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Friction Stir Welding of ISO 3183 X80M (API 5L X80) joints

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Abstract – Friction Stir Welding is a solid-state joining process with numerous advantages as good dimensional stability and repeatability. 12 mm thick plates of ISO 3183 X80M steel were friction stir welded towards to obtain different heat inputs. Micro-hardness tests revealed that joints produced with lower spindle speeds showed lower hardness. The bend tests results revealed no cracks. All the tensile tests samples broke at the base metal, indicating the joint region higher strength, when compared to the base metal. Friction stir welding process parameters that produce fully consolidated and good toughness 12 mm thick joints on X80M plates have been developed.

Friction Stir Welding (FSW) is a solid-state joining process with numerous advantages as good dimensional stability and repeatability, which has huge potential use for critical applications involving high melting temperature alloys (Fig. 1) [1-2]. 12 mm thick plates of ISO 3183 X80M (API 5L X80) steel were friction stir welded using two passes on both sides of the plate. PCBN tools were used. Different heat inputs were obtained using a fix travel (welding) speed in combination with several spindle speeds. The ISO 3183 X80M (API 5L X80) base material (BM) presented a microstructure formed by Ferrite (F), Degenerated Perlite (DP) and Martensite-Austenite constituent (MA). The heat affected zone (HAZ) microstructure was composed by F, some carbides, and MA. The microstructure of the stir zone (SZ) presented F, M-A constituent, and degenerated upper Bainite (DUB).

Micro-hardness tests revealed that joints produced with lower spindle speeds presented lower hardness at the SZ. On the other hand, the HAZ hardness was not influenced by the used process parameters. The SZ of joints produced with higher spindle speeds presented higher hardness and moderate toughness, which is explained by the presence of deleterious micro-constituents (bainitic microstructures) (Fig. 2). The welded joints were also subjected to bend and tensile tests, which were performed according to ISO 3183: 2007. The bend test results revealed no cracks. All the tensile tests samples broke at the BM, indicating the joint region higher strength, when compared to the BM.

Friction stir welding process parameters that produce fully consolidated and good toughness 12 mm thick joints on ISO 3183 X80M (API-5L-X80) plates have been developed. Therefore, this unprecedented result will for sure bring a great deal of attention to this new process development for critical applications in the energy generation industry, especially for advanced construction and repair applications[1-3].

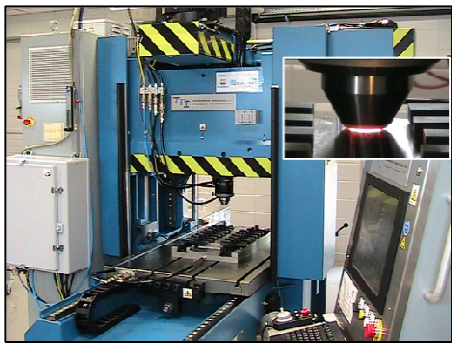

Figure 1: FSW system in LNLS. Right upper detail shows the friction stir welding process.

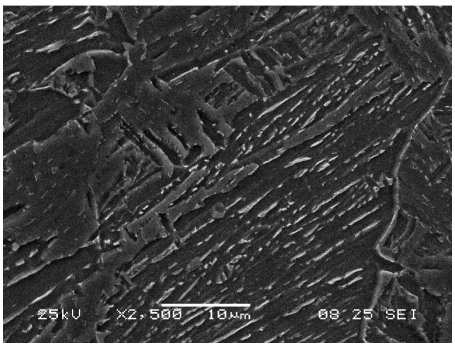

Figure 2: The SZ of joint produced with higher spindle speeds. Bainitic microstructures.

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