Die Casting Defects – Causes and Solutions

1) Chapter One

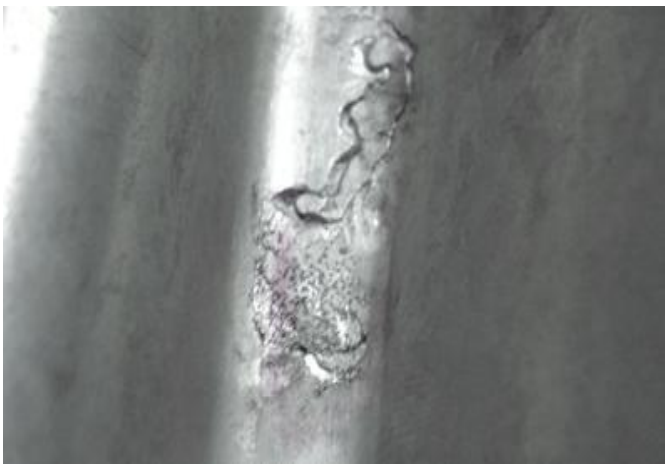
Surface Defects -- Those defects commonly called cold flow or non-fills.

(Cold flow, cold lap, chill, non-chill, swirls, etc.)

MAIN CAUSE：Metal is frozen when two metal fronts join.

Solutions :

- Increase mold temperature
- Shorten feeding time
- Change feeding way（gate）
- Inspect what lowered the metal melts temperature
- Inspect what lowered the injection pressure at the latter phase
- The pressure of the accumulator was set too low or to high
- Material cakes are too thin
- Severe flash



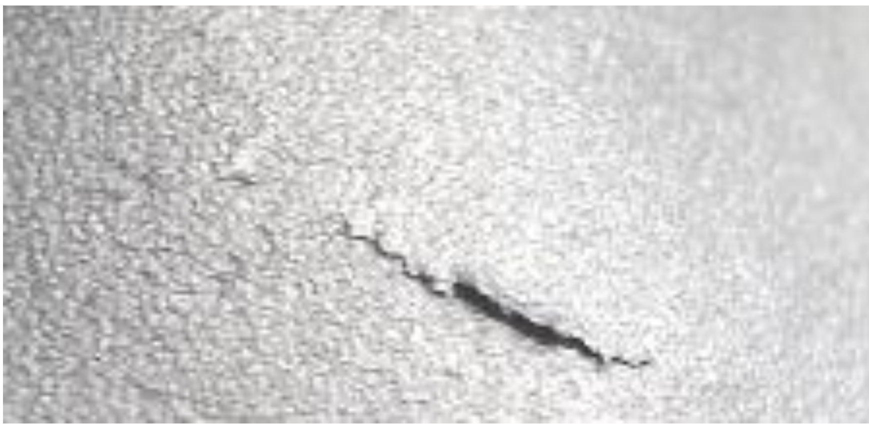
2）Chapter Two

Laminations -- Defects from layers of metal forming during the process.(Layers of metal inside or outside of casting)

MAIN CAUSE：Metal melts flows improperly during the process.

Solutions ：

- Inspect the parameter of the die casting machine
- Use the right metal flowing ways, try to avoid long distance metal flowing, and make sure that the metal melts doesn‟t join too far away from the gate.
- Adjust the temperature of the mold; make sure that the temperature of the target area is well-distributed or higher than it should be.
- Stabilize the process of the pressure increasing
- Make sure that the shape of the mold doesn‟t change with the increasing of the pressure; inspect if the mold is strong enough to keep its shape with the increasing of the pressure.



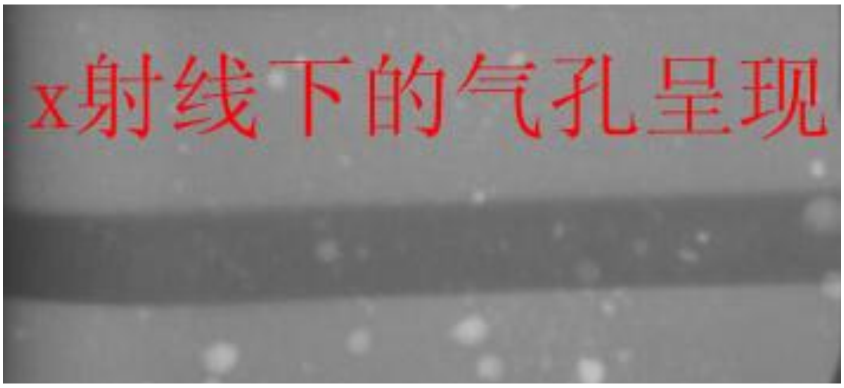
3) Chapter three

Gas Porosity -- Internal porosity from trapped gas of various kinds.

MAIN CAUSE: In the feeding process, gas porosity is formed from the gas drawn into the metal melts flow.

Solutions :

- Inspect the ways how gas is drawn into the metal melts flow or inspect whether the gas is from the air, the steam, the mold lubricant etc.
- Inspect the gate to make sure the steady flow of metal melts.
- Inspect the exhaust vent.
- Assure the proper functioning of vacuum system
- Inspect the gas from the mold lubricant.
- Inspect the water vapor, especially the water in the mold.



4）Chapter four

Blisters -- Surface manifestation of trapped gas.

MAIN CAUSE: In the feeding process, blisters are formed from

Solutions :

- Blister is just another form of gas porosity. Therefore, its solutions are similar to those of gas porosity. For example, we can decrease the gas from the air or better the exhaust vent and vacuum system.
- The essential solution is to solve the shrinkage porosity problem. However, as a temporary solution, we can cool down the target area by mist spray.
- Cool down the castings immediately after taking out, which can improve the intensity of the casting surface and prevent blisters.
- Lower the metal melts temperature and pay attention the others problems it will produce.

5) Chapter five

Flow Porosity --Surface or internal porosity from poor pressure conditions

MAIN CAUSE :Surface or internal porosity caused by poor flowing conditions or low temperatures of the metal melts.

Solutions :

- Flow porosity is a defect that caused by poor flowing conditions of the metal melts. So the solutions for the surface defects can also be applied to solve flow porosity.
- The gaps occurred during the process of die casting can be on the surface of the casting, which are called cavitations, or inside of the casting, which are called holes. Stabilize the temperature of the furnace, keep the right temperature and keep the tolerance to be within +/- 5.6°C.
- Stabilize the temperature of the mold, and use a relatively higher temperature (higher than 204.4°C) for the mold.
- Inspect and adjust the pressure of the metal melts.

6) Chapter six

Shrink Porosity -- Porosity from the volume change as the metal changes state.

MAIN CAUSE: During the solidification of casting material, the volume of casting will shrink, which form the cavity or shrinkage porosity under the volume difference between solidity and liquid.

Solutions:

- Increase the pressure of semi-solid metal, especially the area where the shrinkage porosity happens.
- Inspect the static pressure, the pressure boost setting etc.
- Provide extra metal melts in the target area.
- Too thin material cake or its size varies frequently.
- Inspect the temperature difference between the shrinkage area and other areas.
- Decrease the metal melts temperature during pressure injection. It‟s helpful for shrinkage porosity solution, but pay attention whether it will lead to other problems.
- Inspect the temperature fluctuation of metal melts. Check up whether drastic temperature fluctuation exits and the keep steady of the metal melts temperature.

7) Chapter 7

Shrink Porosity -- Porosity from the volume change as the metal changes state.

MAIN CAUSE: Shrink porosity under the surface of the casting which causes sinks on the surface.

Solutions :

- The solutions for the shrinkage porosity can be applied here.
- Cool down the hot spots which cause the defects directly.
- The material biscuit is too thin, and the punch is in poor condition.
- Heat the defect area or the mold on the opposite side
- Inspect the poorly-distributed temperature of the moving die and the fixed die, especially where the sinks took place.
- Higher the pressure while the metal melts is becoming solid to provide more metal melts to the places where sinks took place.

8) Chapter 8

Leakers -- Porous sections of the casting(Shrinkage porosity)

MAIN CAUSE: the dendritic crystal structure got loose and is partially on the surface of the casting, which provided path ways for the leaking. (Known as another form of shrinkage porosity)

Solutions :

- Inspect if there are sharp corners where the leakers took place, and try to increase the diameter of the transition arc.
- Cool down the defect area by mist spraying, and keep spraying even though the effect can‟t be recognized by naked eyes.
- The material biscuit is too thin, or the size of it changes too much (this is the main cause in many factoris)
- Maintain the surface of the defect area to be in good condition
- Inspect the pressure
- Balance the heat—cool down the leaking area and heat the area around the leakers.
- Stabilize the metal melts‟ temperature, and reduce the temperature fluctuation.
- Inspect the composition of the metal melts, and no fluctuation should exist.
- Decrease the proportion of the element Si within the requirements.

9) Chapter nine

Cracks -- Visible and not-so-very visible cracks in the casting.(Cracks, tears, hot cracks)

MAIN CAUSE: Cracks may be caused by contraction in the surface of casting, stretch, mechanical stress. They may occur during the final stage of solidification.

Solutions :

- If cracks are caused shrinkage, inspect whether the transit angle of cracks is proper. Cool down the hot spot or warm up the target area whose temperature is relatively low.
- If cracks are caused by stress while cooling down, reduce the dwell stress. Shorten the static pressure time. Increase wall thickness. If material cake decide the static pressure time，alter the runner as to take out the casting earlier.
- If cracks are caused by the shift of mould, inspect mould separation and its evidence. Reset the mould so the moving clamp can direct again. Check up pressure of push rod as to assure well-distributed locking.
- If cracks are caused by ejector, then we must assure ejector moving is straight and directive. No swing during the ejector process and assure the proper functioning of sliding block.
- Check up the metal melts component.

10) Chapter ten

Inclusions -- Foreign material that may cause machining problems (inclusions, hard spots)

MAIN CAUSE:In aluminium alloy, its inclusions are mainly the oxide, which caused by incomplete purifying of melts. Inclusions can also be something that is difficult to be melt. Chemical compound between chopper and aluminium will lead to problems of polish and process.

Solutions:

- Aluminums alloy oxide may get into while is melting. Inspect the purifying process.
- Inspect the cleaning process of melt stove wall.
- Inspect the stewing time between transportation to metals after purification. It needs at least half an hour for the stewing time. And the more stewing time, the better, which is very important.
- Inspect the disposal process of dissolvent. Make sure just one time or more.
- Inspect the degassing process.
- Inspect if the temperature inside the metal liquid is too high.ues the same setting, don dot change it

- Inspect whether the central part of the metal melts is too high. Adopt the same setting and setting alteration is not allowed.
- Inspect the situation of oxide inside the holding furnace and the purify process.
- Hard spot may contain the metal residue. Inspect if there are any metal residue in the bottom of melting furnace and the heat preserved furnace.
- Some hard spots may be materials that are difficult to melt. They were drawn into because of too early leading-out of metal melts from melting furnace.
- As for zine and zine- aluminums alloy, reduce the heat pot in the crucible and dispose the over fluctuation temperature of melting furnace.
- Inspect the filter system.
- If process permits, most hard spots floating on the surface of melting can be dislodged.

11) Chapter eleven

Solder -- Buildup of the cast material on the die, and damage

to the surface condition of the casting.

MAIN CAUSE: alloy Al or Mg join with steel mold , casting materials stick to mold face

Solutions：

1. Al alloy：

- Inspect the temperature of the target area, which is the best way to solve mold stuck problem.
- Increase water-cooling of the target area. 1/8 inch diameter water jet will be much useful.
- Use material with high heat conduction modulus, like TZM, ANVILLOY, MITECH, etc. in the target area.
- Make sure that the water pipe has no deposit sediment.
- Slow down casting speed and lengthen manufacture period.
- Reduce feeding time. Reduce the time that metal melts impact the target area.
- Check up whether the metal melts speed is too fast. The speed should be higher than nebulization, but not too much.
- Check up the angle of lifting pattern
- If possible, adopt a relative pressure.

2. Zn alloy accumulation

- If possible, adopt a relative pressure.
- Cool down the die, if possible, it is the best way to solve soldering.
- Increase the fineness of the die surface and reduce its roughness.
- Increase the angle of lifting pattern.
- Tin coating
- Polish the die or use weak acid to reduce the damage of die.

12）Chapter 12

Carbon -- Deposits other than the cast material on the die causing damage to the surface condition of the casting.

MAIN CAUSE: the deposit of fouling from lubrication or mixture of water and lubrication gathers.

Solutions :

- Inspect the usage of lubrication
- Inspect the minimum amount of lubrication usage.
- Increase the mold‟s temperature and reduce the casting ion cycle at the same time, adjust water streams and the amount of spraying.
- Even the temperature of the mold, and get rid of the parts that are either too cool or too hot.
- The amount of the mixture spraying shouldn‟t be changed, especially among different groups.
- Use the lubrication that matches the mold‟s temperature, especially when it is a cold mold.
- At the blind holes, the mold core and other cold parts, don‟t spray lubrication.
- If the spray is too much, clean it with compressed air.
- Don‟t mix hard water and lubrication together

13) Chapter 13

Erosion, Cavitations -- Removal of die steel and subsequent deformation of the casting.

Defects: die erosion, cavitations, and burn out. Die has worn spots causing raised spots on the casting; can be small deep cavities (cavitations), or larger erosion areas at the gate.

MAIN CAUSE: the speed of the metal melts is too high, so when it goes into the mold cavity, bubbles occur; there is too much oxide material or the Si content is too high.

Solutions :

- Inspect the temperature of the gate.
- Inspect the temperature of the metal melts, which shouldn‟t be too high.
- Inspect the temperature of the gate in the mold, lower it down by spraying if possible.
- Inspect the purity of the metal melts; always refer to the oxide material purification steps (chapter 9)
- Inspect the filling time—a longer filling time would speed up the erosion at the gate.
- Inspect the alloy—a higher Si content makes the technological design‟s tolerance smaller(adopt a lower speed at the gate)
- For the zinc alloy, the bubbles in the alloy lead to porosity and “burning through”(refer to the gas porosity‟s solutions in chapter 2)

14) Chapter 14

Out gassing -- Gas escapes from the casting during a painting or finishing operation that causes defective surface finish. (defective surface occurs when bubbles appear during a painting or finishing operation).

MAIN CAUSE: when the casting is heated in the processing, the air involved in the alloy expands with the heat, and pierces through the surface of the casting.

Solutions :

- If the problem is at the overflow gate, then reduce the number of the overflow gates or combine some overflow gates, so the size of the overflow channel can be reduced.
- Increase the distance between the casting and the overflow gates to reduce the heat accumulation near the casting .
- Make the gate thinner but remain the area of the gate to insure the casting‟s quality.
- Lower the temperature of the alloy, but make sure the temperature of the zinc alloy is above 700°F, and the aluminum alloy above 1200°F.
- Lower the temperature of the mold‟s gate.
- Lessen the air that gets involved into the alloy (refer to the gas porosity‟s solutions in chapter 2)
- Make sure there is still pressure during the die casting‟s later phase.

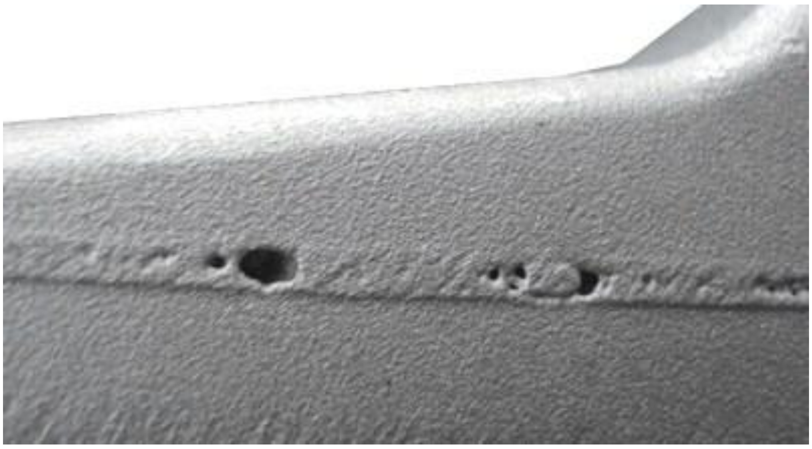
15) Chapter 15

Cold Flakes -- Leakers and break in at the gate.(Edge porosity: porosity at the gates)

MAIN CAUSE: shrinkage porosity or gas porosity

Solutions :

- For shrinkage porosity
- The loose dendritic crystal structure creates gas channels. Using intensive cooling can help remove this defect (super-cooling the thin gate may also help)
- Use a long and flat ramp-way for the gate to reduce the steel mold‟s temperature near the gate.
- Make the gate thinner and wider to help release the heat.
- Move the gate onto the part of the mold whose temperature is lower.
- Try to reduce the filling time—so to reduce the heat that can be passed by the alloy to the gate.
- Gas porosity
- Gas porosity can cause out gassing, but no as much as shrinkage does.
- Apply the gas porosity‟s solutions to remove this problem. (Chapter 2)



16) Chapter 16

Bending, Warping -- Deformation of the casting sometime after it is formed in the die cavity. (bending, warping, out of flatness)

MAIN CAUSE: poor operating and poor designs

Solutions

- For poor designs
- The tolerance of the tool‟s structure is too big.
- Wrong shrinkage calculation.
- Wrong process capacity estimation
- For poor operating
- The most important factor is to stabilize the ejection temperature of the casting , which mush be the same with the mold‟s temperature .
- The pressure holding time should be controlled with thermocouples rather than timers.
- Use a settled technological design to maintain the temperature. (such as settled mold‟s spraying, a settled casting ion cycle, a settled water cooling rate, etc.)

- Uneven ejection force
- The ejection system is poorly designed, or the ejection mechanism is out of date.
- The length of the stop pin is uneven.
- The ejector pin is in a wrong position.
- The casting is frayed, the mold has cracks, or the groove on the mold is sticky.
- The stress put on the casting when the mold is being opened is uneven

17) Chapter seventeen

Flash -- Excessive material extending from a parting line, often accompanied by dimensional deviation.

MAIN CAUSE : Flashes occur when the casting is under high pressure and the metal melts „s temperature is relatively high. Meanwhile, improper die matching or the machine improper die locking may also lead to flashes.

Solutions:

- die matching:
- Inspect die matching when operate the temperature. Use chlorinated time or other ways to inspect the die matching condition under the function temperature.
- Inspect the casting and find out die deviation. Search the differences between high pressure and low pressure. Inspect die design.
- condition of the die locking :
- put the same load on tie-bar.

- Inspect the machine condition and check whether there is wear and tear, the die install is right or not, any deformation of the supporting plank.
- Die sinking force should be in the center of the machine. Load of load center and of each tie-bar need to be calculated.
- question of metal melts pressure
- Static pressure should be set between 3000-6000psi.
- Supercharge pressure of metal melts should be set between 7000-12000psi.
- heat condition of die and casting
- Assure the cooling system in the thermal center, like the material cake, branch pipe etc.
- Assure superposition to the thick portion of casting in mold parting and heated portion of die.

18) Chapter Eighteen

Stained Castings -- Discolored castings.

MAIN CAUSE: stained mark results from the impurities from metal melts, especially the die lubricant or other material.

Solutions:

- review to the use condition of lubricant：
- Inspect the amount of plunger lubricant.
- Assure the consistency of amount
- Check up the amount of mold lubricant.
- Check up the amount of lubricant.
- Inspect the proportion of lubricant mitigation.
- Look for different lubricant.
- Inspect the origin of impurities in metal melts.

19）Chapter Nineteen

Waves and Lakes -- Decorative castings with small imperfections visible only under reflected light.

MAIN CAUSE：It is generally observed in the Zn alloy casting. Metal melts that first enter into cavity solidify fast and then form the surface of casting. This surface of casting does not involve into the re-melting process and its crystal particles are obviously small compared to other area. Differences also exit in their appearances.

Solutions:

- Improve flow condition of the metal melts
- Reduce feeding time
- Change the feeding pattern and reduce spay and injection of the target area.

20) Chapter 20

Drags -- Surface area of the casting is broken by metal stuck to the die.

MAIN CAUSE: deformation of the casting happens when the casting is ejected from the mold because of the conglutination between the casting and the mold. The conglutination may be caused by the buildup material left on the mold before casting or the erosion of the mold.

Solutions :

- Refer to the solutions for Solder and Erosion, Cavitations in chapter 12 and chapter 14.
- Make sure that the surface of the mold is smooth and the traces from processing are polished.

- Inspect the draft.
- Lower the temperature of the mold which causes conglutination by maybe spraying or using a mold that has a higher coefficient of heat transfer.
- Insect the metal melts‟ temperature.

21) Chapter 21

Deformation from Ejector Pins (Pushed Pins) -- Casting is deformed by ejector pins.

MAIN CAUSE: when the casting is connected with the mold, while it is still soft, deformation happens when the casting is ejected by the ejector pins.

Solutions :

- Inspect the following points
- The conglutination and the drags
- If the time that the casting stays in the mold is too long or too short.
- The ejection system is imbalanced which causes big impact on the casting.
- Poorly designed molds
- Ejector pins are too few.
- Ejector pins‟ locations are not right.
- Use stiffeners at the ejector pins‟ area to disperse the load.
- The sectional area of the ejector pins is too small.
- The mechanism of the ejection is not right or is frayed.

■ The load of the ejection can‟t meet the demanding whether the load should be even or not.

22）Chapter 22

Excessive Flux -- Corrosion or porosity from excessive flux.

MAIN CAUSE: excessive flux causes more erosion on the surface of the casting and on the surface of the holes inside the casting. Excessive flux can be tested by leaving the casting in the clean water for a night, and by cutting the parts of the casting where there are holes to inspect the white spots on the holes‟ sectional surface.

Solutions :

■ Reduce the flux usage amount.

■ Review the technological design of the casting, and decide how and how much the flux should be used.

■ Record how to use the flux.

■ Train the operators thoroughly, teach them how much flux should be used, and how to use the flux.