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Visualisation in casting research

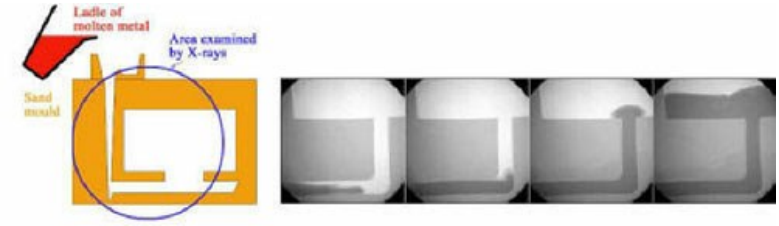
The casting research in the Interdisciplinary Research Centre in Materials Processing aims to apply rigorous science to solve problems in the foundry industry and to develop better casting techniques by combining carefully controlled experimentation with computer simulation.

Research on the reliability of cast engineering components. Although the various casting processes are often the most cost-effective and energy-efficient ways of producing metallic engineering components, they unfortunately suffer from a reputation of being unreliable, i.e. they fail unexpectedly and prematurely in service. Research at Birmingham has clearly shown that much of this problem can be attributed to the defects generated when molten metal is transferred from the melting furnace to the mould (where it solidifies to form a shaped component). This usually involves a gravity pouring operation which inevitably leads to uncontrolled surface turbulence, resulting in bubble formation and the folding in of the oxide film on the surface of the molten metal. This forms oxide defects known as bi-films in the solidified castings which are particularly dangerous as they are so thin that that are they invisible, yet they have a major detrimental effect on the reliability of the components. The emphasis of the research is to understand how to minimise, and preferably eliminate, such defects either by re-designing the moulds to prevent the surface turbulence, or by developing alternative mould filling techniques which avoid gravity pouring.

A great breakthrough in understanding has been achieved by using real-time X-ray radiography to make X-ray movies of the mould filling process. Since the mould filling operation normally only takes a few seconds, it has been invaluable to examine the X-ray movies frame-by-frame to reveal the flow patterns in great detail.

Over recent years, there have been rapid developments in computer software for simulating the filling of moulds with molten metal and its subsequent solidification to form a casting. However, without the use of the real-time X-ray technique, it was impossible to know whether the computer prediction of the metal flow bore any resemblance to reality. Comparisons between the predicted flow patterns and those observed by the real time X-ray technique have enabled such software to be validated so that it can be used with confidence.

The research has shown that a significant reduction in surface turbulence can be achieved by using improved mould designs to control the flow. Extensive tensile and fatigue testing has confirmed that this leads to major improvements in the reliability of castings made in a range of alloys.



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