

Hot-Rolled Steel Coil for High Strength Heavy Wall Spiral Linepipe

1. Introduction

As the distance between gas production site and consuming regions has increased in recent years, there is an orientation toward high pressure transportation in pipelines for transportation of natural gas, crude oil, etc. with the aim of reducing transportation costs. Heavy wall and high strength linepipes are essential for achieving high pressure transportation, and high toughness is also necessary to prevent large-scale disasters¹⁾.

In order to improve the toughness of steel as evaluated by Drop Weight Tear Test (DWTT) and Charpy impact test, austenite grain refinement was attempted during hot rolling²⁾ by using controlled rolling (CR), in which

welds, that is, 85% SATT (Shear area transition temperature) of the base metal in DWTT ≤ 20 C and ductile brittle transition temperature (vTrs) of the weld HAZ (Base metal) ≤ 10 C and Charpy impact test ≤ 10 J at 20 C.

2. Concept of High Strength Heavy Gauge Material

2.1 Target Properties

In order to satisfy the property requirements for steel pipes, it is necessary to improve the performance of the hot-rolled steel coils used as the material for pipe-making. The development targets for this hot-rolled steel coil were set at thickness 20 mm, X70 grade ($TS \geq 570$ MPa) and satisfying the specification of ≤ 20 C or less as the toughness of the base metal and

2.2 Concept

As shown in Fig. 1, the CR ratio of heavy gauge hot-rolled steel strip in the finish rolling process decreases due to the slowed cooling rate of the center of strip thickness, and as a result, the toughness of the product decreases. Therefore, the following approach was adopted from both the directions of chemical composition and the manufacturing process in order to improve the toughness of heavy gauge hot-rolled steel coils.

- (1) Because Nb has a higher austenite recrystallization suppression effect than Al, Ti and ψ , a higher CR ratio was achieved by expanding the austenite non-recrystallization region by adding Nb.
- (2) In addition to adding Nb, a high CR ratio was achieved in the total hot-rolling process by appropriately controlling the temperature and reduction ratio not only in the finish rolling process but also in the rough rolling process.
- (3) To avoid a decrease in weld HAZ toughness due to Nb addition, chemical composition design to hold the weld crack sensitivity composition R_M (parameter crack measurement) at low level was

