De-ironing of aluminium scrap by high shear melt conditioning technology

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Manufacturing primary aluminium ingots requires 20 times more energy and produces 4 times more CO_2 emissions than obtaining ingots from remelted scrap and so aluminium recycling is necessary for a sustainable future.

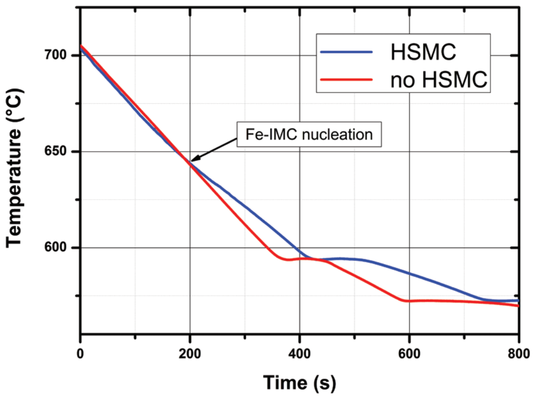

FIGURE 1. Cooling curve of A380-1Fe alloy before and after applying high shear melt conditioning (HSMC) at 700 °C showing the enhanced nucleation of the Fe-rich phase.

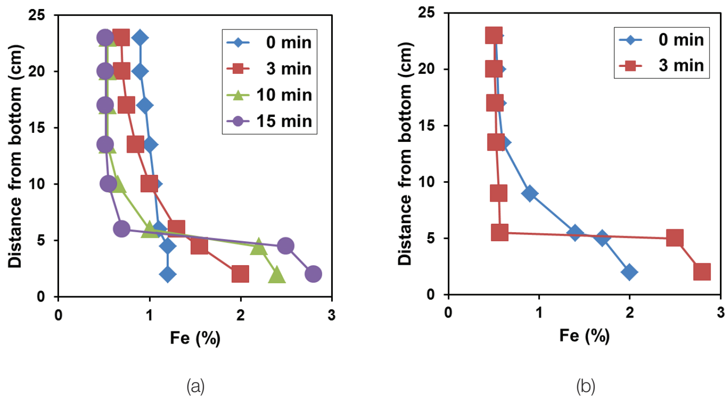

FIGURE 2. Sedimentation of Fe-rich phase in A380-1Fe alloy after cooling and holding at 600 °C for different times (a) without melt treatment (b) after HSMC.

However, one of the main problems of aluminium recycling is the gradual accumulation of impurities in the molten scrap, in particular iron, due to the presence of high iron containing components (rivets, screws, nuts…) or from the steel tools used during casting processes. A key objective of BCAST has been to develop a technology [1] based on intensive high shear melt conditioning (HSMC), that enables efficient iron removal [2], avoiding the recycled aluminium to be either downgraded into low quality cast products or diluted with primary aluminium.

The aluminium purification method is based on the fact that iron tends to form dense intermetallic compounds (Fe-IMCs) during solidification which can be separated to obtain a low-Fe molten metal [3]. The problem is that these compounds tend to nucleate on the wetted side of the naturally occurring oxide films entrained in the Al-alloy melt and as they are normally agglomerated and not well dispersed within the melt, the nucleation and growth of the Fe-rich IMCs is hindered (Figure 1 red line).

The use of HSMC technology can easily disperse the large oxide films and clusters into very fine and uniformly distributed individual particles [4], in turn enhancing the nucleation of the Fe-IMCs (Figure 1 blue line).

As a consequence of the enhanced nucleation, the separation of Fe-IMCs can be achieved much faster, thus increasing productivity and reducing processing costs. Figure 2 shows an example of this for A380-1Fe melt held at 600 °C (above α-Al formation) in a 25 cm chamber. Without melt treatment (Figure 2a), the Fe-IMCs need some time to nucleate (1-3 min), and even more to effectively grow and settle (10-15min). When using HSMC technology (Figure 2b), the nucleation occurs during the cooling stage and this reduces the time needed for the IMC to fully settle (< 3min).

Currently BCAST is focused on scaling up this innovative technology to apply it in a recycling plant, as well as evaluating its applicability to remove other impurities or inclusions in the melt.

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