

TECHNICAL NOTE

THE EFFECT OF VANADIUM ON THE PROPERTIES OF THICK WALL API 5LX 65-70 LINEPIPE

SUMMARY

To investigate the possibility of manufacturing grade API 5LX-65 linepipe for sour service, in wall thicknesses up to 40mm, three laboratory heats (0.033%C, 0.31%Si, 1.3%Mn, 0.04%Nb) with different vanadium contents (<0.002%, 0.061% 0.0120%), were investigated. The heats were thermomechanically rolled in three rolling stages, following the same rolling schedule in all cases. The finish rolling temperature was 710°C. Rolling was followed by accelerated cooling, with a cooling rate of about 10°C/s, down to 450-500°C, after which the plates were air cooled to room temperature.

Strength levels were improved by increasing the vanadium content and it is considered desirable to include an addition of 0.04%V to ensure achievement of API 5LX65 strength requirements. In the case of API 5LX70, a vanadium addition of at least 0.08% is indicated as being necessary to achieve strength requirements.

Both Charpy vee-notch impact and Battelle drop weight transition temperatures exhibited a small deterioration with increasing vanadium level. However, with impact energies of 350J, or more, at -20°C and 85% shear at -5°C, these can be considered to be good for thick wall, sour service, plates.

The microstructures reflected the processing conditions and were similar in all three cases. They consisted of 95-97% elongated ferrite and 3-5% bainite.

1. INTRODUCTION

There is increasing interest in the use of thick wall (>35mm) linepipe for use in sub-sea pipelines. Steels manufactured for such pipelines are also, frequently, required to be suitable for sour service and they, thus, contain low levels of carbon (<0.04%C) and manganese (<1.4%), along with tight control of other elements such as P, Cu, Ni, Cr and Mo, which may segregate and promote martensite formation in the segregated regions. Consequently, achievement of both strength and toughness requirements in such steels can prove to be difficult. It is the objective of this present work to examine the effect of vanadium on the tensile and toughness properties of high strength, heavy wall linepipe produced using accelerated cooling after controlled rolling.

2. EXPERIMENTAL

Three, 100Kg, vacuum induction heats with the same base chemistry (0.033%C, 0.31%Si, 1.35%Mn, 0.04%Nb) but with different vanadium contents <0.002%, 0.06%, 0.12%V, were produced. Full chemical analyses are given in Table 1.

The heats were cast into ingots of cross-section 130mm x 120mm. The ingots were cropped at the top and a 20mm slice was removed for chemical analysis. Afterwards, each ingot was cut into two parts of approximately 230mm length, yielding a total of six coupons.

The six coupons were reheated to 1040°C in an electrically heated furnace, held for 2-3 hours and rolled to 40mm thick plates on a laboratory rolling mill. A three-stage rolling schedule, in which the height of the initial pass was 180mm, was used to roll all six coupons to 40mm