



# MUSOU

MADE IN JAPAN

Fine Automatic Digital Vacuum Wax Injector

Wax injector with self-determination function FA-VWI

## Effective Usage



**EISHIN TECHNOLOGY CO., LTD.**

Please keep this manual for future use.

# Effective Ways of Using FA-VWI: Musou

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Conventional VWIs have too many parameters to be determined, and the users have been required to depend on their own accumulated experiences for the methods of producing wax molds. The makers, assuming that the users should do so, have not strived for innovation. Both the users and the makers are still controlled by their experiences with and ideas about the traditional VWIs.

In order to make best use of the characteristics of Musou and further develop this technology, we feel that it would be necessary to even destroy the users' faith in the production of wax molds using conventional VWIs. We have prepared this manual, hoping that every user will be able to operate Musou correctly.

Our company has developed Musou by scientifically analyzing the functional problems of conventional VWIs based on the desirable direction of innovation of VWIs and devising technologies required to solve the problems. As a result, we have succeeded in developing Musou, which is the world's only VWI with the self-determination function (intelligence). We have obtained 6 Japanese patents on the important new technologies for the actual operation of the machine and are currently applying for 4 international patents on the technologies.

In this manual, first we describe '1. How to Use Musou Correctly', next '2. Three Factors Making Production of Wax Molds Difficult', and then '3. Characteristics of Musou'.

## 1. How to Use Musou Correctly

Musou is the world's only VWI with the self-determination function (intelligence). And makes it possible to substantially reduce the process of trials and errors that you have had to go through in order to produce every new rubber mold using a traditional VWI. Be sure to take the following steps:

**Make a wax mold several times in the automatic mode.**



**Correct the data and store them in the program mode.**

We are certain you will get desired products in the automatic mode alone.

① If you are not satisfied with the resulting wax mold, you can transfer the data of the automatic mode that have produced almost ideal molds to the program mode, and then correct the data to obtain a desired product.

② Furthermore, when a desired wax mold is produced in the automatic mode, you can transfer the data used for the production to the program mode as well and, after checking and correcting the clamp position, store the data in a specified memory number.

### ◆ Items to be Checked in Automatic Mode

1-1 First, set the wax tank temperature and the wax injection nozzle temperature. At this time, please set tank temperature 3 °C higher than nozzle temperature. Refer to "3-15" for the reason.

1-2 Select the injection pressure from Complicate 50Kpa, Normal 80Kpa or Fine 120Kpa.

**Complicate**—For rubber molds with a slit inside instead of a line dividing the upper and lower parts, the injection pressure is set low to prevent burrs from being generated.

**Normal**—For rubber molds that are only to be divided into the upper and lower parts, normal pressure is applied.

**Fine**—For rubber molds with thin elements or delicate and elongated elements, the injection pressure is set high.

1-3 Confirm that the vacuum degree is Max.

1-4 Select Normal or Wide for the rubber mold shape. Wide is selected for molds that are wider than the injection nozzle direction.

1-5 Adjust the clamp position to the rubber mold center.

## ◆ Operation in Automatic Mode

1-6 In order to change the injection pressure, push  $\boxed{+10}$  or  $\boxed{-10}$  button or enter a pressure value using the ten-key pad that pops up when the displayed pressure value is touched.

1-7 If a wax mold is produced with Complicate 50Kpa and burrs are generated inside, reduce the injection pressure to 40Kpa and then to 30Kpa.

① Alternatively, set the nozzle temperature 1°C lower with 50Kpa and produce the wax mold ten minutes later.

② If a hard rubber mold is used, there is enough clamp force during the automatic mode. Therefore, in the program mode described later, try decreasing only the clamp force.

1-8 If a wax mold is made with Fine 120Kpa and its small or thin parts are not filled with wax, you can increase the injection pressure to up to 160Kpa using the  $\boxed{+10}$  button and to up to 250Kpa using the ten-key pad.

However, if a rubber mold is large or if the wax temperature is set high, the clamp force increases automatically, but the operation stops during clamping due to insufficient air supply pressure and the pressure needs to be increased to reactivate the operation. In this case, adjust the injection pressure to the point where the automatic mode works normally.

1-9 For a rubber mold combining the elements for which the injection pressure needs to be set by both Complicate and Fine, make a wax mold by arranging the rubber mold to closely fit its side and rear walls using the separately sold 'rubber mold holder'. The deformation of the rubber mold can be controlled, and the injection pressure can be set higher than Complicate.

1-10 If you are not satisfied with a product produced in the automatic mode, try making a wax mold by transferring almost ideal data of the automatic mode to the program mode and changing the parameters. As is described later, adjusting the clamp pressure is operationally the most effective, and adjusting the vacuuming or injection time is not very effective.

1-11 If no satisfactory products result from the methods described above, change the wax temperature. If still no good products come out, the cause may be that the air has not been sufficiently released.

## **2. Three Factors Making Production of Wax Molds Difficult**

In conventional VWIs, the clamp position, clamping force, wax tank temperature, injection nozzle temperature, rubber mold's forward pressing force, hold time and other parameters had to be separately determined for each rubber mold. Since these different parameters affected one another, the users had to go through many trials and errors until the optimal conditions were found. Particularly, setting the optimal clamping force was the most difficult.

### **2-1 Clamping Force**

① Firstly, the clamping force must be high enough to seal the dividing line of a rubber mold without wax burrs being generated.

This clamp force is affected mainly by the rubber mold size, the injection pressure and the injected wax temperature (strictly speaking, the force is also influenced by the rubber mold hardness, the inside cavity cross sectional area size and the rubber mold temperature). The higher the clamping force is, the stronger the force for sealing the dividing surface of the rubber mold. As the rubber mold size, the injection pressure or the wax temperature increases, the clamping force must increase. It should be noted that the clamping force is proportionate to the rubber mold size.

② Secondly, the clamping force must be weak enough to prevent burrs from occurring inside the slit cut in the same direction (vertical direction) as the clamp.

Generally, too much clamping force causes a rubber mold to deform in the crushing direction. Then, a gap occurs in the inside slit, and wax enters there, generating burrs. In this case, the clamping force should be as low as possible.

The situations described in ① and ② above are contrary to each other.

## 2-2 Injection Pressure

- ① In a rubber mold, the wax in the thin or slim part hardens almost instantaneously after injection. Therefore, as for a wax mold designed to have a thin, slim or pointed element, it is necessary to inject wax in the rubber mold at high speed.
- ② Firstly, the injection pressure needs to be raised to increase the injection speed.
- ③ Secondly, it is important to reduce fluid resistance through the injection nozzle tube and increase wax quantities injected in unit time by the same injection pressure. If, in spite of high injection pressure, the nozzle resistance is strong, the injection speed will remain low. Musou's injection valve enables high-speed injection.

## 2-3 Release of Air from Rubber Mold and Temperature Change inside

- ① Even when the vacuuming level is enhanced, it is impossible to release 100% of the air from the cavity in a rubber mold. The performance of the vacuum pump used in a VWI is not very high, and the reachable vacuum degree is gradually lowered over years of use.
- ② Generally, however long the vacuuming time is, some percentage of the air remains due to cavity volume ratio in a rubber mold. Therefore, if the air remains at the dead end in the mold, no wax can be put in there however high the injection pressure is.
- ③ Consequently, it is important to prevent the air from being concentrated at the dead end part. It is recommendable to arrange an outlet for releasing the air directly at the dead end part, but if it is not possible an outlet close to the dead end is useful enough. In this way, the air concentration can be effectively lowered.
- ④ When wax molds are produced in succession, the rubber mold temperature rises gradually, resulting in a low sealing force, changes in the deformation degree during clamping due to the softened rubber mold and an easy generation of burrs due to delay in cooling of injected wax. Therefore, it is necessary to appropriately cool the rubber mold while making wax molds.

### 3. Characteristics of Musou

Musou is the world's only VWI with the self-determination function (intelligence). Its functions are described in detail below.

#### ◆ Self-Determination Function (Intelligence)

Musou realizes automation based on the methods described in 3-1 to 3-6.

##### 3-1 Positioning of Nozzle and Rubber Mold

The unit self-determines the rubber mold thickness at the same time as clamping and automatically adjusts the positions of the nozzle and the mold (however, if the gate is not located at the mold center, it is necessary to adjust the positions using a spacer).

##### 3-2 Clamping Force

① The unit automatically carries out the optimum clamping by calculating the required clamping force based on the three factors of the automatically measured rubber mold size, the current wax temperature and the set injection pressure. However, the clamping force is calculated for not only hard rubber molds and soft ones. When a hard rubber mold is used, a wax mold can be formed by further decreasing the clamping force in the program mode.

##### 3-3 Rubber Mold's Forward Pressing Force (Forward Force)

The pressing force (Forward) of a rubber mold is automatically calculated according to the injection pressure.

##### 3-4 Vacuuming Time

The unit automatically judges from a change in the vacuum tank pressure that the vacuuming is complete, and finishes the vacuuming step (described later).

### 3-5 Injection Time

At the same time, the volume of the cavity in the rubber mold is automatically calculated based on the changed vacuum tank pressure to determine the required wax injection time (described later).

### 3-6 Hold Time

The hold time is calculated based on the wax temperature and the injected wax volume.

## ◆ Other Characteristics

3-7 The users are required to set only the injection pressure and the wax temperature, and all the other parameters are automatically determined by the unit. Consequently, it is possible to substantially reduce the process of trials and errors that you have had to go through in order to produce wax molds.

3-8 The unit automatically determines the vacuuming time, the wax injection time and the hold time, and realizes the shortest operation time.

3-9 The clamp shaft lock mechanism makes it possible to provide the clamp which is lighter than those used in conventional VWIs, thereby reducing the deformation of rubber molds and solving the problems described in 2-1 ① and ②.

3-10 The vacuum and wax valves are integrated in the nozzle tip to realize high-speed injection even when the injection pressure is low.

3-11 Almost no wax is drained.

3-12 We have confirmed through experiments that if the injection nozzle temperature is changed by, for instance, 1°C, the temperature of injected wax is changed to the set value in about 10 minutes. This data will probably help you when you change the injected wax temperature.



3-13 When you transfer the data of the automatic mode to the program mode, changing the clamping force is operationally the most effective among the parameters. Musou is well designed for both hard and soft rubber molds, and regarding hard molds the sealing range is quite wide even when a low clamping force is applied.

3-14 Extending the vacuuming time or the injection time has almost no operational effect. In Musou, the time can be set by the 1/100 second, and the automatic mode program has been developed based on the data of the experiments in which the vacuuming time and the injection time were changed to zero. The vacuuming and injection time on the display is pretty long.

3-15 The temperature of the WAX itself to be injected is corrected to match the injection nozzle temperature indication. Since the conventional VWI shows the temperature control value of the WAX valve, it does not necessarily match the actual WAX temperature to be injected.

You may feel the time is very short compared to conventional VWIs and other machines, but the time is long enough except for special rubber molds. We have conducted no such experiments for the conventional VWIs, so the setting may have been quite inaccurate.

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