

TUESDAY, AUGUST 23, 2005, A.M.

SESSION 19: INTERNATIONAL SYMPOSIUM ON PIPELINES FOR THE 21ST CENTURY IN HONOR OF DOUG BOYD

PROCESSING AND PROPERTIES II — PROCESSING AND MANUFACTURING

Sponsor: Iron and Steel Section, The Metallurgical Society of CIM

Room: Imperial Ballroom 1

Chairman: H. Heinen, University of Alberta, Canada

PAPER 19.1 — 9:00 (KEYNOTE)

THE METALLURGY OF HIGH STRENGTH LINEPIPE STEELS.

A.J. DEARDO, University of Pittsburgh, U.S.A.

Linepipe steels have come a long way in the past forty years. In fact, modern, high strength steels for large diameter linepipe applications represent one of the seminal accomplishments in metallurgy of the past half-century. The synergy of advanced steelmaking, alloy design including microalloying, hot rolling, and interrupted accelerated cooling has led to the marvelous steels being used today.

The drive for higher performance pipelines has been motivated by the energy sector of our global economy who wanted both higher throughput capacity, i.e., larger diameters and higher pressures, and lower material cost, i.e., relatively thinner gauge wall thicknesses. These requirements led to new steels with higher strengths, better toughness and improved weldability. The goal of this paper is to trace the evolution of linepipe steels from the X42 grades of the small diameter pipelines of the 1960s to the (X80 – X120) grades used in the large diameter pipelines of today. The metallurgical triumphs permitting this success story, e.g., clean steel practices, controlled rolling, microalloying with Nb, and using IAC to obtain low temperature transformation products, will be highlighted and discussed.

PAPER 19.2 — 9:35

DEVELOPMENT OF HIGH QUALITY STEEL SLAB FOR OIL AND GAS LINE PIPE APPLICATION.

R. HENDRAJAYA , B. SETYOTOMO, W. BASUKI and L. HAKIM, PT. Krakatau Steel, Indonesia

Due to high crack sensitivity of slab product of gas and oil line pipe application, its steel making process and alloy composition were evaluated and then improved to overcome its critical solidification process and reduced surface defects. The study was conducted at Slab Steel Plant Krakatau Steel. The purpose was to improve slab surface quality by reducing surface defects so that the slab surface doesn't need to be totally repaired. The method applied was by performing plant trial process, which the secondary process parameters such as alloying method and the casting parameters such as casting powder selection, metallurgical cooling, mould level control, and superheat were continuously monitored and then adjusted to the surface quality of the product. Based on the calculation of Ferrite potential of the steel, the chemical composition was designed to achieve optimum casting parameters in order to avoid high shrinkage during solidification. The results of the study are decreased surface defect quantity, and smooth casting process. The quantity of crack decreased by almost 90%. The slab surface repairing was significantly reduced from 85. % to less than 10%. These new casting parameters and developed alloy composition are then used and standardized for the mass production of the steel.

PAPER 19.3 — 10:00

RUNOUT TABLE COOLING SIMULATION FOR ADVANCED LINEPIPE STEELS.

V. PRODANOVIC and M. MILITZER, University of British Columbia, Canada

Production of advanced linepipe steels with strength levels of 685MPa (100ksi) and higher requires excellent control of runout table cooling to produce the desired final fine-grained microstructures, which may include acicular ferrite. Cooling is exerted on the runout table by applying water jets onto the hot surface of the strip and heat is removed from the steel by forced convective boiling. The associated boiling mechanisms are complex and include film, transition and nucleate boiling.

A pilot-scale runout table test rig has been built to systematically study boiling heat transfer from a moving steel plate by employing industrial scale headers. Experiments were conducted using test plates moving at speeds between 0.3 m/s and 1.4 m/s. The plates were cooled down from 850oC to temperatures below saturation by a single water jet supplied through an industrial size circular nozzle. Based on these experiments heat fluxes were determined and further used to develop improved runout table cooling models.

COFFEE BREAK — 10:25 – 10:45

PAPER 19.4 — 10:45

PRODUCTION OF HIGH STRENGTH PIPE STEELS BY THE CSP® THIN SLAB TECHNOLOGY.

C.-P. REIP, W. HENNIG, J. KEMPKEN and R. HAGMANN, SMS Demag Aktiengesellschaft, Germany

The CSP technology symbolizes a highly productive process for the cost-effective production of steel grades with a range of sophisticated properties comprising both the inner quality of hot strip, its surface formation as well as the relating technological characteristics. Thanks to extensive development work undertaken during the last 15 years, the range of steel grades that can be produced was continuously expanded and the process technology optimized.

The present paper describes the ongoing development work concerning the production of higher-strength, microalloyed pipe steels. The resulting hot strip, due to the associated thickness and the potential pipe diameters, is particularly suited for being processed to HFI-welded pipes. Based both on ferrite-pearlite as well as very fine-grained, ferrite-bainite hot-strip microstructures, strength levels of up to grade API X80 can be realized. It can be demonstrated that hot strip produced in a CSP plant has very good toughness values at temperatures down to -60°C and can even make application with required sour-gas resistance possible.

PAPER 19.5 — 11:10

THE EFFECT OF PLASTIC STRAIN AT COILING TEMPERATURES ON THE HARDNESS OF GRADE 483 (X70) STEEL.

J.B. WISKEL, E. NIEMI, J.F. LU, D.G. IVEY and H. HENEIN, University of Alberta, Canada

Simulated TMCP using a Gleeble was undertaken to evaluate the effect of the austenite to ferrite cooling rate, coiling temperatures of either 400°C or 500°C and the magnitude of plastic deformation at the coiling temperature on the hardness of a Grade 483 (X70) steel. For comparable apparent cooling rates and deformation conditions, the hardness of the samples were independent of coiling temperature. The application of a minimum compressive deformation > 8% was required to increase hardness at both simulated coiling temperatures of 400°C and 500°C. An increase in hardness was also observed with increased cooling times between 800°C and 500°C (i.e., slower cooling rates).

PAPER 19.6 — 11:35

ULTRA CLEAN STEEL FOR ADVANCED LINEPIPE APPLICATIONS.

R. BRUCKHAUS, H. LACHMUND, AG der Dillinger Hüttenwerke, Germany

At Dillinger Hüttenwerke/Germany steel production of grades for linepipe applications especially for sour service has a long tradition. The BOF process after replacement of the vessels is optimized by a newly developed lime addition model and variations in lance tip geometry. Equipped with three state-of-the-art VOD tank degassers metallurgical requirements of lowest contents of e. g. sulphur, nitrogen and hydrogen can be achieved.

Three continuous casting machines of vertical bending type with solid core even improve already high levels of cleanliness. The vertical part corresponds to the metallurgical length of 12 to 15 m and therefore assures a maximum of cleanliness after solidification before bending.

Slab thickness up to 400 mm can be produced with model controlled dynamic soft reduction. The accurate alignments of the casters assure minimized segregation and microporosity. Surface and internal cracks can be avoided by special cooling, bending and straightening strategies.