CHAPTER 1

Overview

The past few years have witnessed increasing interest in the use of 11% to 12% chromium steels as construction material in the transport, mining and agricultural industries[1]. The attraction of these steels lies mainly in the resistance offered to atmospheric corrosion. Wider acceptance has however been limited by certain potential problems associated with the welding of conventional 11-12% chromium duplex martensitic-ferritic stainless steels. Delta ferrite grain growth, with subsequent embrittlement and loss of strength, has been observed in the high temperature heat affected zone adjacent to welds in these steels[2,3,4].

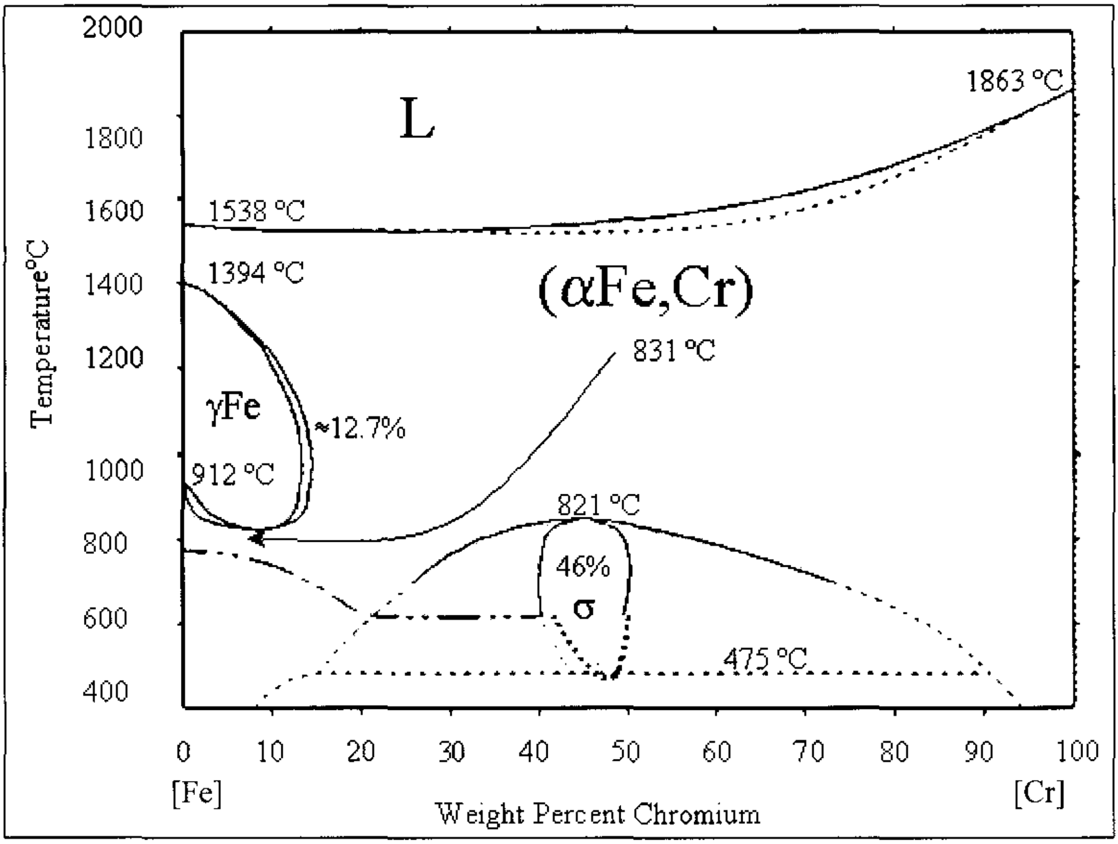

Figure 1.1: The iron-chromium equilibrium diagram[5]

The possible problems associated with the welding of 11-12% chromium steels could be overcome by raising the amount of austenite formers in the steel in order to enlarge the duplex austenite-ferrite region at high temperatures (see figure 1.1). Unfortunately, this approach would necessitate costly and time consuming alloy development, lead to increases in production costs and most probably cause an alteration in the properties obtained due to the duplex nature of the steels[1]. A possible alternative would be to increase the amount of austenite formers during welding in order to obtain a duplex structure in the heat affected zone at elevated temperatures. Interstitial diffusion of small austenite forming atoms such as carbon or nitrogen into the heat affected zone may be a way of promoting dual phase austenite-ferrite structure at high temperatures. In a dual phase structure the austenite on the ferrite grain boundaries effectively arrests ferrite grain growth. The carbon or nitrogen content (or both) of the heat affected zone may typically be inflated locally by diffusion from the weld metal during welding, as the atoms of both these elements are small and diffuse rapidly by interstitial migration. The high temperatures and typical thermal cycles encountered during welding suggest that this approach may have some merit, and that the microstructure of the heat affected zone may be altered in this manner (see Chapter 3).

In order to raise the interstitial carbon and nitrogen content of the heat affected zone by diffusion from the weld metal, the interstitial content of the weld metal must be raised as a pre-condition. This increase will have some practical implications. In the first place, the hardness of the weld metal will increase due to the higher levels of interstitial solute atoms. This could affect the overall behaviour of the weld under impact conditions as well as during slow loading (see chapter 3 and 4). Secondly, because of the higher carbon content of the weld metal, the corrosion resistance of the welded joint may be affected, and sensitizing would be more likely to occur. In spite of these anticipated limitations, an investigation into the feasibility of altering the phase composition of the heat-affected zone by diffusion was carried out in this study.

1.1. References

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