8nd International Conference on Physical and Numerical Simulation of Materials Processing, ICPNS'16
Seattle Marriott Waterfront, Seattle, Washington, USA, October 14-17, 2016

Physical Simulation of the Effect of Mechanical Vibration on Feeding Flow during Solidification of Paste Alloy

Wu Shiping[1], Chen Wei[1], Wang Rujia[1], Li Kunquan[1]

[1] The material science and Engineering in Harbin Institute of Technology
Harbin, 150001, China

ABSTRACT

In this paper, the physical simulation of the effect of mechanical vibration on feeding flow during solidification of paste alloy was finished. Using microcrystalline wax as simulated metal fluid, applying different particle size of sand instead of the loose skeleton of paste alloy during solidification, the effects of vibration frequency, amplitude and vibration direction on the feeding flow of the paste alloy during solidification were obtained. The research shows that the distance of feeding flow increase with the increase of vibration frequency and amplitude, when the resonance frequency is achieved, the distance of feeding flow is the farthest. When vibration direction and feeding flow are in the same direction, the feeding flow can obtain the maximum distance.

Keywords: Physical Simulation, Mechanical Vibration, Feeding Flow, Solidification, Paste Alloy

1. INTRODUCTION

A lot of researches on the influence of vibration to the solidification of metal, but the research mainly focused on the effect of vibration on the solidification microstructure and grain refinement, few in-depth study on the effect of vibration to casting feeding. Although the application of vibration to get through the obstruction has been widely used, the use of vibration to clear the obstruction of solidification process is little. The main reason is that the mechanism of vibration promotion feeding is not very clear in the medium with temperature gradient and structure changing. Relevant theoretical and experimental research is urgently needed. In this paper, a simplified experimental model is used to study the effect of vibration on the solidification and shrinkage of the medium with a temperature gradient.

2. EXPERIMENT

As shown in Figure 1, in order to form a one-dimensional solidification shrinkage process, we use the insulation material in the upper part of the mold to carry out heat preservation, using recycled water in the lower part of the mold to carry out cooling. The mould is connected with the vibration platform through the bolt. The vibration source is the warehouse wall vibration motor. We can control the amplitude and frequency of the platform by adjusting the voltage and frequency, by adjusting the installation position of the motor, to change the direction of vibration. Sand was used to build the loose skeleton and paraffin as the liquid metal filled in the backbone. Through the depth of liquid paraffin in the sand as the evaluation function of solidification feeding. In the experiment, the mesh number of sand is 18-24; the preheating temperature of sand and mold is 80℃; the casting temperature of wax is 80℃; the temperature of circulating water is 20℃, and rate is 2L / min.

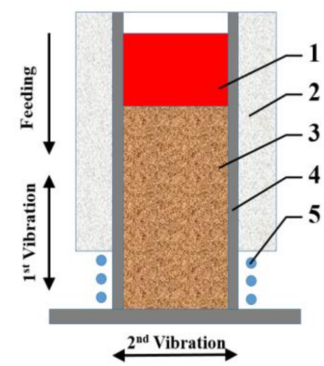

Figure 1 *Schematic diagram of experimental set-up.*

1-microcrystalline wax 2- insulation asbestos 3-sand 4-mold
5- cooling circulation water

3. RESULTS

3.1 Effect of vibration direction

The vibration, which is the first vibration mode, and the flow direction of paraffin, which is the same as the flow direction of paraffin, is applied in seepage experiment. The frequency of vibration motor is 40Hz, the voltage is 120V, and the amplitude of the source is 0.209mm. When the vibration is applied in the horizontal direction, the metal guide rod is used in the mould. In Figure 2, we can see that there is a significant increase in the depth of seepage after vibration, and the promoting effect of the vibration on the seepage is more obvious when the direction of the vibration is consistent with the direction of seepage.

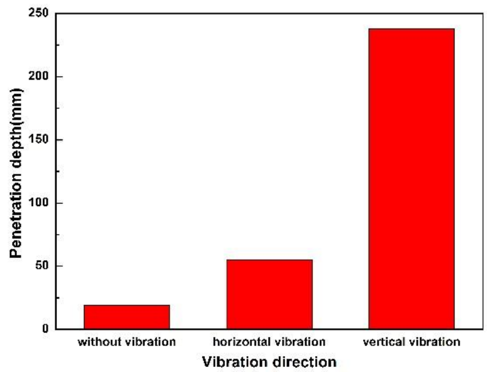

Figure 2 *Effect of vibration direction on seepage depth.*

3.2 Effect of vibration frequency

When the first vibration mode is used, only the frequency of the vibration is changed, the relationship between the depth of penetration and the frequency is measured. From Figure 3, we can know that the penetration depth increases with the increase of the frequency, when the frequency reaches the level of the first order resonance frequency of the platform, the depth of the seepage gains the maximum value. Therefore, the best frequency to promote the flow of the percolation is the resonance frequency

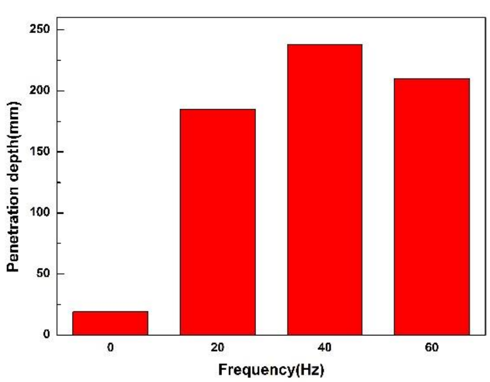

Figure 3 *Effect of vibration frequency on seepage depth.*

3.3 Effect of vibration amplitude

When the second vibration mode is used, only the amplitude of the vibration is changed, the relationship between the depth of penetration and the amplitude is measured. It can be known from Figure 4 that the depth of penetration increases with the increase of the amplitude of vibration.

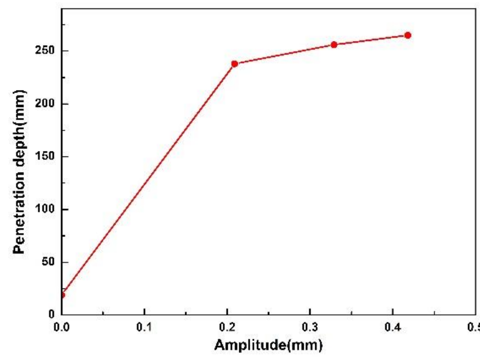

Figure 4 *Effect of vibration amplitude on seepage depth.*

4. CONCLUSIONS

This paper explores the effect of vibration on the percolation of the paste solidified alloy. When the wax poured into the sand skeleton with a temperature gradient, the front wax curdled firstly, the viscosity increased, and the fluidity decreased. After applying vibration, due to the shear force, the viscosity of wax decreased, the further flow of paraffin got much more easily. At the same time, the block can be broken up by the vibration, which makes the high temperature wax of the upper layer can penetrate again. The following conclusions can be obtained:

(1) Vibration can promote the flow of viscous fluid, and the effect is more obvious when the vibration direction is consistent with the flow direction;

(2) With the increase of the vibration frequency, the promoting effect to viscous fluid flow is more obvious, when the vibration frequency is the natural frequency of the platform, the promotion is the strongest;

(3) With the increase of the vibration amplitude, the promotion effect of the vibration on the viscous fluid flow is more obvious.

ACKNOWLEDGEMENT

This work was supported by the National Natural Science Foundation of China (No. 51475120)

REFERENCES

Eskin, G. I., & Eskin, D. G. (2014). *Ultrasonic treatment of light alloy melts*. CRC Press.

Chun, L. (2006). Research and Application of Hydraulic Vibration for Oil Layer Treatment [J]. *Petroleum Geology & Oilfield Development in Daqing*, 2, 022.