Method of high quality die casting

Through transmitting nonflammable gas into the cavity, the impure gas inside the cavity will be discharged. High quality die will be produced by using the solution as following.

According to the present invention, a valve type gas venting device is connected to a mold which has a cavity when it is closed. Sleeve connected with a molten metal supplying inlet and a plunger which pushes molten metal. A suction path connects with a vacuum tank and a gas transmitting path connects with a gas source. Both of them are connected to the valve type gas venting device which has a switchable function. Nonflammable gas is transmitted into the cavity from the gas source via the gas venting device. The time slot is from the time just before the completion of mold clamping to the time before filling the molten metal into the cavity. The impure gas inside the cavity will be discharged from the inlet of molten metal by transmitting nonflammable gas consistently. The nonflammable gas will be discharged from the gas venting device during the filling of the molten metal.
Description

[FIELD OF THE INVENTION]

[0001] The present invention relates to a method of die casting wherein the gas in a cavity is displaced by nonflammable gas at least by the time just after the completion of mold clamping and the nonflammable gas in the cavity is suctioned in the middle of filling molten metal, thereby enabling high quality die casting.

[BACKGROUND OF THE INVENTION]

[0002] In die-casting, since molten metal is filled in a cavity at high speed and high pressure, the adiabatic compression of impure gas sealed in the cavity (if air is subjected to adiabatic compression at 500Kg / cm², air temperature rises up to 3000 degree or more) and the oxidation reaction of oxygen in the air occur, and thereby temperature rises high. Further, it is known that when the filling of the molten metal is completed, blow holes occur inside the products due to the adiabatic compression, which causes a temperature rise in the involved gas and the oxidation reaction between oxygen in the air and the molten metal, thereby causing welding problem in the appearance.

[0003] When molding a high precise and high accurate die cast product, a gas venting device is attached to a molding die, a suction means is connected to the device, and the impure gas such as the air sealed in the cavity or the vaporized gas of a release agent is suctioned such as blow holes are prevented from occurring or the material can reach the each corner of the cavity.

As another means, the impure gas in the cavity is displaced by inactive gas before filling molten metal, then the molten metal is filled in the cavity.

As a gas venting device, for example, one valve type which electrically opens and closes a single valve and a two valve type (also referred to as mechanical valve) which operates a passive valve which acts by molten metal pressure, transmits the operation of the valve to an on-off valve via a lever, thereby closing the on-off valve, are known.

[PRIOR ARTS]

[PATENT LITERATURE]

[0004]

[PATENT LITERATURE 1]Japanese unexamined patent publication 08-90197

[SUMMARY OF THE INVENTION]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0005] In the conventional die casting, inactive gas in the cavity is discharged to the outside of the cavity by filling molten metal into cavity at high speed. However, the inactive gas in the cavity cannot be discharged to the outside completely.

Furthermore, since the inactive gas remaining in the cavity is compressed at high speed and high pressure, adiabatic compression occurs. When this adiabatic compression happens on the surface of a product, a welding problem occurs, and when it happens inside the product, a blow hole occurs.

Since an aluminum product is light and can be easily recycled, the range of application is growing larger and larger. For example, aluminum products of automobile. High quality and high precision has been anticipated and low cost bases on the enhancement of product yield.

Therefore, the present invention is conceived in view of these problems brought by the old techniques. In order to solve these problems, at least, discharging the gas which inside the cavity by filling the cavity with nonflammable gas. Then vacuum tank absorbs the nonflammable gas, while the cavity is filled with molten metal.

[MEANS USED TO SOLVE THE ABOVE MENTIONED PROBLEMS]

[0006] In order to achieve the above-mentioned object, according to Claim 1, the method of high quality die casting for a die casting device includes a product casting means for attaching a molding die and opening and closing the molding
die a molten metal supplying means for filling molten metal into the molding die, and an electrical control unit corresponding
to the means, wherein the molding die includes a cavity between a fixed die and a movable die, a valve type gas venting
device which communicates with the cavity is attached, the molten metal supplying means includes a molten metal
supplying inlet at a sleeve connected to the fixed die, and a plunger is provided to push out toward the molding die the
molten metal injected through the molten metal supplying inlet. The method includes the steps of connecting a swithable
suction path equipped with a vacuum tank and a gas compress transmitting path equipped with a gas source to the
valve type gas venting device, compress-transmitting nonflammable gas from the gas source to the cavity via the gas
venting device from the time just before the completion of mold clamping of the molding die to the time before the filling
of the molten metal into the cavity, releasing the impure gas sealed at least in the cavity to the outside through the molten
metal supplying inlet in the sleeve, displacing the gas in the cavity by the nonflammable gas, and suctioning the non-
flammable gas in the cavity by the vacuum tank via the gas venting device during the filling the molten metal.

Herein, the cavity is a space which forms a product when the movable die and fixed die is clamped.

Herein, the impure gas includes the air in the cavity and the sleeve, and the gas occurring from the molten metal which
is filled to the cavity and the gas occurring from the release agent, which is sprayed to the cavity, due to the heat applied
to the molding die and the sleeve.

The gas source comprises flameproof gas and the nonflammable gas includes the air with a large amount of nitrogen
(in particular dry air) or inactive nitrogen gas, etc.

Herein, the vacuum tank has at least a volume which is enough for one cycle of the molding die, capable of suctioning
the gas in the die cavity in a short time as possible, thereby generating substantial vacuum state.

The vacuum tank has at least a volume which is enough for one cycle of the molding die, capable of suctioning
the gas in the die cavity in a short time as possible, thereby generating substantial vacuum state.

Here, the time just before the completion of mold clamping means the time when, the first, the second and the third
sensors, receiving a signal from the second sensor.

Claim 2 recites the method of high quality die casting according to claim 1, wherein the nonflammable gas
compress-transmitted to the molding die from the gas source releases the impure gas in the cavity and the sleeve to
the outside through the molten metal supplying inlet, and the nonflammable gas is filled in the cavity before the molten
metal supplying inlet of the sleeve is closed by the plunger.

Claim 3 recites the method of high quality die casting according to claim 2, wherein the gas source of the gas compress
transmitting path is either the compressed air of an existing compressed air path or a gas filled tank.

Claim 4 recites the method of high quality die casting according to claim 1, 2 or 3, wherein the gas venting device is
either a single valve type gas venting device including a molten metal detecting sensor and an on-off valve operating in
response to a signal of the sensor, or a mechanical valve type gas venting device including a passive valve operating
on the basis of molten metal pressure and a close valve operating via a lever having contact with the passive valve.

Claim 5 recites the method of high quality die casting according to claim 3 or 4, wherein the gas source filled in the gas
filled tank is nitrogen gas, and the gas at least in the cavity is displaced by the nitrogen gas by the time when the plunger
sliding toward the molding die closes the molten metal supplying inlet of the sleeve.

Herein, the gas compress transmitting path is a pipeline extending from the gas venting device to the gas
source, air blasting nonflammable gas into the cavity, and the suction path is a tube extending from a gas venting device
to a vacuum tank, suctioning nonflammable gas from the cavity.

Herein, the existing compressed air path is a compressed air tube laid at plant, transmits the compressed air with at
least 1 atmosphere or more, comprises an existing compressed air source generating compressed air, such as a compres-
sor, cylinder, etc.

Herein, the valve type gas venting device comprises a movable type device attached to a movable die of a molding die
and a fixed type device attached to a fixed die, opened or closed concurrently with the molding die. The valve type gas
venting device includes a single valve type gas venting device and a mechanical valve type gas venting device, enabling
the suction of the impure gas from the cavity in mold clamping, while preventing the suction of the molten metal.

[ADVANTAGE OF THE INVENTION]

The method of high quality die casting according to the present invention provides the following effect.

According to the method of casting recited in claim 1, from the time just before the completion of mold clamping to the
completion of the filling of the molten metal into the die cavity, nonflammable gas is compress-transmitted from the gas
source into the cavity via the gas venting device, thereby the impure gas such as the air heated by the molding die or
the sleeve and the vaporized gas of the parting agent sprayed to the cavity is released to the outside through the molten
metal supplying inlet of the sleeve, and the gas at least in the cavity is displaced by the nonflammable gas, thus the
impure gas in the molding die and the sleeve is reduced.

As a result, the occurrence of defective products due to impure gas is suppressed, thereby enabling production of high-
quality die-casting products (free of Oxide).

Also, the nonflammable gas in the cavity can be suctioned into the vacuum tank in the middle of filling the molten metal
via the gas venting device communicated with the cavity, and thus the occurrence of adiabatic compression due to
remnant gas can be suppressed, thereby contributing to the production of high-quality products.

According to the method of casting recited in claim 2, in addition to the aspect of claim 1, the nonflammable gas compress-transmitted to the cavity releases to the outside the impure gas not only in the molding die but also in the sleeve through the molten metal supplying inlet, thereby effect due to the impure gas can be further reduced.

According to the method of casting recited in claim 3, in addition to the aspects of claims 1 and 2, when the gas source of the gas compress transmitting path is an existing compressed air path laid at plant, the method can be practiced only by connecting to the air pipeline.

Also, when the gas source is a gas filled tank, the gas source can be easily moved to and arranged at any place, for example, near the valve type gas venting device.

According to the method of casting recited in claim 4, in addition to the aspects of claims 1, 2 and 3, when the valve type gas venting device is a single valve type gas venting device, the most appropriate compress-transmission and suction of the nonflammable gas can be achieved depending on the position where the molten metal detecting sensor is attached. Also, when the valve type gas venting device is a mechanical valve type gas venting device, no electrical wiring is required.

According to the method of casting recited in claim 5, in addition to the aspects of claims 1, 2, 3 and 4, since the gas source filled in the gas filled tank is nitrogen gas, adiabatic compression’s influence will be reduced further. Since the impure gas in the cavity and the sleeve is displaced by nitrogen gas, the oxidation reaction by oxygen in the air with the molten metal can be eliminated. As a result, the production of high-quality products can be achieved. Since the compress-transmitted nitrogen gas is a part of the atmosphere, it is not only innocuous and low cost, but is less affected by adiabatic compression than air due to the character of a small molecular weight.

**[BRIEF DESCRIPTION OF THE DRAWINGS]**

**[0013]**

Fig. 1 is a schematic view illustrating a die-casting machine used for a high quality die casting method according to the present invention.

Fig. 2 is a plan view of a fixed die (left) and a movable die (right).

Fig. 3 is a schematic view illustrating an example of continuity between a suction path and a gas compress transmitting path for a mechanical valve type gas venting device.

Fig. 4 is a cross-sectional view of an on-off valve in an open state (left) and a closed state (right) of the on-off valve of a single valve type gas venting device.

Fig. 5 is a process chart illustrating each process from before and after mold clamping to completion of suction in chronological order.

**[BEST MODE OF PRACTICING THE INVENTION]**

**[0014]** First, a schematic structure of the die-casting device used for the method of high quality die casting according to the present invention is described with reference to Figs. 1 and 2. The die-casting device is provided with a product casting means for opening and closing a molding die B which is attached to the product casting means, a molten metal supplying means 8 for filling molten metal M in the molding die B, and an electric control unit (not shown) for controlling these components.

The molding die B has a cavity C between a fixed die B1 and a movable die B2, and a valve type gas venting device 1 that communicate with the cavity C. As shown in Fig. 5, the molding die B includes a first sensor S1 detecting the initial stage of mold clamping, a third sensor S2 detecting the completion of the mold clamping, and a second sensor S3 detecting the intermediate stage of the mold clamping.

The molten metal supplying means 8 is provided with a molten metal supplying inlet 82 at a sleeve 81 continuing to the fixed die B1, and includes a plunger 83 pushing out the molten metal M, which supplied into the sleeve 81 through the molten metal supplying inlet 82, toward the molding die B.

**[0015]** Next, a first embodiment of the high quality die casting method according to the present invention is described. As a valve type gas venting device 1, a mechanical valve type gas venting device 1B (hereinafter referred to as gas venting device 1B) is provided, and this gas venting device 1B communicates with a gas compress transmitting path 2 and a suction path 3. The gas compress transmitting path 2 is provided with a gas source 21, and the suction path 3 is provided with a vacuum tank 31. Solenoids 23 and 32 are respectively provided in the middle of the gas compress transmitting path 2 and the suction path 3, and the gas compress transmitting path 2 and the suction path 3 are switched by opening and closing the solenoids 23 and 32, and an existing compressed air path F functions as the gas source 21.

The gas compress transmitting path 2 and the suction path 3 are separated from a common path 4 connected with the gas venting device 1B, and the supply solenoid 23 is provided between the bifurcation point and the gas source 21 while...
In contrast, according to the present invention, nonflammable gas is blown into the cavity C and the sleeve 81, and the sleeve 81 is in a heated state, gas inside it also to be gasified, thereby this part of gas will also be mixed into molten metal M. Such as the gas, etc. generated from the molten metal M filled in the cavity C have caused a poor casting. When the sealed in the cavity C and a part of the parting agent sprayed to the cavity C are gasified, and further the impure gas keep a positive pressure while controlling the other cylinder part 124 to keep a negative pressure.

The on-off valve 12 has a piston part 122 at the top of a piston 121, and has cylinder parts 123 and 124 at both sides of the piston part 122 in the forward and backward direction. The valve 12 is controlled to open or close on the basis of the operation of the second sensor S2) to the completion of filling the molten metal into the cavity C. That is, due to the opening of the air blasting solenoid 23, the compressed air flowing through the existing compressed air path F, preliminarily, thus the compressed air flowing through the existing compressed air path F is defined as the nonflammable gas. Under the condition that the solenoids 23 and 32 on the gas compress transmitting path 2 and the suction path 3 are closed such that both paths 2 and 3 are in the closed state and the vacuum tank 31 is in substantially the vacuum state, if the molding die B is mold clamped, the air blasting solenoid 23 on the air compress transmitting path 2 is opened from just before the completion of mold clamping of the molding die B (in response to the electric signal on the basis of the operation of the second sensor S2) to the completion of filling the molten metal M into the cavity C.

The suction of the displacing air sealed in the cavity C is performed substantially in the same manner as the vacuum device disclosed in the patent No. 4292822 previously invented by the applicant. Thus, the displacing air in the cavity C is suctioned in the vacuum tank 31 of the suction path 3 via the gas venting device 1B. That is, in the middle of filling the molten metal, at least the displacing gas in the cavity C is suctioned via the gas venting device 1B from the cavity C is started slightly delayed before the filling of the molten metal M into the molding die B. The suction of the displacing air sealed in the cavity C is performed substantially in the same manner as the vacuum device disclosed in the patent No. 4292822 previously invented by the applicant.

Next, a second embodiment of the high quality die casting method according to the present invention is described. In this embodiment, nitrogen gas is used instead of the compressed gas as the gas source 21, more specifically, a gas filled tank 22 filled with nitrogen gas is used. That is, the second embodiment is the same as the first embodiment except that the gas filled tank 22 is connected with one end of the air compress transmitting path 2. In this second embodiment, the nitrogen gas in the gas filled tank 22 is compress-transmitted into the cavity C from the compress transmitting path 2 via the gas venting device 1B, further flows in the sleeve 81 from the cavity C, and thus is discharged to the outside through the molten metal supplying inlet 82. Thus, the impure gas in the molding die B and the sleeve 81 is released to the outside through the molten metal metal supplying inlet 82, thereby at least the gas in the cavity C is displaced by the compressed air air-blasted into the cavity C. Thus, the impure gas in the molding die B and the sleeve 81 is released to the outside through the molten metal supplying inlet 82, thereby at least the gas in the cavity C is displaced by the nitrogen gas.

Next, a third embodiment of the high quality die casting method according to the present invention is described. In this embodiment, a single valve type gas venting device 1A (hereinafter referred to as gas venting device 1A) is used instead of the gas venting device 1B. As shown in Fig. 4, the gas venting device 1A has an on-off valve 12 and a molten metal detection sensor 11. The on-off valve 12 is provided at the end of the gas venting path 19. The molten metal detection sensor 11 electrically detects the molten metal M flowing in the gas venting path 19, and is located in the middle of the gas venting path 19 closer to the cavity C than the valve 12. The on-off valve 12 has a piston part 122 at the top of a piston 121, and has cylinder parts 123 and 124 at both sides of the piston part 122 in the forward and backward direction. The valve 12 is controlled to open or close on the basis of information of molten metal detected by the molten metal detection sensor 11 by controlling one cylinder part 123 to keep a positive pressure while controlling the other cylinder part 124 to keep a negative pressure.

In the conventional molding die B, when mold clamping the molding die B in a heated state, a part of the air sealed in the cavity C and a part of the parting agent sprayed to the cavity C are gasified, and further the impure gas such as the gas, etc. generated from the molten metal M filled in the cavity C have caused a poor casting. When the sleeve 81 is in a heated state, gas inside it also to be gasified, thereby this part of gas will also be mixed into molten metal M. In contrast, according to the present invention, nonflammable gas is blown into the cavity C and the sleeve 81, and the
impure gas is displaced by the nonflammable gas (compressed air or nitrogen), and thus the environment inside the cavity C is changed so as to improve the quality of product.

[0022] In the mold opening state of the molding die B, the gas compress transmitting path 2 and the suction path 3 are closed. The pressure of press-transmitting the nonflammable gas to the cavity C from the gas source 21 via the gas venting device 1 is preferably 4.5 to 6.5 Kg/cm².

If the gas in the cavity C is displaced by the air with a small molar specific heat at constant pressure or nitrogen, then the effect of the adiabatic compression is small, thus improving the quality.

Fig. 5 is a flow chart illustration of chronological order of each process in the mold clamping of the molding die B and Table 1 shows the relationship between each step.

Table 1

| Step of injecting molten metal into sleeve | start | end |
| Step of pushing out molten metal into cavity by plunger | t1   | t2  |
| Step of filing molten metal into cavity | t3   | t4  |
| Step of air blasting nonflammable gas (air or nitrogen) into cavity | t5   | t6  |
| Step of suctioning nonflammable gas (air or nitrogen) from cavity | t9   | t10 |

[EXPLANATION OF SYMBOL]

[0023]

1 valve type gas venting device
1A single valve type gas venting device
11 molten metal detection sensor
12 on-off valve
121 piston
122 piston part
123, 124 cylinder part
1B mechanical valve type gas venting device
13 fixed mold
14 movable mold
15 passive valve
16 close valve
17 lever
18 molten metal path
19 gas venting path
2 gas compress transmitting path
Claims

1. A method of high quality die casting for a die casting device including a product casting means for attaching a molding die and opening and closing the molding die a molten metal supplying means for filling molten metal into the molding die, and an electrical control unit corresponding to the means, wherein the molding die includes a cavity between a fixed die and a movable die, a valve type gas venting device which communicates with the cavity is attached, the molten metal supplying means includes a molten metal supplying inlet at a sleeve connected to the fixed die, and a plunger is provided to push out toward the molding die the molten metal injected through the molten metal supplying inlet,

the method comprising the steps of:

connecting switchably a suction path equipped with a vacuum tank and a gas compress transmitting path equipped with a gas source to the valve type gas venting device;
compress-transmitting nonflammable gas from the gas source to the cavity via the gas venting device from the time just before the completion of mold clamping of the molding die to the time just before the filling of molten metal to the cavity; discharging the impure gas sealed at least in the cavity to the outside through the molten metal supplying inlet in the sleeve; displacing the gas in the cavity by the nonflammable gas; and suctioning the nonflammable gas in the cavity by the vacuum tank via the gas venting device during the filling the molten metal.

2. The method of high quality die casting according to claim 1, wherein the nonflammable gas is compress-transmitted to the molding die from the gas source discharge the impure gas in the cavity and the sleeve to the outside through the molten metal supplying inlet, and the nonflammable gas is filled in the cavity by the time when the molten metal supplying inlet of the sleeve is closed by the plunger.

3. The method of high quality die casting according to either one of the claims 1 or 2, wherein the gas source of the gas compress transmitting path is either the compressed air of an existing compressed air path or a gas filled tank.

4. The method of high quality die casting according to any one of the claims 1, 2 or 3, wherein the gas venting device is either a single valve type gas venting device including a molten metal detecting sensor and an on-off valve operating in response to a signal of the sensor, or a mechanical valve type gas venting device including a passive valve operating on the basis of molten metal pressure and a close valve operating via a lever contacting with the passive valve.

5. The method of high quality die casting according to one of the claims 3 or 4, wherein the gas source filled in the gas filled tank is nitrogen gas, and the gas at least in the cavity is displaced by the nitrogen gas by the time when the plunger sliding toward the molding die closes the molten metal supplying inlet of the sleeve.
Fig. 2

plan view of a fixed die

plan view of a movable die
Fig. 4

suction

negative pressure

positive pressure
Fig. 5

mold clamping is completed
### DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims.

**Place of search**  
Munich

**Date of completion of the search**  
19 October 2011

**Examiner**  
Lombois, Thierry

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