Effect of Thermal Gradient on the Shrinkage of Aluminum Bearing Cap by Computer Simulation

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ABSTRACT

This study was aimed at the effect of thermal gradient on the shrinkage defect of A356 aluminum alloys bearing cap casting by the computer simulation analysis. Since there was little study on the computer-aided simulation for the vehicle components cast by aluminum alloy, this study conducted especially on this topic including the effect of the thermal gradient change, the three different gating and riser systems design on the shrinkage of bearing cap. The bearing cap possesses complex geometry and curvilinear surface. The A356 aluminum alloy is lightweight for casting bearing cap and replace the cast iron in many vehicle components. This study used computer-aided simulation analysis software AFSolid System to investigate the effects of gating and riser systems, thermal gradient on the shrinkage of A356 aluminum alloy bearing cap cast by sand mold. The results show that a gating system with a gating ratio of 1:4:4 reveals a more smooth flow of molten aluminum melt, the phenomenon of turbulent flow and envelopment of gas can not occur any more. As for the riser systems design, in addition to locating two larger risers(D = 50mm) at the two thicker ends of bearing cap, for the sake of complete feeding the shrinkage of bearing cap, there must be another riser(D = 40mm) located at top of bearing cap. For different gating system designs, the thermal gradient change of the A356 aluminum alloy bearing cap is very small, but for different riser system designs with larger dimension difference, there exists a very large change on the thermal gradient change of the A356 aluminum alloy bearing cap. At the same time, this study also verifies using the thermal gradient criteria by computer-aided simulation analysis to predict and feeding the solidification shrinkage defects of A356 aluminum alloy vehicle castings is extremely feasible.

Keywords : A356 aluminum alloy ; Bearing cap ; Computer-aided simulation ; Shrinkage ; Thermal gradient

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REFERENCES

[1] Geoffrey Davies, “ Materials for Automobile Bodies, Butterworth -Heinemann, (2004).

[2] 樊翔雲，凝固冷卻條件對A356鋁合金之顯微組織與機械性質之影響，國立台灣大學材料工程學研究所碩士論文，中華民國78年。

[3] 余聲均，微量元素添加對A356鋁合金機械性質之影響，國立中央大學機械工程研究所碩士論文，中華民國85年。

[4] 胡瑞峰，鋁-矽(鎂)系合金及鋁-矽-銅系合金流動性之研究，國立台灣大學機械工程研究所博士論文，中華民國86年。

[5] J. B. Andrews and M. V. C. Seneviratne, “ A New, Highly Aluminum-Silicon Casting Alloy For Automotive Engine Block Applications ”, AFS. Trans., Vol.97, (1989), PP. 209 – 212.

[6] Metals Handbook Tenth Ed., “ Aluminum Foundry Products ”, ASM Vol.2, (1999), P. 123.

[7] C. Jordan, J. L. Hill and T. S. Piwonka, “ Compute Designed Gating System: Promises and Problems ”, AFS Transaction, Vol.96, (1988), PP. 603 – 610.

[8] 楊惠春教授編著，鑄造學，五洲出版社，中華民國七十三年四月。

[9] R. W. Heine, C. R. Loper Jr. and P. C. Rosenthal, Principles of Metal Casting, (1965), P. 101.
[10] K. Grube and L. W. Eastwood, "A Study of the Principles of Gating", AFS Transactions, Vol.58, (1950), PP.76 – 107.
[11] 謝世俊，鑄件的澆口系統與冒口，中華民國五十二年，PP. 337 – 357.
[12] Campbell, J., Feeding Mechanisms in Castings, AFS Cast Metals Research Journal, (1969), P. 1.
[13] Piwonks, T.S. and Flemings, M.C.,“ Pore Formation in Solidification ”, Transaction AIME, (1966), PP. 1157 – 1164.
[14] M. F. Spotts,“ Design of Machine Elements ”, 滄海書局, 中華民國八十八年八月, PP.619 – 620.
[15] L. Lasa, J.M. and Rodriguez-Ibabe,“ Characterization of the Dissolution of the Al2Cu Phase in two Al – Si – Cu – Mg Casting Alloys Using Calorimetry ”, Materials Characterization 48, (2002) , PP. 371 – 378.
[16] 魏伯州，過共晶Al-Si合金之快速凝固組織研究，國立中興大學碩士論文，中華民國九十二年。
[17] 金屬鑄造原理，工業技術研究院金屬工業研究所譯，中華民國鑄造學會編印，中華民國六十九年十月。
[18] 陳向詠，CAE應用於高品質?喃樹脂模灰鑄鐵件冒口設計之研究，逢甲大學機械工程研究所碩士論文，中華民國九十二年六月。
[19] E. T. Myskowsi, H. F. Bishop and W. S. Pellini:Am. Foundrymen ’s Soc. Trans. Vol.61, (1953), PP. 302 – 308.
[20] J. F. Wallace and E. B. Evans, Gating of Gray Iron Casting, AFS Transactions, Vol.65, (1957), P. 267.
[21] Len Estrin, A Deeper Look at Casting Solidification Software, Modern Casting, Vol. 114, (1994), PP. 20 – 23.
[22] 林惠娟、黃振東和鄭憲清，鑄造程式之電腦模擬-ProCAST應用實例介紹，鑄工77期，中華民國八十五年二月，PP. 20 – 48。
[23] R. Wlodawer著，鑄鋼件凝固原理及澆冒口設計，中華民國鑄造學會編，中華民國六十五年。
[24] SOLIDCast Handbook, Finite Solutions Inc., (2002).
[25] Finite Solutions, SOLIDCast Training Course Workbook (Version 6.1.3), Finite Solutions Inc., (2002), P. 13-2.
[26] Pellini, W. S.,“ Factors which Determine Riser Adequacy and Feeding Range, ” AFS Transactions, Vol. 61, (1953), PP. 61 – 80.