ36
- Separate type nozzle
  - Standard: φ40 and up
  - Option: up to φ36
  - For molding precision parts of LCP, PA, etc.
- One-piece type long nozzle
  - For special form parts
- Special type nozzle
  - For hot runner molds

Screw check triplet
- Screw check triplet (non-rotation)
  - Option: φ16 to φ32
  - For molding precision parts of LCP, PA, etc.
- Screw check triplet with CrN or C-1IN coating

Specifications on plasticizing components

<table>
<thead>
<tr>
<th>Material</th>
<th>Heat barrel</th>
<th>Nitriding</th>
<th>Wear-resistant I</th>
<th>Wear-resistant II</th>
<th>Wear-resistant III</th>
<th>Fluorine-resistant material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw</td>
<td>Plating</td>
<td>Wear-resistant I</td>
<td>Wear-resistant II</td>
<td>Wear-resistant III</td>
<td>Fluorine-resistant material</td>
<td></td>
</tr>
<tr>
<td>Check triplet</td>
<td>Wear-resistant I</td>
<td>Wear-resistant II</td>
<td>Wear-resistant III</td>
<td>Fluorine-resistant material</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Available surface treatment:
- Nitriding
- Plating
- Cr1
- C-TIN

Applicable resin:
- With no GF, no inflammability
- GF: 30% or less inflammability H=V1
- GF: 30% or more, GF: 50% or more inflammability V1
- Fluorine resin

Corrosion resistance:
- More ★ signs show greater performance

Other special options

The SRC-II metering system (PAT.) prevents melt back flow [PAT. No. 342776, No. 343278]

Expansion of temperature control circuit

By adding temperature controlling ATC boards, mold and hot runner temperature controls can be performed at the molding machine.

Servo unscrewing unit [PAT. No. 3304980]

Ejector axis rotation linked to the mold rotation axis. The controls can be performed at the molding machine.

Evaluation of melt density stability by SRC-II metering

- The condition of melt density was observed by checking the length of par-flow flaps were molded with a constant injection stroke, without using holding pressure control.
- Product: Barflow material, GF-PS

| Conventional metering system
| SRC-II metering system

Melt density (mm)

<table>
<thead>
<tr>
<th>220</th>
<th>221</th>
<th>222</th>
<th>223</th>
<th>224</th>
<th>225</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>230</th>
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<th>232</th>
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<tbody>
<tr>
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<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
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</tbody>
</table>