MARUTI SUZUKI
SUMMER TRAINING REPORT ON

"STUDY OF ENERGY EFFICIENCY OF
ALUMINIUM MELTING FURNACE"

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Way of Life!

SUBMITTED TO:
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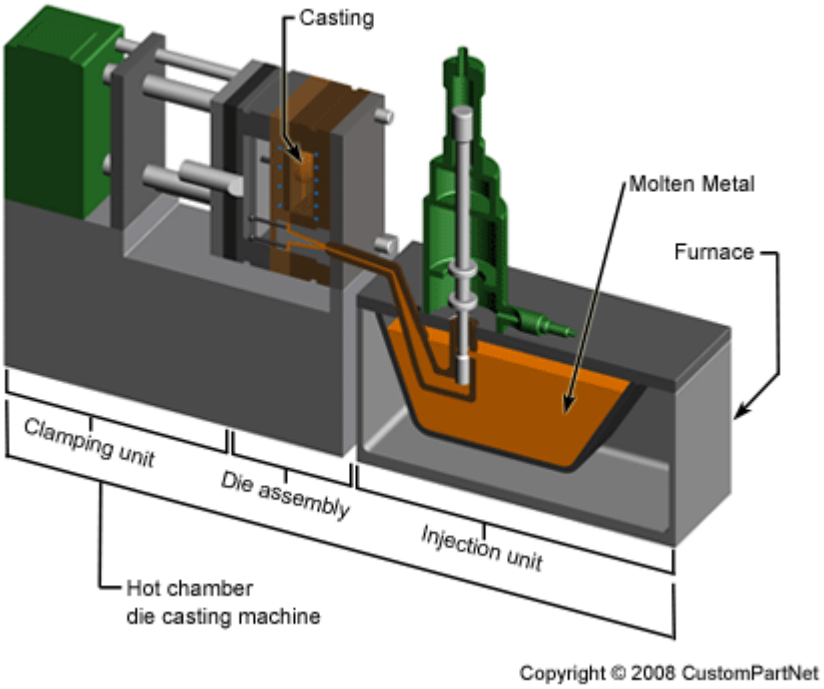
INTRODUCTION TO MSIL

Fig 1.1 MSIL Plant

Maruti Suzuki India Limited (MSIL) was established in Feb 1981 through an Act of Parliament, to meet the growing demand of a personal mode of transport caused by the lack of an efficient public transport system. Suzuki Motor Company was chosen from seven prospective partners worldwide. This was done not only due to their undisputed leadership in small cars but also due to their commitment to actively bring to MSIL contemporary technology and Japanese management practices (which had catapulted Japan over USA to the status of the top auto manufacturing country in the world). A license and a Joint Venture agreement were signed between Govt. of India and Suzuki Motor Company (now Suzuki Motor Corporation of Japan) in Oct 1982.

HPDC
(HIGH PRESSURE DIE CASTING)

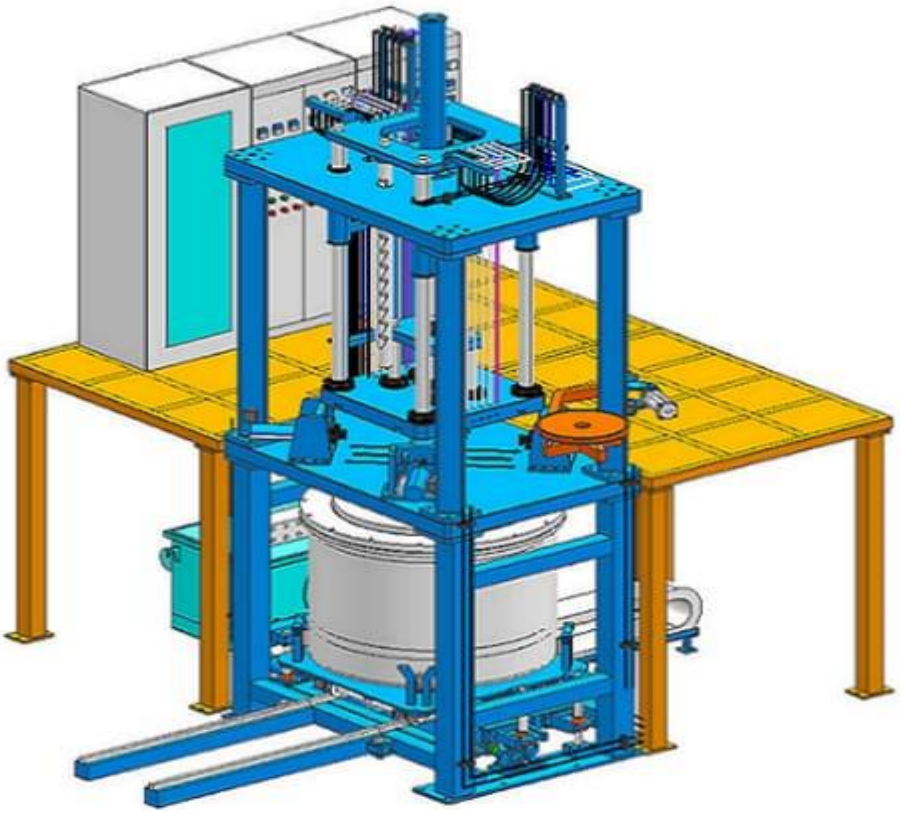


High Pressure Die Casting (HPDC) is a manufacturing process that involves forcing molten metal at high speed and high pressure into a closed steel die cavity. This process produces various product forms with complex geometries and tight tolerances.

Key Characteristics:

- High pressure injection: **Molten metal is injected into the die at pressures ranging from 10 to 175 megapascals (1,500 to 25,400 psi).**
- Quick fill: The high-pressure injection ensures the entire die cavity fills before any part of the casting solidifies, minimizing discontinuities and air entrapment.
- Complex geometries: HPDC can produce parts with intricate shapes, thin sections, and tight tolerances.
- High-volume production: The process is suitable for mass production, with dies capable of producing thousands of parts per hour.

LPDC
(LOW PRESSURE DIE CASTING)



LPDC is a casting process that involves filling a permanent mold under low pressure. The molten metal is injected from the bottom of the mold using a pressurized furnace generating a neutral gas whose pressure is slightly higher than atmospheric pressure (maximum 1 bar).

Key Characteristics:

- Filling mold under low pressure (20 to 100 psi)
- Suitable for producing complex shapes with moderate to high complexity
- High dimensional accuracy (± 0.005 in)
- Excellent surface finish
- Can produce parts with thin walls
- Minimal post-processing required

CASTING PROCESS FLOW CHART

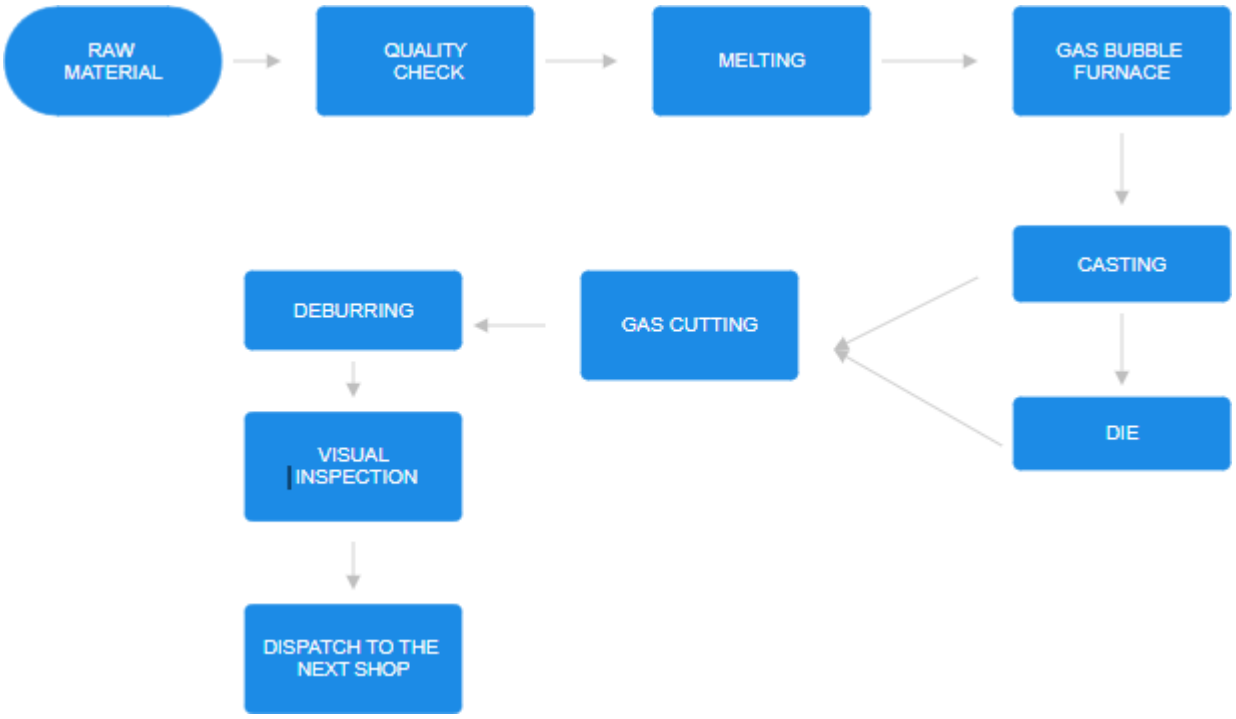


Fig 1.2 Casting process flow chart

THE FURNACE PLANT AS A WHOLE

The furnace plant comprises the following components:

- Melting shaft with ETAmax
- Furnace melting area
- Furnace holding area
- Waste gas hood
- Gas conditioning system
- Control cabinet

If the furnace is equipped with a charging system, a separate operating manual for the charging system will be included. In connection with a horizontal charging system an atomized charging process (half or fully automatic) is possible (optional).It is also possible to fill liquid aluminum into the furnace via a separate filling pocket (optional).The charging material is filled into the melting shaft after opening the charging door of the waste gas hood. The material slides from the melting shaft through the preheating zone into the melting chamber, where it is melted. In the preheating zone the charging material is dried and preheated by the waste gases. This procedure is called the ETAmax®-shaft furnace principle.

The material is melted at the bottom of the melting shaft The required energy at the bottom gas or oil burners, depending on the

type is supplied the number of burners depends on the any type of furnacy needed for melting and is defined by StrikoWestofen Group .From the melting shaft the melted metal flows into the holding chamber. The burners installed in the furnace roof produce the necessary heat for superheating and holding of the liquid metal bath heat for no. of burners depend of the required amount of heat needed and is determined by StrikoWestofen Group.

FURNACE - MELTING SECTION

Fig 1.3 furnace melting section

The melting charge is melted at the bottom of the melting shaft by means of burners. The operating times and power levels of the burners are controlled according to the shaft filling level, the temperature in the combustion chamber and the temperature of the

waste gas. The temperature limit detector of the melting chamber switches the burners off and/or to low load level 1. The cooled furnace is to be heated up in accordance with the heating up curve included in this operating manual.

FURNACE – HOLDING AREA

The metal to be molten flows from the melting area to the holding area. In furnace with molten metal charging, the furnace is filled directly in the holding area using a separate filling pocket. The holding burners create the heat energy necessary for heating the melting bath and keeping it warm. Measuring the bath fill level. The holding equipment for the bath thermo-element and the max, bath fill level electrodes and alarm electrode are mounted in the cover of the thermal pocket.

The thermal pocket measuring devices must be checked regularly to make sure they function property and have the right settings and to make sure the electrodes are the proper length. This inspection is the only way to prevent overfilling and molten metal from flowing out uncontrollably.

TAKE - OUT OF LIQUID METAL

Fig 1.4 tapping valve

The take-out of liquid metal takes place according to the furnace type:

- Stationary furnaces with tapping valve
- Hydraulic tit table furnace with pouring spout

- Furnaces with bale-out pocket

Metal take-out via tapping valve

The metal is generally taken out via a tapping valve type I with is installed at the lowest point of the metal bath. It is possible to install two tapping valves at different heights. Then the bottom tapping valve is used for residual discharge only. Variable amounts can be taken out at different times.

The tapping valve consists of the following components:

- Safety bolt to avoid unintentional operation
- Operating handle with counter weight
- Catch to look the ’open’ position.
- Valve plate at furnace
- Valve plug at tapping valve
- Hand wheel to turn the valve plug

Before the tapping valve is operated, the following has to be ensured:

- That a sufficiently large and preheated ladle is prepared and located underneath the tapping valve or a lauder system is ready to take over the liquid metal.
- That no metal will get onto the floor, danger of splashes(if necessary, prepare sand bed)
- That an emergency valve plug, mounted on a long rod, is always at hand.
- When only a residual amount of metal (up to approx. 150kg) is to be taken out of the furnace, the valve type II is installed.

HOLDING AND MELTING CHAMBER DOOR

Depending on the furnace type the furnace is either equipped with hinged doors or lifting doors

WASTE GAS HOOD

For the purpose of charging the furnace, the door of the waste gas hood is opened by means of either a gear motor or hydraulically. Should melting charge in the approach path

prevent closure of the waste gas hood door, an appropriate message will be displayed at the operator panel.

The end positions of the waste gas hood doors are scanned by limit switches, in addition to which the moving time is set as a safety function. The waste gas hood incorporated the thermocouple to measure the temperature of the waste gases. The waste gas hoof door can be operated in automatic mode and manually.

GAS CONDITIONING SYSTEM

Gas heated furnaces are equipped with a gas conditioning system. Its position is indicated in the general drawing (connection points). Please refer to the flow diagram with regard to the system's design and individual components. Information on settings and maintenance is to be found in the technical data sheets and component description.

CONTROL CABINET

The control cabinet contains all the electrical control devices, which are required for the StrikoWestofen melting and holding furnace plant.

The front doors incorporate the necessary input and output devices and command buttons for manual and/or automatic operation of the furnace plant. With regard to the design of the switchgear, see electric wiring diagram and the description of the electrical function.

TYPES OF FURNACE PROGRAM

There are three different furnace program:

- Holding/melting program: this program is the actual program for production. When this program is running. The bath temperature is kept to the preset set-point by means of a PID closed loop controller.
- Sintering program: this program is only run after a new refractory lining has been installed in the furnace and the furnace is cold. To start the sintering process, turn the holding burner ON switch to the ON position and select the sintering program in the visualization device. The instructions for the sintering process must be strictly adhered to.
- Heat-up program: this program is used only in connection with a cold furnace where the furnace has been switched OFF for some time or on a furnace where the temperature in the holding chamber has dropped below 400 degree celcius. To start the heat-up program turn the holding burners on switch to the on position and select the heat-up.

CLEANING FREE MELTING

The free melting mode allows you to clean the melting chamber. To activate this operating mode. press "Free melting" push button. To start the cleaning process, switch on the melting burners if the melting burners are inadvertently switched off, e.g. because the furnace is full, the cleaning process is interrupted. When the

melting burners are switched on again, free melting is resumed.

The furnace cannot be set to free melting mode, if one of the following has occurred:

- Emergency-stop has been activated
- Control voltage must be switched on
- Melting mode is selected
- Wire break on bath thermocouple
- Melting OFF button has been pressed
- Fault signal "Wire break on melting chamber thermocouple" should not be active
- Fault signal "Wire break at waste gas thermocouple" should not be active
- Fault signal "Wire break at bath thermocouple should not be active
- Fault signal "Error in bath temperature controller should not be active
- Fault signal "Error in melting chamber temperature controller" should not be active
- Fault signal "Error in waste gas temperature controller" should not be active

If one of the above events occurs, or if none of the melting burners has been running for two hours, the free melting mode is terminated.

In this operating mode, the air flap of the melting burner is opened to level 2 (High).

AIR FAN

The air fan supplies the air required for the production of the gas-air mixture to the burners so that a stable flame is generated. Generally, the fan is started by means of motor soft-start. Small models might allow for direct starting of the fan.

The fan cannot start, if one of the following has occurred:

- Emergency-stop has been activated
- Control voltage must be switched on
- "Holding burner ON" switch is turned "OFF"
- Fault signal "Motor protection switch of fan has tripped" should not be active
- Fault signal "Thermostat protector for the fan has tripped" should not be active

If all above conditions are met, the fan is automatically switched on, providing that

- A start burner request has been received, or
- The sintering programme has been selected, or
- The heat-up programme has been selected, or
- The gas leakage test system on the supply requires a leakage test, or

When the fan is switched on, a timer is started. After the pre-set time has lapsed, the pre-set value for minimum air pressure must be reached, otherwise the, fault "Air pressure below set value" is issued. When the fan is switched off, another timer is started. After the pre-set time has lapsed, the actual pressure must be below the minimum

air pressure value; otherwise the, fault "Air pressure switch has push.

SHAFT COVER

The extractor hood is equipped with a shaft cover. The cover is operated by means of an electric motor and closes the melting shaft off when the furnace is in holding mode in order to prevent heat loss that would otherwise occur due to the partial vacuum in the waste gas system. On the control panel, users can select the function that the shaft cover opens and closes automatically.

MANUAL OPERATION

The shaft cover cannot be operated, if one of the following has occurred:

- Emergency-stop has been activated
- Control voltage must be switched on
- Motor protector is tripped
- Charging container must be in it's initial position
- The watchdog monitoring system tripped

- Hand/auto charging unit select switch not in position "Hand".
- The emergency end position should not be reached
- Hand crank should not be inserted in the motor

If none of the above occurred, the shaft cover can be opened by pressing push button "Open shaft cover". The movement is immediately halted, when the push button is released or when the cover has reached end position "Shaft cover opened" (limit switch). To close the cover, press push button "Close shaft cover". The movement is immediately halted, when the push button is released or when the cover has reached end position "Shaft cover closed" (limit switch).

AUTOMATIC OPERATION

At the control panel, select automatic mode. When this mode is selected in conjunction with automatic mode for charging, the shaft cover is opened, as soon as a melting programme is pre-selected. When the melting process is started, the shaft cover is automatically closed. The opening and closing of the cover is controlled by a pre- set time element. If the runtime set in the time element is exceeded, the movement is halted. Message "Runtime exceeded" can be acknowledged by pressing the "Reset" push button.
If the charging operation is set to automatic, while automatic mode has not been pre-selected for the shaft cover at the control panel, the shaft cover is automatically opened. In this case, is must however be

closed manually. The shaft cover cannot be operated, if one of the following has occurred:

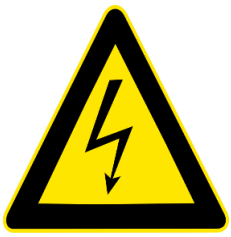
- Motor protector is tripped

- The watchdog monitoring system tripped
- Hand/auto charging unit select which not in position “auto”
- The emergency end position should not be reached
- Hand crank should not be inserted in the motor
- Emergency-stop has been activated

WARNING SINGS AND SYMBOLS

All the components of our plant, which are of relevance to safety, are provided with clear warning information signs. The following terminology and signs are employed to indicate dangers in this inspections manual.

This symbol indicates a potentially dangerous situation



Warning-dangerous electric voltage

Warning- danger of hand injuries

Warning-danger of crushing

Warning-danger of slipping

Warning- danger of falling

Warning-hot surface

Warning- suspended loads Gantry crane

BASIC SAFETY INSTRUCTION

Wearing of chemical processes

Warning- risk of explosions – work on gas piping

Warning – potential damage to the environment

Information

Wear safety helmet

Wear heat resistant face protection

Wear eye protection

Wear heat resistant gloves

Wear safety boots

Wear protective cotton clohing

Date

Calculations :

Time duration (1 hour)
Charging in one hour - (kg)
493 (Ingot)
110 (Scrap)
120 "
115 "
120 "

CNG Consuption per hour
Initial - 711710
final - 711820

Total charging = 958 kg
CNG Consumption = 110 m^3
(1 m^3 = 0.986 scm)
(110 m^3 = 108.46 scm)

For 958 kg of Aluminium ADC-12 metal
108.46 SCM of CNG is Consumed

∴ for 1 kg of Metal = $\frac{108.46}{958}$

= 0.113 scm/kg

Conclusion

To summarize, our study on the energy efficiency of the melting furnace revealed that the natural gas (NG) consumption per hour for melting 1 kg of aluminum metal is 0.113 scm/kg. This is in line with Maruti Suzuki's commitment to maintaining optimal energy efficiency in their manufacturing processes, thus supporting their dedication to sustainability and cost-effectiveness. These findings not only confirm the efficiency claims but also establish a benchmark for further improvements in energy management practice.