World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:09, 2017

Effect of Crystallographic Characteristics on Toughness of Coarse Grain Heat Affected Zone for Different Heat Inputs

Authors : Trishita Ray, Ashok Perka, Arnab Karani, M. Shome, Saurabh Kundu

Abstract : Line pipe steels are used for long distance transportation of crude oil and gas under extreme environmental conditions. Welding is necessary to lay large scale pipelines. Coarse Grain Heat Affected Zone (CGHAZ) of a welded joint exhibits worst toughness because of excessive grain growth and brittle microstructures like bainite and martensite, leading to early failure. Therefore, it is necessary to investigate microstructures and properties of the CGHAZ for different welding heat inputs. In the present study, CGHAZ for two heat inputs of 10 kJ/cm and 50 kJ/cm were simulated in Gleeble 3800, and the microstructures were investigated in detail by means of Scanning Electron Microscopy (SEM) and Electron Backscattered Diffraction (EBSD). Charpy Impact Tests were also done to evaluate the impact properties. High heat input was characterized with very low toughness and massive prior austenite grains. With the crystallographic information from EBSD, the area of a single prior austenite grain was traced out for both the welding conditions. Analysis of the prior austenite grains showed the formation of high angle boundaries between the crystallographic packets. Effect of these packet boundaries on secondary cleavage crack propagation was discussed. It was observed that in the low heat input condition, formation of finer packets with a criss-cross morphology inside prior austenite grains was effective in crack arrest whereas, in the high heat input condition, formation of larger packets with higher volume of low angle boundaries failed to resist crack propagation resulting in a brittle fracture. Thus, the characteristics in a crystallographic packet and impact properties are related and should be controlled to obtain optimum properties.

Keywords : coarse grain heat affected zone, crystallographic packet, toughness, line pipe steel
Conference Title : ICWMP 2017 : International Conference on Welding Metallurgy and Processes
Conference Location : Rome, Italy
Conference Dates : September 18-19, 2017