X100 Induction Heated Bends from SAW

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ABSTRACT
X100 induction heated bend from Submerged Arc Welded (SAW) pipes was produced with good balance of toughness and X100 high strength.

In case of SAW pipes, the mechanical properties of the weld should be taken into consideration. The key control point to produce high strength hot bends is to achieve high toughness on the weld and to keep yield strength of pipe bend body. The present work discusses the effect of boron on the toughness of the weld and the method of heat treatment to achieve X100 strength of the pipe bend body.

KEY WORDS
X100; induction heated bends; high strength; SAW; toughness

INTRODUCTION
In these days, the world’s demand for high strength line pipe over X80 grades is increasing and many reports concerning X100 and X120 have now been published. (Takeuchi 2006, Fairchild 2002, 2005, Papka 2004, Barsanti 2002, Endo 2002, Makino 2002, Hamada 2002, Okaguchi 2004, Takahashi 2005, Hamada 2004) On the other hand, induction heated bends is a very important accessory for the pipeline construction, the development is not promoted as line pipe. (Batista 2006, Kondo 1993) The development of X100 induction heated bends from SAW pipe is presented in this paper. This achievement of high-grade hot bend pipe will accelerate the tendency to apply higher grades for line pipe.

The most important aspect with induction heated bends from SAW pipe is to achieve high toughness in the weld. In case of SAW pipe, it is known that acicular ferrite is the best microstructure to obtain a good balance of strength and toughness in the weld. We must now study what is the best solution to obtain the appropriate microstructure for welds of induction heated bends.

Appropriate chemical composition for tensile strength of welds was studied to achieve a good balance of toughness and X100 tensile strength after heat treatment.

Firstly, we focused on the boron content. It is reported that in the case of weld metal of SAW pipe, boron is a very effective element in order to achieve high toughness when the tensile strength of the pipe is lower than 700MPa. (Hamada 2002, Okaguchi 2004) The toughness of the weld was studied in various heat treated conditions and results showed that in the case of X100 induction heated bends, boron-free was an effective method to maintain high toughness.

Secondly, the tensile strength of the weld was investigated. The strength of bend pipe after quenching and temper is lower than that of the bend mother pipe, which is produced by TMCP. The chemistry of the bend pipe is generally higher than that of as-welded pipe in order to achieve the same tensile strength.

Though, in the case of X100 induction heated bends from SAW pipe, when TMCP is applied to bend mother pipe, tensile strength of weld becomes so high to keep overmatch that the toughness of weld metal becomes very low. It is proved that for X100, high toughness of the weld after bend could be obtained by controlling the base metal strength of bend mother pipe.

X100 induction heated bends from SAW pipe could be produced by controlling the appropriate design for chemistry of weld and the tensile strength of bend mother pipe.

VERIFICATION OF THE DESIGN FOR CHEMSTRIES
Tensile strength after heat treatment was investigated. Fig.1 shows the relationship between chemistries and tensile strength. Those data includes the results of base metal and weld metal. This figure indicates two conclusions as follows,

- Tensile strength after heat treatment was predicted by the Ceq values.
- Test results on both base metal and weld metal have same