Discussion

Discussion of “Characterization of Ceramic Foam Filters Used for Liquid Metal Filtration” and “Electromagnetically Modified Filtration of Aluminum Melts—Part I. Electromagnetic Theory and 30 PPI Ceramic Foam Filter Experimental Results”

JOHN CAMPBELL

DOI: 10.1007/s11663-013-9922-9

© The Minerals, Metals & Materials Society and ASM International 2013

The two papers by Kennedy *et al.*^[1,2] in the June issue of MMTB are nice examples of careful, accurate work.

However, it is a significant disappointment to this reader, who would wish to use ceramic foam filters for liquid metal filtration, to note that the authors limit their study to liquid metal velocity in the range 0 to 0.8 m/s, when practically all liquid metals in casting systems flow at velocities in the range 2 to 10 m/s.^[3]

Also disappointing is the fact that in my experience most industrial castings use filters of 10 and 20 ppi (pores per inch), but the authors have selected to study only filters of pore sizes of 30, 40, 50, and 80 ppi.

It is yet a further disappointment to see that the authors assume that the primary action of filters is to remove particulate inclusions.^[2] I personally do not rate particulate inclusions in Al alloys as of any importance. Over recent years, it has become abundantly apparent that the inclusions of overwhelming importance in nearly all cast metals are films, usually oxides, and usually bifilms, entrained into the melt during stirring and pouring.^[3] Although in melting and casting of Al alloys there are very common instances of bifilms the size of newspapers, they seem to be more commonly in the range of a few micrometers to a few millimeters across, and in dense populations of millions or billions

per liter. These doubled-over films are initially tumbled by turbulence into compact, raveled forms, and in this form appear to pass through a filter with a pore diameter in the region of 1 mm. However, if a trailing fragment becomes caught up, it is possible to envisage the compact form unraveling to some extent, or even bridging across pores. Having passed through a filter and finally arriving in the casting, the quiescence of the melt in the mold cavity, together with the action of gases in solution and other mechanisms, unfurls the compact films, effectively maximizing their size to develop their potential as engineering cracks. The presence of unfurled bifilms is clear in Figure 12(a), and their ability to support bridges of other inclusions is seen in Figure 18^[2] (otherwise the presence of bridges of fine, apparently non-contacting particulates is not easily explained).

The SiC agglomerates which the authors report (Figure 20) are also common features explained by the action of oxide films: The SiC particles penetrate the surface oxide on the liquid metal as clumps (the penetration of individual particles are resisted by the combined mechanical forces of surface tension and the surface oxide), automatically submerging around the clump a wrapping of the surface oxide. This “paper bag” of oxide surrounding the agglomerate becomes stronger with time as oxygen in the agglomerate is consumed, and so becomes difficult to break up and disperse. All vortex addition techniques for the creation of metal matrix composites suffer from this phenomenon. Although, as is usual, the oxide is too thin to be easily seen, the presence of the porosity, its alignment, and the presence of unmodified Si particles are all indicative of the presence of bifilms.^[3]

Do the authors have plans to extend their excellent laboratory study to conditions of real engineering interest? Such data have never been provided by filter manufacturers despite repeated requests. It would be welcomed in the casting industry with open arms, and put to immediate use.

REFERENCES

1. M.W. Kennedy, K. Zhang, R. Fritzsche, S. Akhtar, J.A. Bakken, and R.E. Aune: *Metall. Mater. Trans. B*, 2013, vol. 44B, pp. 671–90.
2. M.W. Kennedy, S. Akhtar, J.A. Bakken, and R.E. Aune: *Metall. Mater. Trans. B*, 2013, vol. 44B, pp. 691–705.
3. J. Campbell: Entrapment of oxides, pp. 19–103; Al Metallurgy and Oxides, pp. 269–309; use of filters in running systems for castings, pp. 833–852, in *Complete Casting Handbook*. Elsevier, Oxford, U.K., 2011.

JOHN CAMPBELL, Emeritus Professor, is with the Department of Metallurgy and Materials, University of Birmingham, Birmingham B15 2TT, U.K. Contact e-mail: jc@campbelltech.co.uk

Manuscript submitted June 24, 2013.

Article published online August 14, 2013.