Overview of Microalloying in Steel

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1. Introduction

Microalloy (MA) or High Strength Low Alloy (HSLA) steels constitute an important category of steels estimated to be around l2% of total world steel production. They are used in every major steel market sector in various parts of the world and their development has played an important role in the expansion of certain key industries such as oil and gas extraction, construction and transportation.

2. Definitions

Definitions for alloy, low alloy and microalloy steels are given in Table l. The Steel of interest in this seminar is microalloy which contains vanadium, niobium, and/or titanium in amounts at least an order magnitude smaller than the amounts of the normal alloys in alloy or low alloy steels. Despite the low levels of alloying these microalloys can cause major strength and toughness improvements. The obvious economic advance associated with using such small additions together with the significant benefits to mechanical properties are the reasons for the popularity of MA Steels in the market place.

3. Microalloy Steel Development

The historical aspects will be presented as well as the metallurgical basis for Steel development.

3.l. Historical Events

Table 2 reveals the fact that early structural steels were generally of the C Mn type. These early steels contained relatively high carbon contents but this caused no problems in construction since up to the 1940s riveting was used as a means of joining not welding. However even in the l960s the steel in the Melbourne king Street Bridge had fairly high carbon and manganese contents which led to welding problems and subsequent bridge failure. By utilising microalloy steels such welding problems were greatly reduced and a modem offshore steel, produced by a controlled rolling procedure, is shown in the table as a good example of a microalloy Steel. The first national steel standard to allow a microalloy addition was BS 968 in l962 (Fig l) and this resulted in a large reduction in the carbon equivalent value (CEV) combined with an increase in strength.

The first microalloying element to be widely used was vanadium added to C Mn steels in the USA as reported by Bullens in l9l6 (Tab1e 3). Indeed early in the 20th century Hemp Ford made wide use of vanadium steels for the construction of the Mode1 T, the first mass produced motor car. Small titanium additions can also improve the strength of steel and this was first exploited in Germany in l92l. Micro titanium and micro vanadium additions began to be used in China in the l950s and l960s. However the major event that initiated the HSLA Steel revolution did not occur until 1988 when the Great Lakes Steel Corporation of the USA began production of low C Mn steels microalloyed with niobium. This event created widespread interest among the world's steelmakers leading to the rapid deve1opment of HSLA Steels containing the microalloys vanadium, niobium and titanium either singly