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Effect of coating thickness on Melt Filling Rate of Cast Iron in Evaporative Pattern Casting Process

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The increment of a melt filling rate of cast iron on EPC process was investigated. The melt filling rate, the decomposition rate of a polystyrene formed pattern were measured during the casting experiment. A copper alloy was also cast in the same method for comparing with the case of cast iron. The melt filling rate of the cast iron was lower than that of the copper alloy. Liquefied resin was formed by thermal decomposition of the formed pattern. A volume of gas gap was increased with increasing melt temperature. The melt filling rate increased with increasing coating permeability, and more increased with increasing the coating thickness. Misrun tends to occur in the case of cast iron melt although the coating permeability increased. In the case of a thick coating, misrun was prevented.

Keywords: *Cast iron, Coatings, Evaporative pattern casting, Permeability, polystyrene.*

1. Introduction

Molten metal is filled into mold by exhausting thermal decomposition products through castings in evaporative pattern casting process. Coating permeability is important factor for melt filling [1, 2], and higher permeability is recommended because large amount of thermal decomposition gas forms during casting. Liquid products also form, and can penetrate into the coatings. The coating permeability may decrease by filling porous parts in the coatings with the liquid products. The coatings with large thickness are expected to absorb the liquid products for exhausting the liquid products from a gas gap [3], especially in aluminum alloy melt whose temperature is smaller than that of cast iron melt. However, there are few reports about influences of absorption of liquid products on filling of cast iron melt. Cast iron melt was poured into a polystyrene form coated with same permeability coatings whose thickness was changed even the coating permeability was same.

2. Experimental Procedures

The casting design of bottom pouring method was applied to avoid turbulence flow of molten metals. A density of the polystyrene foamed pattern was 15.4 kg m^{-3}. Dimension of a columnar pattern was 40 mm in outer diameter and 250 mm in height. Melt tough sensors and gas pressure ports were inserted into the pattern. The sensor points were set at 5mm, 65mm, 125mm, 185mm and 245mm form bottom of the pattern. For collecting the thermal decomposition products, the products were flowed from the gas gap to a sampling bin with PTFE tube inserted in the formed pattern at 245mm from bottom. The patterns were coated by coatings whose thickness was 0.25 mm and permeability was changed from 1.10 to 4.84. Coatings of 0.72 mm in thickness of 1.29 in permeability were also applied for understanding the influence of coating thickness on the melt filling. Cast iron melt (CE: 4.3) and Cu-25mass%Sn alloy melt were cast into the mold at 1473K and 1173K respectively.

3. Results and discussion

Figure 1 shows the relationship between elapsed time after pouring Cu-25%Sn alloy melt at 1173K and thermal decomposition distance and melt filling distance from bottom of pattern whose permeability is 3.71. The pattern decomposition and the melt filling progressed with elapsed time. The pattern decomposition and the melt filling were almost finished in 3 s and 9 s, respectively. Figure 2 shows the relationship between elapsed time after pouring cast iron melt at 1473K and thermal decomposition distance and melt filling distance from bottom of pattern whose permeability is 3.71. The progresses were similar to 1173K in melt temperature. However, rates of both the pattern decomposition and the melt filling were lower than those of 1173K even the melt temperature is 300 K higher than Cu-25%Sn alloy.

The cast iron melt was not filled to 250 mm and misrun occurred.

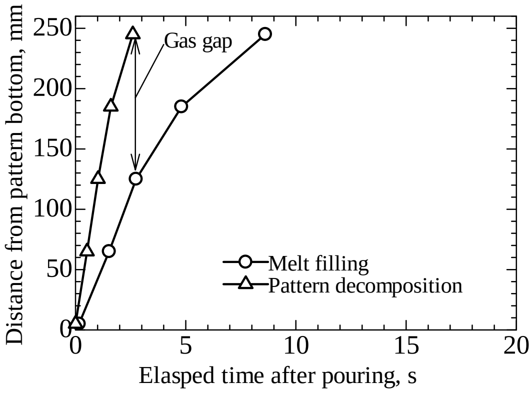

Fig. 1 Relationship between elapsed time after pouring Cu-25%Sn alloy melt at 1173K and thermal decomposition distance and melt filling distance from bottom of pattern whose permeability is 3.71.

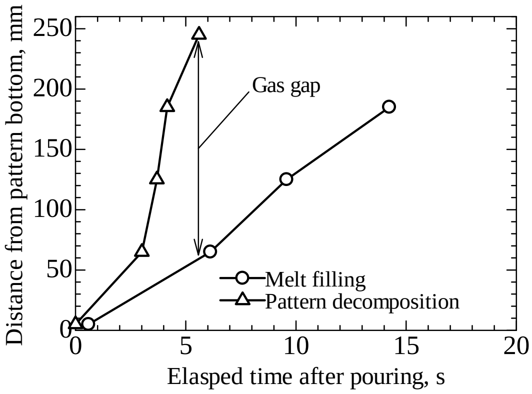

Fig. 2 Relationship between elapsed time after pouring cast iron melt at 1473K and thermal decomposition distance and melt filling distance from bottom of pattern whose permeability is 3.71.

The gas gap thickness in the case of 1473K was larger than that in the case of 1173 K. Large gas gap thickness means that rate of exhaust of thermal decomposition products is also large, and large melt filling rate is expected. However, the melt filling rate of the cast iron melt was considerably-slow. It is suggested that exhaust of thermal decomposition gas is inhibited from any cause. For understanding state in the gas gap, the thermal decomposition products in the gas gap during casting were collected. The collected products were gas, mist and liquefied resin. The amount of liquefied resin from cast iron melt was much larger than that from Cu-25%Sn alloy melt. In the case of the cast iron melt, it is considered that the liquefied resin penetrates into the coatings and clogging in the coatings occurs.

Figure 3 shows the influence of coating permeability and thickness on melt filling times of cast iron and Cu-25%Sn alloy. The melt filling times of both alloys decrease with increasing coating permeability and with increasing coating thickness. Also, misrun did not occur in the case of thicker coating thickness. Large permeability and thickness means large porosity volume in coatings. It is suggested that large porosity volume in coatings absorbs the liquefied resin formed by thermal decomposition and the clogging in the coatings is prevented.

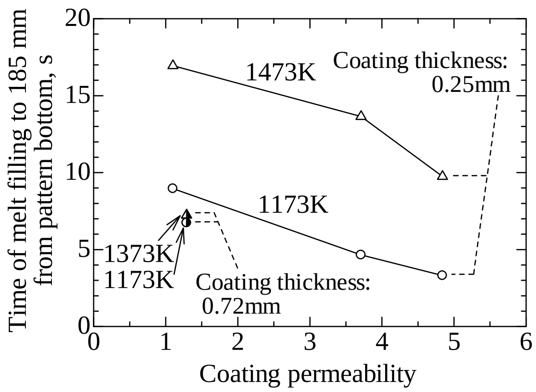

Fig. 3 Influence of coating permeability and thickness on melt filling.

4. Conclusions

The melt filling rates of cast iron and copper alloy were measured in changing coating permeability and thickness. The following results and conclusions were obtained:

(1) In cast iron melt at 1473 K, thermal decomposition rate and melt filling rate are smaller than those in Cu-25%Sn alloy melt at 1173 K.

(2) The larger permeability and thickness of coatings increases, the larger melt filling rate increases.

References

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