

WEDNESDAY, AUGUST 24, 2005, A.M.

SESSION 40: INTERNATIONAL SYMPOSIUM ON PIPELINES FOR THE 21ST CENTURY IN HONOR OF DOUG BOYD

PIPELINE WELDING AND CONSTRUCTION — PROPERTY ASSESSMENT AND CONSTRUCTION ISSUES

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

Room: Imperial Ballroom 1

Chairmen: J. GIANETTO, CANMET, Canada and
J. THOMSON, McMaster University, Canada

PAPER 40.1 — 9:00 (KEYNOTE)

PIPELINE DESIGN FOR NATURAL GAS TRANSMISSION USING HIGH STRENGTH TECHNOLOGY.

A. GLOVER and J. ZHOU, TransCanada PipeLines Ltd, Canada

As the demand for natural gas as a prime global energy source continues to grow, the search for new sources of the fuel spreads into geographical areas that are more remote from the marketplace. Along with this comes the need for longer and ever more efficient pipelines. This requirement for higher value in natural gas transportation is satisfied to a large extent through the application of high strength technology and innovative design approaches that support increased design and operating pressures. This paper reviews the latest accomplishments and successes in these technologies for use in gas transmission. It also explores some of the technologies which are targeted for the future to allow the industry to achieve even higher benchmarks in reliability and cost-effectiveness.

The central element in the theme of high strength technology for gas pipelines is that of high strength steel. From tensile strengths of Grade 359 a few decades ago, more and more operators are now specifying Grade 550 linepipe for their large diameter projects. As well, Grade 690 steel is operating successfully in limited transmission applications and Grade 825 has recently been installed. With the introduction of the latest high strength pipe comes the need for high strength fittings. The industry's first Grade 550 fittings were recently specified and installed on a project with Grade 825 line pipe.

High strength materials can only be implemented successfully if compatible design and construction processes are in place. The latest developments in strain- and reliability based design will be described as well as the corresponding advancements in welding and inspection technology.

PAPER 40.2 — 9:35

FACTORS INFLUENCING MECHANICAL PROPERTIES IN DSAW PIPE WELDS.

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Attaining required mechanical properties in welds made using the double submerged arc welding (DSAW) process is difficult, and it is becoming more difficult as the strength level of the base materials continues to increase. Producing weld metal with adequate mechanical properties involves factors that are often overlooked and not taken into consideration. Not least amongst these problems is simply finding information to use in selecting the appropriate flux/wire combination. Most of the available data on flux/wire combinations provided by consumables manufacturers is generated using the multiple pass welding procedures required for classification per specifications such as AWS A5.17 and A5.23. This data really gives no insight into the properties that can be expected in a DSAW application. Also, base plate composition plays a very significant role because of the fact that base plate dilution can be as high as 70% in DSAW welds. This means that if any elements are present in the base metal that are deleterious to mechanical properties, they will also be present in significant quantities in the weld deposit. Some of these elements can decrease toughness and increase hardness (increased hardness is a concern if the pipe is intended for sour service). Some of these problems can be mitigated by proper selection of welding consumables. Selection of proper welding consumables means selecting an electrode that provides the appropriate alloying elements to obtain the desired level of impact toughness while also keeping the hardness within any specified limits. In order to attain the necessary impact toughness, selection of a flux with an appropriate composition (in terms of its basicity and its ability to control the nitrogen content of the weld deposit) is required. As with all welding processes, the mechanical properties of DSAW welds is also highly dependent on the welding procedures. This work clarifies how to select appropriate consumables to meet a given set of requirements, and also how to achieve the optimum mechanical properties from those consumables.

PAPER 40.3 — 10:00

THE EFFECT OF WELD METAL TOUGHNESS ON THE CVN TEST RESULTS OF THE HEAT-AFFECTED ZONE.

X. CHEN, F. HAMAD, S. ABRAHAM and D. BAI, IPSCO Inc., Canada

For the integrity of welded structures such as pipelines, the toughness of the heat-affected zones (HAZ) is an important property. This property is often specified in terms of Charpy V-notch (CVN) impact toughness and determined by the standard test method. An experimental study has been conducted in an industrial laboratory to measure the impact toughness of the coarse grain heat-affected zones (CGHAZ) of an X80 line pipe material. The field girth welding conditions in terms of heat input were simulated, together with special edge preparation to improve the targeted testing of the CGHAZ. The effect of toughness of the neighboring regions, in particular the weld metal, on measured impact toughness of the CGHAZ was investigated. The fracture paths of the CVN tested samples were examined by both optical and scanning electron microscopy. The deviation of segments of the fracture path into the weld metal was found to have a significant effect on the measured impact toughness of the CGHAZ.

COFFEE BREAK — 10:25 – 10:45

PAPER 40.4 — 10:45

SHEAR PUNCH TESTING AS A TOOL FOR EVALUATING WELDED PIPELINE STEEL.

G.R. STEWART, A. ELWAZRI, R. VARANO, S. YUE, J.J. JONAS, McGill University, Canada and N. POKUTYLOWICZ, ExxonMobil Research & Engineering Company, U.S.A.

Differing thermal histories in and around a weld can lead to differences in grain size, phase composition and morphology of precipitates; mechanical properties will vary accordingly. Hardness testing gives limited information and the machining and testing of tensile and/or impact specimens that would reveal these variations (which may occur over very small distances) is not practical. Therefore, in this investigation, shear punch testing was applied to measure the variation in the room temperature mechanical properties of a welded pipeline steel.

PAPER 40.5 — 11:10

ASSESSMENT OF PROPERTIES AND MICROSTRUCTURE OF X100 PIPELINE GIRTH WELDS.

J.A. GIANETTO, J.T. BOWKER, CANMET, Canada and

D.V. DORLING, TransCanada Pipelines, Limited, Canada

Over the last few years, interest in the development and construction of large diameter, high pressure pipelines from the Mackenzie Delta in northern Canada and Alaska's North Slope has steadily increased as a result of the projected decline in recoverable natural gas from existing reserves in western Canada. The success of such enormous pipeline projects, which will require utilization of advanced strain-based design, is largely based on successful application of high strength line pipe grades, such as X80 and X100. To fully realize the economic benefits of high strength steels, welding processes and procedures must be developed to ensure that the stringent requirements for high strength and good low temperature toughness are confidently obtainable in field girth welds used in the construction of such pipelines. This study aims to provide a better understanding of the factors that control weld metal strength and toughness of mechanized field girth welds produced in high strength X100 line pipe steel using a range of narrow-gap mechanized gas-metal arc welding procedures. Of particular importance is the attainment of high yield strength (≥ 810 MPa) to ensure welds exhibit overmatching strength when compared to the line pipe steel. Some factors that have been considered in this evaluation include influences of gas-metal arc welding process variants (single and multi-wire) and changes in welding procedure specifications, including joint design preparation. Key components of this work related to the reliable measurement of weld metal strength variation through-thickness and as a function of position around the circumference of a given girth weld.

PAPER 40.6 — 11:35

FABRICATION INDUCED DEGRADATION AND SAFETY ASSESSMENT DURING SERVICE IN PIPELINES.

A.N. KUMAR, Indian Institute of Technology, India

Two fabrication stages in the manufacture of pipelines are identified as causing significant deterioration of the steel plates, namely cold bending and welding. The objectives of this work include quantitative assessment of the degradation of the quality of the steel plate by the loss of fracture toughness, and an estimation of the safe working pressure. The study was conducted on three API grade steels: X42, X46 and X60. After cold bending by the UO technique, various welding techniques were employed for joining of the bend plates along the pipe length. A crack-tip opening displacement parameter (CTOD) was used at the onset of initiation and at the first load maxima as the criterion for assessing the toughness degradation under various fabrication stages and regime (such as WZ, HAZ and parent body). In addition, strength, hardness and impact energy values were determined to check the degree of degradation. Microstructural and microfractographic investigation of the fractured samples were also carried out in the scanning electron microscope (SEM). X60 grade steel plate suffers from CTOD toughness loss by around 38 and 55% after welding and cold bending, respectively, for the conditions studied. A combined effect of the two stages results in a loss in toughness by around 70% for the same steel. In X42 grade, the loss in impact energy ranges from 78 to 35 J due to electrical-resistance welding study (ERW).

