High Thermal Conductivity Tooling Steel Fastcool 55 Solving Soldering Problems in Die Casting Applications

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Abstract: Fastcool 55 material has a thermal conductivity of 47 W/mC which doubles the figure of commonly used hot work tooling steel H 13 material. The result of this leading to a higher and faster solidification of liquid Aluminum when in contact with Fastcool 55 materials in die casting dies.

With typical application of insert pins and square inserts, Fastcool 55 material increased the insert tooling life 3 times and more.

Also, Fastcool 55 material has much higher tempering resistance. This property increased the thermal fatigue resistance of the material. Leading to longer tooling life.

Applicatiion case studies are cited which illustrate that Fastcool 55 material has much better performance in resisting soldering problems when used as die casting die steels.

Key words: Fastcool 55; soldering; tooling life

1 Introduction

High Pressure Die casting is an application technology which produces near net shape Al/Mg/Cu alloy products at a rather fast speed as against normal low pressure or gravity castings. The process of die casting is designed with a runner and gating system which sprays the alloys into die cavities to form the demanded products. With different designs of the runner and gates the liquid metal has certain designed speed to inject into the cavity.

In Al die casting, soldering may happen when the Al temperature is too high or gating speed is over 60m/s. With normal Din 1.2344 (H13) tooling steels or modified Din1.2367 materials such as NADCA C category soldering occur when injected liquid Al temperature is over 690°C or gating speed over 60m/s[(1)]. This is due to the fact that Al has solubility to iron.

When tooling steel changed to Fastcool 55 [(2)] material which has a higher thermal conductivity than Din 1.2344 (H13) materials, the material has superior tooling failure resistance leading to longer tooling life.

2 Mechanism

The Fastcool 55 material has a chemical composition which has high Mo content which yields more ferrite formation leading to high thermal conductivity of the material. The Si and Cr content lowered down to< 0.05%wt.

Typically, Din1.2344 (H13) tooling steels have a thermal conductivity of 25W/mC; whereas Fastcool 55 material has a thermal conductivity of 47W/mC. The higher thermal conductivity of Fastcool 55 transfers the liquid Al solidification heat faster into the tooling steel materials than conventional Din 1.2344 (H13) steels or NADCA C category steels.

In Al high pressure die casing, when liquid Al in contact with Fastcool 55 tooling steel it solidifies immediately which over comes the soldering problem between tooling steels and Al alloy.

Figure 1 shows Fastcool 55 material being used as die casting dies which have no water cooling lines. The die surface temperature is between 215-236°C in the high temperature zones and 122-188°C in the low temperature zones.

Figure1 Surface temperature of Fastcool 55 material in die casting dies

3 High temperature tempering resistance

Figure2 shows the tempering curve of Fastcool 55. The tempering resistance is exceptionally high. Conventional hot work tooling steel such as modified Din 1.2367 materials i.e. typically NADCA C category materials have tempering resistance of 600ºC to reach hardness of 46HRC hardness. Whereas, Fastcool 55 needs 640ºC temperature to temper the material in order to reach 46HRC which has a high temperature margin of 40ºC than the conventional hot work tooling steels.

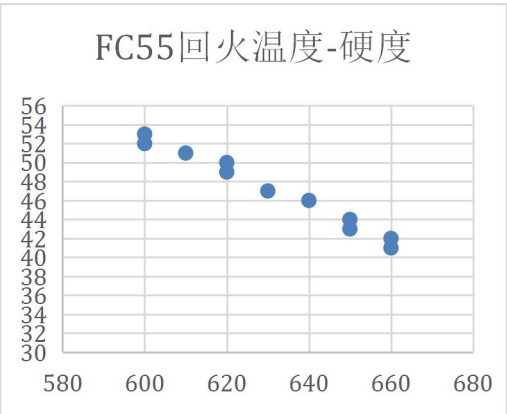

Figure2 Tempering curve of Fastcool 55 material.

4 Thermal fatigue resistance

When performing thermal fatigue test, Fastcool 55 material showed maximum crack length of 120µm whereas NADCA C category materials showed 500µm maximum crack length. Also, much less cracks are found with Fastcool55 material. Figure 3 shows the cracks distribution of Fastcool 55 material with maximum crack length of 120µm. By comparison NADCA C category material which has maximum thermal fatigue crack length of 500µm. The tests are conducted with a V notch specimen by induction heating up the samples to 600ºC with water spray cooling to room temperatures after 2400 cycles.

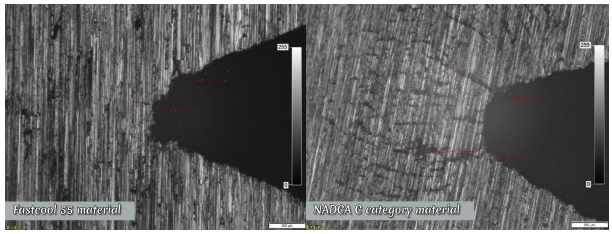

Figure 3 Thermal fatigue tests showed maximum crack length of 120 µm with Fastcool 55 material; and crack length of 500µm with NADCA C category materials.

5 Conclusion

1. Fastcool 55 material has high thermal conductivity、which over comes soldering problems in many die casting applications when used as die steels.
2. Fastcool 55 material has high tempering resistance which leads to better thermal fatigue resistance
3. Thermal fatigue tests demonstrates that Fastcool 55 material has more than 4 times of better thermal fatigue resistance than NADCA C category materials.
4. With many die casting applications when Fastcool 55 material is used the die casting cycle time is being reduced over 20%.
5. Fastcool 55 material yields longer tooling life in Al high pressure die casting.

Reference

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