NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATION IN ENGINEERING, RESEARCH AND TECHNOLOGY [IJIERT]
NATIONAL CONFERENCE ON INNOVATIVE TRENDS IN ENGINEERING & TECHNOLOGY-2016
11TH & 12TH MARCH 2016
CONFERENCE PROCEEDINGS ISSN NO - 2394-3696

Paper ID: NITETMECH06

EFFECT OF MOULD VIBRATION ON MICROSTRUCTURE AND MECHANICAL PROPERTIES OF CASTING DURING SOLIDIFICATION - A REVIEW.

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ABSTRACT

In order to achieve better performance from alloy, manufactures may alter the alloy composition or the manufacturing process. The alterations can be done by composition or the manufacturing process. The alteration can be done by means off addition of alloying elements, by means of changes to the component design, or by means of changing the processing parameters. In the present work, a review on the work carried out on the effect of mold vibrations on the microstructure and mechanical properties of casting i.e of aluminum alloy during solidification is presented.

KEYWORDS: aluminum alloy, vibration, mould, casting

INTRODUCTION

The mechanical properties of fine and non dendritic grain structure of casting are superior to the dendritic and coarse cast structure. The non dendritic structure is obtained by rheo casting and thixo casting [1-3]. In this process grain becomes globular leads to increase in strength as well as ductility. It means toughness of globular grains will be higher than the dendritic structure. Application of mechanical vibration during solidification of melt is one of the techniques of grain refinements. This is simpler than any semisolid processing like rheo casting and thixo casting. There are number of methods for producing vibration, like electromagnetic vibration, ultrasonic vibration and mechanical vibration, however, mechanical vibration is easy to produce and control over it. A number of researchers investigated the effect of electromagnetic vibration and ultrasonic vibration on the microstructure of castings [4,5]. However, mechanical vibration is easier and economical than ultrasonic and electromagnetic methods for production of castings. By mechanical vibration during solidification, dendritic structure gets break into very fine cellular structure. Abu-Dheir et al. studied the modification of Si in Al-Si alloy for a constant mechanical mould vibration at a frequency of 100 Hz and variable amplitudes [9]. However, he has not focused on the variation of frequency of vibration. Olufemi and Ademola studied the effects of mechanical vibration on the mechanical properties of Mg-Al-Zn alloy, however he has not investigated microstructure changes due to mechanical vibration. Sayuti et al., reported variation of tensile strength with respect to the frequency of vibration, but he has covered a very narrow range of frequencies viz. 10.2, 12 and 14 Hz. Campbell observed improvement in corrosion resistance along with mechanical properties of alloys too.

LITERATURE REVIEW

Toshio Haga, P. Kapranos [1] in their work describes two recently invented simple rheo casting processes. One process used a cooling slope and the other low super heat casting in order to generate semisolid slurries with spheroidal microstructures that are amenable to thixo forming. In the former process, A356aluminum alloy was poured into the lower part of a die and immediately an upper die, containing an internal cavity, was inserted in the lower die half. The A356 alloy when in semisolid slurry form, it flows into the lower die via a cooling slope. In the latter process, the A356changed from fully liquid to semisolid slurry condition by cooling in the lower die half after being poured into it as low superheat casting. The primary crystals of the cast metal in the both processes became spheroidal. There was no major observable difference between conventional thixo casting microstructures and those of the two processes used in the present study. The mechanical properties obtained in the present study were: tensile strengths of 310 MPa and 18% elongation for the process using the cooling slope, and tensile strengths of 290 MPa and 12%elongation for the process using the low superheat casting.

In mass production of thixo die casting, there are many disadvantages such as high raw material cost, billet reheating cost, non-destructive control cost, the difficulty of scrap recycling and billet loss during reheating process. On the contrary, in rheo die casting, on-demand slurry like not only cast alloy but also structural alloy can be used and the recycling of scrap is comparatively easy. However, metal composition may be varied and treatment of liquid metal is difficult. Two processes have been adapted to the production of automobile suspension parts. In order to investigate advantages of rheo and thixo die casting process, both processes were compared with optimal process parameters. Microstructure by image analysis and the mechanical properties of produced automobile suspension part are compared between thixo and rheo die casting process. Particularly, the effect of injection conditions on liquid segregation has been investigated for thixo and rheo die casting. The interrelation of microstructure, injection condition and mechanical properties was discussed [2]

The experimental and analytical approaches were taken to investigate the non-dendritic microstructure formation and evolution of AlSi9Cu3 alloy during rheo casting. The results show that the globular primary α(Al) particles free of entrapped eutectic form after rheo casting for 3 s, and could be morphologically stabilized during subsequent growth. The fine and globular particles underwent a coarsening process under quiescently continuous cooling in which the particle density decreases, the solid fraction increases, the average particle size increases with the increase of solidification time at a rate that closely followed the classical Ostwald ripening.[3]

The eutectic silicon in A356 alloy can be refined and modified using either chemical, quench, or superheating modification. We observed, for the first time, that the eutectic silicon can also be significantly refined using high-intensity ultrasonic vibration. Rosette-like eutectic silicon is formed during solidification of specimen treated with high-intensity ultrasonic vibration. [4]

It is well known that ultrasonic melt treatment (UST) provides many benefits to casting processing, especially for the refinement or modification of as-cast structure. There is a lack for systematic studies on Al-Si alloys, although a number of reports are available on hypo-eutectic A356-type and hyper-eutectic (18-24 wt% Si) alloys, showing primary Al or Si refinement. In this paper, the effect of UST on the formation of microstructure was systematically analyzed in hypo-eutectic, near-eutectic and hypereutectic Al-Si alloys, including commercial piston alloys. The results show that UST usually results in the refinement of grains and primary Si particles when it is applied in a proper temperature range, while ultrasonic treatment during the whole solidification processing leads to coarsening effect on eutectic Si phase or primary Si particles.[5]

X. Jianin their investigation attempted to evaluate the effect of ultrasonic vibration on the nucleation and growth of aluminum alloy A356 melt. A356 melt was treated at various solid fractions isothermally with ultrasonic vibrations by dipping the acoustic radiator into the melt. Experimental result confirmed that globular grains could be effectively obtained when the melt was ultrasonically treated at the temperature close to its liquidus and subsequently cooled quickly. It further illustrated the difficulty to form globular grains when the specimens were treated at isothermal temperatures in the mushy zone. It may imply that in the given experiments cavitations-induced heterogeneous nucleation plays a more important role than dendrite fragmentation in the formation of globular grains. [6]

Vardhaman S Mudakappanavar in their work, mold containing the solidifying melt is subjected to mechanical vibration which is considered as one of the process parameters. Other parameters considered were mold material and pouring temperature. Factorial design of experiment technique was used to conduct the experiments. It was observed that inducing vibration to the mold containing molten metal resulted in fragmentation of silicon needles thereby improving the hardness and wear properties of the alloy. [7]

The effect of controlled mechanical vibration of the mold during alloy solidification on the dendrite coherency point, the hot tearing tendency, and the microstructure of aluminum casting alloys was evaluated. [8]

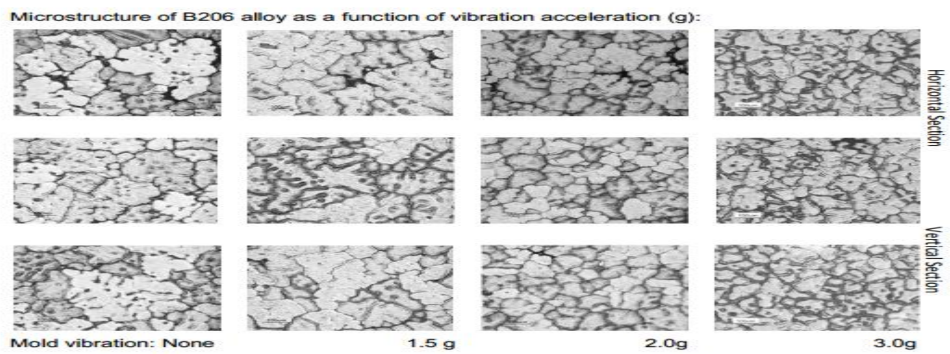

Figure:- The microstructure of aluminum casting alloys

The effect of mould vibration during solidification of Al-Cu alloys was investigated to understand the modification in microstructure and mechanical properties of casting. The casting was done in a graphite mould. Frequencies were varied from 40 to 150 Hz. A casting was also was also made without vibration to compare the results of castings with vibration. The experimental results showed significantly grain refinement and remarkably improvement in hardness of castings with mechanical mould vibration during solidification.[9]

CONCLUSION

The vibration causes grain refinement and non-dendritic structure. The refinement of grain size increases with the increase in frequency of vibration. Thus there is need of study to be carried to know the effect of vibration on the mould for the different metals and their alloys.

REFERENCE

1. Toshio Haga, P. Kapranos, Simple rheocasting processes, Journal of Materials Processint Technology 130–131 (2002) 594–598
2. P.K. Seo, D.U. Kim, C.G. Kang, The characteristics of grain size controlled microstructure and mechanical properties of Al-Si alloy by thixocasting and rheocasting process, Volumes 162–163, 15 May 2005, Pages 570–578
3. GUO Hong-min, LIU Xu-bo, YANG Xiang-jie, ZHANG Ai-sheng, LIU Yong, Microstructure evolution behavior of AlSi9Cu3 alloy during rheocasting, Trans. Nonferrous Met. Soc. China 20(2010) s815-s820
4. X. Jian a,T.T. Meek, Q. Han Refinement of eutectic silicon phase of aluminum A356 alloy using high-intensity ultrasonic vibration, Scripta Materialia 54 (2006) 893–896
5. L. Zhang, D.G. Eskin, A. Miroux1,2 and L. Katgerman, Formation Of Microstructure in Al-Si Alloys Under Ultrasonic Melt Treatment, TMS (The Minerals, Metals & Materials Society), 2012
6. X. Jian, H. Xu, T.T. Meek, Q. Han, Effect of power ultrasound on solidification of aluminum A356 alloy, Volume 59, Issues 2–3, February 2005, Pages 190–193]
7. Vardhaman S Mudakappanavar, H M Nanjundaswamy, Modification of Eutectic Silicon Under The Influence Of Mold Vibration During Solidification Of LM6 AlloyCasting Casting Castings., International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 4, Aug-Sept, 2013
8. http://www.wpi.edu/Images/CMS/MPIACRC/Vibrations_with_Sizzle_Fact_Sheet.pdf
9. Amitesh Kumar, Rahul Kumar, Md. Salim Ansari, Sudhansu Sekhar Mishra, Effect of Mould Vibration on Microstructure and Mechanical Properties of Casting During Solidification, International Journal of Engineering Research and technology Vol. 3 – Issue 4 (April-2014) .