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INTRODUCTION

Hardfacing refers to a process in which a hard surface layer is deposited on to a component in order to improve its wear resistance. An arc welding process is often employed to deposit the layer when resistance to abrasion is required. High-chromium white iron alloys are the most widely used overlay materials in applications involving abrasive wear.

A great deal of research effort has been directed at studying the factors affecting the wear performance of high-chromium white irons. Unfortunately, the majority of these studies have focussed on the wear performance of white iron castings and little effort has been devoted to weld deposits, despite their widespread use in industry. This is possibly related to the flexibility that casting processes offer with regard to the range of heat treatments and microstructures that can be achieved. For practical reasons weld deposits are usually left in the as-welded condition and, in that regard, the range of attainable microstructures is reduced. However, another significant difference arises in that, until now, casting processes have offered a greater degree of control of the alloy composition. The composition of a casting is determined before the process proceeds, whereas with a weld deposit the composition is essentially determined by the dilution that occurs as the overlay is deposited. The dilution, in turn, is very sensitive to the selected welding parameters. At the time this work commenced the hardfacing industry did not have a formal or reliable procedure for predicting the dilution, and hence the composition of a hardfacing overlay. Thus the most important variable has either been an unknown quantity or, at best, a quantity that is determined retrospectively.

The aims of this work were to identify the effects that welding parameters have on the dilution of a weld deposit and to develop principles for predicting and controlling overlay dilution. Attention was focussed on the flux-cored arc welding (FCAW) process and self-shielded high chromium, high carbon welding consumables. The terminology is somewhat of a misnomer in that the consumables studied were alloy-cored tubular electrodes, comprising a carbon-steel sheath and a fill with high-carbon ferrochromium as the main constituent. The contribution of flux to the core ingredients was small. This process was selected, however, primarily because it affords better control over process variables than manual-metal-arc welding. FCAW is an increasingly popular choice in the Australian hardfacing industry as it also offers higher deposition rates than manual-metal-arc welding. Electrodes 2.8mm in diameter are used extensively as they achieve higher deposition rates than consumables with smaller diameters. Most hardfacing in Australia is also performed with the direct-current, electrode-positive configuration (DCEP) and most manufacturers recommend using this polarity with their product. For these reasons, the emphasis was placed on DCEP hardfacing with 2.4 and 2.8mm diameter consumables.

This work commences with a review of the literature. The review is intended to provide the background for research described in later chapters, and it includes some analysis where appropriate. Attention is then given to single-bead deposits and, in particular, the factors affecting dilution, geometry, composition and abrasive wear performance under laboratory test conditions. Chapter 5 is concerned with a series of field trials that proved to be a turning point in the work. In designing the experiments for these trials it was observed that minimising dilution in multi-pass overlays is a fundamentally different problem to minimising the dilution of a single-bead deposit. Consequently chapters 6 and 7 address the dilution of multi-pass overlays. Chapter 8 then describes, for the first time, a set of principles for open-arc weld deposition of both single-bead and multi-pass overlays. Finally, conclusions and suggestions for future research are presented in chapter 9.