Advances In ENGINEERING

Innovative solution for degassing aluminum melts in industry

Aluminum alloys are attractive for a number of applications due to their high specific strength, and therefore developing efficient processing technologies is a major goal for materials engineers. Casting is one of the many stages of the manufacturing of aluminum alloy products and it involves the handling and pouring of molten metal into shape molds. However, the presence of porosity in most castings presents a challenge considering its detrimental effects on the post-processing steps and the final mechanical performance of the aluminum products. Porosity is formed during the solidification stage and is often difficult to remove once formed. Thus, it is important to eliminate or at least reduce the causes of porosity before casting to increase weld quality and produce high-quality casting products. Two main factors determining the quality of aluminum melts are dissolved hydrogen and oxide bi-films with poor wettability, both due to the reaction of the liquid aluminum surface with the ambient moisture. Therefore, removing hydrogen and bi-films before casting, i.e. degassing, is a crucial step in ensuring high melt quality and reducing the formation of porosity during solidification.

Among the available molten aluminum degassing methods, the industry uses rotary degassing due to its simplicity and improved performance compared to other available methods. For this method, the degassing efficiency is dependent on the effective size reduction and distribution of the gas bubbles inside the molten metal. However, strategies for improving the degassing efficiency in conventional rotary degassing are still not well understood. For example, while increasing rotor speed could reduce the size of bubbles and accelerate the removal of hydrogen, higher speeds can cause vortex and surface turbulence leading to reabsorption of new oxides and hydrogen. The increase of gas flow rate that could solve such problems is also limited in terms of efficiency. Additionally, redesigning the rotary impeller with the assistance of computer modeling, which has been deemed as a promising approach for process optimizing, has proved to be inadequate for achieving full degassing efficiency.

To this note, Dr. Jaime Lazaro-Nebreda, Dr. Jayesh Patel and Professor Zhongyun Fan from Brunel Centre for Advanced Solidification Technology (BCAST), at Brunel University London (UK), have developed an innovative melt conditioning technology that can help industry to significantly increase the degassing efficiency of aluminum melts in comparison with current rotary degassing units.

The technology is based on advanced high shear melt conditioning (HSMC) and consist of a rotor-stator configuration with a controlled gas injection, which allows the rotor speed to be increased without vortex generation and at the same time a more effective dispersion of bubbles and oxide bi-films in the molten metal. The processing parameters, in terms of rotor speed and gas flow rate have been optimized by water modeling under controlled representative conditions for later testing on a A356 aluminum alloy melt. The castings obtained with the HSMC degassed melt have been examined for microstructural defects and also for mechanical properties performance. The process efficiency has been compared to that obtained with conventional degassing methods. The outcome of this work is published in the *Journal of Materials Processing Technology.*

Compared to the conventional techniques, the present technology is much faster in removing oxide bi-films and hydrogen that causes porosity without generating vortex or surface turbulences because it can operate at much higher speeds. In addition, very low gas flow rates are required to achieve effective bubble dispersion, which is of great benefit in improving process efficiency and reducing processing costs.

The resulting melts exhibit high quality for long after processing. Unlike rotary degassing, aluminum melts processed by HSMC degassing do not require covering fluxes. Furthermore, the resulting castings have less defects, low porosity levels and significantly improved mechanical properties.

In summary, the possibility of improving degassing efficiency and mechanical properties of aluminum alloys castings via innovative HSMC degassing technology has been successfully validated in this study. Overall, HSMC degassing technology outperformed the conventional degassing methods like rotary degassing in terms of efficiency, cost implications, weld quality, and mechanical properties of the resulting castings were significantly improved. This makes HSMC degassing and an excellent alternative for improving melt quality and casting productivity in different industries. The authors, in a statement to *Advances in Engineering*, said that the new technology can be easily implemented in the industry by replacing the existing rotary impeller design with minimal impact on the casting process operations.

Reference

Lazaro-Nebreda, J., Patel, J., & Fan, Z. (2021). **Improved degassing efficiency and mechanical properties of A356 aluminium alloy castings by high shear melt conditioning (HSMC) technology**. *Journal of Materials Processing Technology*, *294*, 117146.