Die Casting Technology Develops Steadily

— A Commentary on the 5th China International Die Casting Congress

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The 5th China International Die Casting Congress & Exhibition, sponsored by the Chinese Mechanical Engineering Society (CMES) and the China Productivity Promotion Center of Machinery Industry, and organized by the Foundry Institution of Chinese Mechanical Engineering Society (FICMES), Shenyang University of Technology and Foundry Journal Agency, was held in Shanghai, China, from June 28 to July 1, 2006. There are 44 academic papers included in the proceedings of the congress, which were chosen from a large number of papers submitted, reflecting the development of China's die casting industry in the last two years.

1. Development of the Die Casting Industry

The globalization of the world economy, demand for light weight castings for automobile parts, and the sustainable development of our country's economy all promote the die casting industry to transfer gradually from the developed development of our country's economy all promote the die casting industry to transfer gradually from the developed countries to the developing countries such as China. The output of die castings in China in 2005 exceeded 40 million RMB, growing 10.9% compared with last year.

The diversity of die casting castings of varieties of nonferrous alloys in 2005 and their share in the total output. The diversification of die casting development in China was discussed in detail covering six areas of die casting development - production of aluminum alloy cylinder blocks for automobile engines, production of aluminum alloy hubs and pistons, the continued increase in output and sale of motorcycles, the large market for automobile parts, real estate promoting the rapid development of the hardware industry, and the output of die castings of magnesium alloy growing 20% annually. Finally, the problems the die casting operations facing in China were pointed out.

Mr. TANG Yu-lin, of the Productivity Promotion Center of Foundry Industry of China, analyzed the development trends of the die casting industry in China in his paper Making Light-
In recent years, the number of die-casting enterprises and science & research organizations engaging in magnesium alloy production has increased rapidly from the original few to nearly a hundred. Considering the availability of magnesium resource in our country, it is hopeful that this research development might become industrial reality.

The paper *Study on Interfacial Heat Transfer Coefficient between Metal/Die Interface of High Pressure Die Casting Process of AZ91D Alloy* presented by GUO Zhi-peng and XIONG Shou-mei of the Key Lab. for Advanced Manufacturing by Materials Processing Technology, Department of Mechanical Engineering, Tsinghua University, won the silver award of the ‘Wanfeng’ Cup for excellent foundry papers. In the paper the temperature profiles inside the die were measured based on high pressure die-casting experiments using AZ91D magnesium alloy. Using a computer program based on solving the inverse heat problem, the metal/die interfacial heat transfer coefficient (IHTC) was calculated and studied. The results indicated that the IHTC between metal and die increases right after the liquid metal is brought into the cavity by the plunger and decreases as the solidification process of the liquid metal proceeds until the liquid metal solidifies completely, when the IHTC tends to be stable. The interfacial heat transfer coefficient shows different characteristics under different casting wall thickness and varies with the change of solidification behavior. This will have a directive function to theoretical investigation for the solidification processes of die castings.

High vacuum die-casting is a valuable method for the reduction of gas porosities of the die castings and removal of air, gas and lubricant vapor from die cavity. Ryobi Limited has developed the high quality die-casting technology to mass-production of the front sub-frame. This has achieved a 40 % weight reduction for the front sub-frame in comparison with the ordinary stamped steel products. At the congress, Mr. Mamoru Murakami, of the Research and Development Division, Ryobi Limited, Japan, introduced in detail the high quality die-casting technology. This technique has been used for the large automobile safety die-casting parts requiring high quality.

Mr. LONG Si-yuan of Chongqi Shuolong Science and Technology Co. Ltd., introduced advanced melting and pouring furnaces for magnesium alloys all over the world, and described the effect of the characteristics of magnesium alloy melting furnaces on its operation, melt quality, and production cost. A comparison of the national and foreign furnaces was made in technique, function, material, and economy. The results show that the gap between our country and developed countries for magnesium alloy melting furnaces is being narrowed. Some techniques at home have reached the international advanced level. This shows that the technology in China has made a great progress.

In the paper *Discussion on Thixocasting Processing of Magnesium Alloys* presented by Prof. YAN Feng-yun, of the Key Lab. for Non-ferrous Metal Alloys, Ministry of Education, Lanzhou University of Technology, the process and technological parameters for thixocasting of magnesium alloys were analyzed in detail by comparison with traditional die-casting technology. Combined with unique features of die-casting machinery, some valuable technological parameters for thixocasting of magnesium alloys were given to offer reference for researchers.

**4. Progress of Squeeze Casting Technology**

Attention is still being paid to squeeze casting technology. The paper *Study on Bubbling in Heat Treatment Process of Squeeze Casting* presented by Mr. QI Pi-xiang, of Ningbo Sub-academy of the National Weapons Science Research Academy, won the silver award of the ‘Wanfeng’ Cup for excellent foundry papers. In the paper, the author pointed out that bubbling is one of the common defects in the heat treatment process of squeeze casting, and it has relationships with squeeze mode, technique, mould, etc. Therefore, for direct squeeze-casting parts, solution heat treatment can be performed smoothly as
long as oil-based paint is not used and air exhaust is well arranged; for indirect squeeze casting parts, solution heat treatment can also be applied when additional factors are taken into consideration, including well designed internal feeding system and strictly controlled liquid metal filling velocity to prevent from inclusions.

The paper *Influence of Squeeze Casting Parameters on Microstructure and Mechanical Properties of Plunger Type ZA27 Alloy Castings with High Ratio of Height to Thickness*, which was presented by Prof. LI Rong-de of Shenyang University of Technology, won the gold award of the ‘Wanfeng’ Cup for excellent foundry papers. In the paper, the fundamental problem of plunger type squeeze casting of ZA27 alloy, with high ratio of height to thickness (M=H/D=7), was investigated. The influence of the squeeze casting parameters on the mechanical properties and microstructure of the ZA27 alloy was analyzed. The plunger type squeeze casting parameters best suited for ZA27 alloy, with high ratio of height to thickness, were preliminary decided. Squeeze casting improves the mechanical properties of ZA27 alloy and offers important maintenance logistics for developing the applied range of ZA27 alloys.

In addition, *Continuous Squeeze Casting Process By Mass Production* by Mr. YUN Xia, of SPX Contech, USA, and *Latest Development of Fabrication Technique for Ultra-Fine Grained Mg alloys* by CHEN Yong-jun, of Light Alloy Net Forming National Engineering Research Center, Shanghai Jiaotong University, both have great influence.

5. Application of Computer Simulation Technology in Die Casting

In the last two years, domestic computer simulation technology has been developed rapidly, especially for some simulation softwares now commercially available. At present, more and more enterprises are using it in the R & D of products. So the theme of computer application in the congress is still an important topic for discussion.

In the paper *Application of KBE in HPDC Optimization* by Prof. WANG Guo-xiang, of Shanghai Jiaotong University, on constructing the framework for the application of KBE in high pressure die casting process and die design, the author created the rules database, based on the rule-based reasoning technology. It is beneficial to shorten the development period of new high quality products.

In the paper *Application of Numerical Simulation Technology in Die Casting Process* by Prof. LIAO Dun-ming, of the College of Materials Science & Engineering, Huazhong University Science and Technology, the author introduced the main contents of numerical simulation of die casting process and some applications of InteCast CAE Software in die casting die design; and described its function in improving the rationality and accuracy of structure for die casting dies.

In the paper *Numerical Simulation on the Temperature Field of Magnesium Alloy Die Casting Dies* by Prof. YU Bao-yi, of Shenyang University of Technology, the effects of the die casting process, the variation of temperature field, and the type of cooling on magnesium alloy automotive mantle were calculated and analyzed by using Z-cast software. Based on the results, reasonable process parameters and type of cooling were pointed out for improving the service life of dies used for magnesium alloy automotive mantle.

In addition, the papers *Application of CASTsoft in Low Pressure Casting Process* by ZHANG Zheng, of the Casting Engineering Centre, North University of China, and *Optimization of Injection Velocity for an AM60 Die - Cast Dynamotor Support* by ZHANG Yan, of Shenyang University of Technology, also made a hit.

6. Summary

We can see from this congress that although the research on die casting technology and equipment in our country has made a great progress and the die casting operation level has been enhanced remarkably, the gap is still large compared with developed countries, especially in die casting equipment. Therefore, the authors think that the future further research and application on die casting technology in our country should be conducted on several aspects as follows:

1. Because of the tremendous contribution of advanced die casting equipment to die casting operations, the investment in the development of die casting machines, melting equipment, and other auxiliary devices should be increased. Replacements and technical innovations should be made to increase the manufacturing level of die casting equipment in our country.

2. Since computer simulation and emulation technology has gradually matured, enterprises should pay greater attention to and make full use of such advantages of the technology in the development of products and process design. Shortening the period of design and development for products, optimizing processes, etc., will increase the productivity, reduce the costs of production, and enhance market competition.

3. The automobile industry in our country is being rapidly developed and the technology level of die casting aluminum alloys for automobile parts has been increased. Therefore, the development of complete of die casting technology, especially for aluminum alloys with thin wall, complex shape, and high-level properties, should be strengthened.

4. In recent years, magnesium alloy and its die casting technology have been developed quickly, and the technology level has also been increased markedly, but the potential for further development of magnesium alloy is still large, especially for automobile parts. Therefore, its development should be carried through in detailed depth to extend the scope of application of magnesium alloy and to improve its properties.

5. Fundamental research on squeeze casting and semi-solid forming technology has made a great progress, but is still at an early stage. Therefore, future research work should focus on the development of related products and advanced equipment to allow the advanced technology to be applied as soon as possible.