MANUFACTURING PROCESS DIAGNOSTICS AND DAMAGE ASSESSMENT OF HSLA STEEL BUTT WELDED PIPELINES

Design of complex infrastructures requires a multidisciplinary approach to prevent Natech accidents, which are secondary effects due to natural hazards. This approach follows two main directions: i) prevention of the loss of control over risk and ii) recovery from the loss of control over risk. These concepts may be applied to piping system installations, which are key elements of petrochemical and refinery plants. They are critical components that require special attention towards hazardous events because their rupture could cause leakage of the content resulting in possible explosions. Piping systems for oil and gas applications are generally an interconnection of carbon steel linear pipes, elbows, pipe fittings and auxiliary elements joined together using welding technology. The connection between the elements is a sensitive part that could trigger failure mechanisms in case of extreme loads. In fact, the manufacturing of the joints can take place under different condition e.g., technology adopted, manual or automatic welding process, manufacturing location, significantly affecting the final quality of the connection.

Therefore, it is important to carry on new studies regarding innovative diagnostic methods for defects detection as well as regarding ultimate resistance of butt-welded joints under extreme loads. In the thesis was studied a specific class of pipe consisting on high strength low alloy (HSLA) steel pipes. In detail was investigated the possibility to adopt infrared cameras with the purpose to assess the development of imperfections inside butt-welded joints. In addition was studied the behaviour of welded connection, which were manufactured with optimal quality acceptance levels, under impact load test.

During preliminary experimental activity, were manufactured several pipe specimens using three different manual welding technologies. Each specimen consisted in two portions of X80 high strength steel pipe (diameter 12’’3/4) connected through butt-welded joints having induced imperfections inside. The actual position and the magnitude of these imperfections were then determined using radiographic analyses. This information was subsequently combined with the measurements of the welding pool temperature recorded with an infrared camera. This process allowed to obtain the thermal signature of each specific defect, which is the temperature of the molten material that is associated to the development of the imperfection.

At the same time were performed impact load test on pipe specimens manufactured with optimal quality acceptance levels. These samples were tested using a forging hammer with its initial height selected after numerical simulations. Impact load test allowed to assess the resistance of welded joint simulating catastrophic loads.