Presenting an Appropriate Way of Reducing Delay Cracking of Pipeline Systems

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Abstract. These days implementing pipeline for transmitting various products including oil, gas and its compounds have a very essential role in the economy of a country. It's obvious that performing appropriate pipeline system considering design and construction according to required standards can have a conspicuous effect on people's life. In general, all of the engineers and designers would make a supreme attempt to perform an executive procedures with the highest quality and quantity in order to reach the best results. It's quite natural that for achieving these goals, we should take some factors into consideration. One of the most important mechanical processes in real projects is welding process in which presenting a suitable welding procedure specifications can prevent many common defects, large amount of money and even dissipating time in welding. The goal of this article is making use of suitable electrode for filling and cap-passes in order to reduce delay cracking in heat affected zone.

Introduction

As mentioned, presenting a series of suitable procedures in welding along with some standards can reduce many welding defects. Undoubtedly, one of the common and at a same time the most dangrous defects of pipeline welds is a crack in which different factors can be the case of it's reduction. One of the easiest ways which can be used for reducing crack is using suitable electrode for different passes. It is noticeable that in welding procedure specification (WPS) for filling and cap-pass in the pipeline, E7010 electrodes, No 4-3or5 are common. As we know, in categorizing the electrodes, E7010 electrodes are consided as the cellulosic electrodes. Choosing cellology electrodes and using them can increase the possibilty of delay cracking in filling and cap passes because of the large amount of hydrogen content that this type of electrodes have.

Attempts to eliminate or prevent some mentioned causes will result the reducation in nucleation of delay craking in Heat Affected Zone (HAZ) due to the nature of sheilded metal arc procedure. Hydrogen can be formed from the humidity of electrode flux or shield gases. Several valuable works about good selection of electrode in various welding process can be found in litareture [1-3]. Some researchers have investigated the microstructure of heat affected zone in the presence of hydrogen content deposite [4-6]. J. Ćwiek has studied the effect of hydrogen degradation in delayed crack. He reported that the lack of delayed crack is a good evidence of hydrogen degradation [7]. The aim of this study is to introduce the new and less dangerous electrode in the application of welding of steel pipes.

Material and Methods

Heat affected zone (HAZ) cracking is characterized by separation that occurs immediately adjacent to the weld bead. Although it is related to the welding process, the crack occurs in the base material, not at the weld material (figure 1). This type of cracking is also known as "under bead cracking" or "delayed cracking " because this cracking occurs after the steel has cooled below approximately 400’F. It can also be called "cold cracking" and because of its associated hydrogen content, it is also called "hydrogen assisted cracking"

Figure 1: Example of delay cracking in a plate

In order the heat affected zone cracking to occur, three condition must be present simultaneously; sufficient level of hydrogen; sufficiently sensitive material involved; and sufficiently high level of residual or applied stress. Adequate reduction or elimination of one of the three mentioned conditions will generally eliminate heat affected zone cracking. In welding applications, a typical approach for reduction of delayed cracking is to limit two of three parameters, namely the level of hydrogen and the sensitivity of the material. The microstructure of delayed cracking can be seen in figure 2.

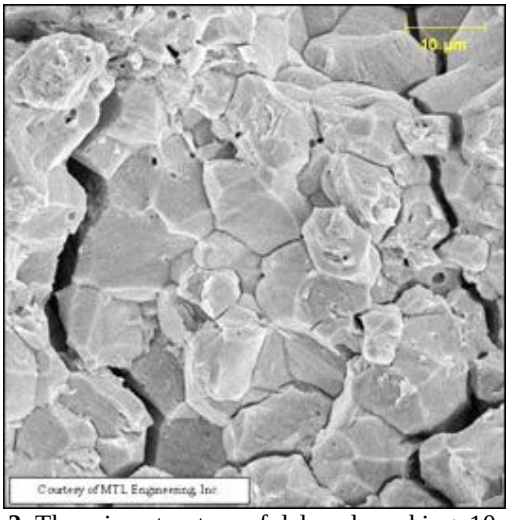

Figure 2: The microstructure of delayed cracking, 10 µm [8].

Proposed Approach

To occur HAZ hydrogen cracking, it is necessary the hydrogen to migrate into the heat affected zone. This procedure needs time. For this reason the ASME Sev. V, D1.1 code applies the delay of 48 hours after completion of welds for the inspection of welds made on A514,517 and A709Gr,100 and 100W steels, known to be sensitive to hydrogen assisted heat affected zone cracking with time. The hydrogen diffuses from weld deposits. Sufficient diffusion to avoid cracking normally takes place in a few weeks, although it may take many months depending on the specific application. The greatest concentrations of hydrogen mostly occur near the time of welding, and if hydrogen cracking is possible to occur, it generally occur within a few days of fabrication. However, it may take longer for the cracks to grow to sufficient size to be detected.

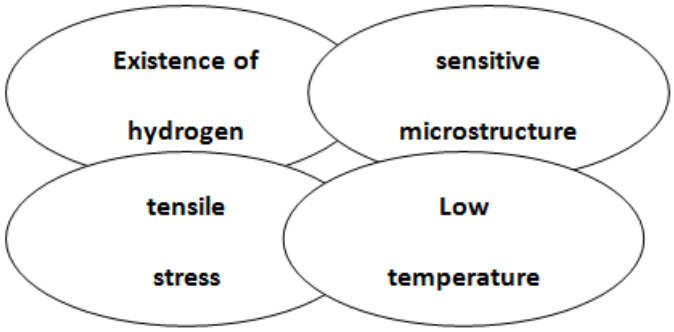

Figure 3: Delay cracking necessary conditions

In a case of the absence of one of the four conditions (fig. 3), delay cracking will not be formed.

1- existence of hydrogen
2- Sensitive microstructure
3- low temperature
4- tensile stress

Trying to eliminate or prevent some cause factors mentioned above will cause dramatically reduction in nucleation of delay cracking in HAZ. All the processes of arc welding will cause the entrance of hydrogen into base material. Hydrogen can be formed from the humidity of electrode flux or shelded gases. The source of humidity can originate from the oxidation process at the surface of the base metal or other existing dirts on the electrode surface and/or even existing humidity in the air. The extreme heat of arc welding can be adequate for decomposing must of dirty sources on weld surface.
Pipe metal has an extreme power for solving hydrogen. Just in a short time of cooling, the rate of penetration of hydrogen in metal is so high. Until the metal has a higher temperature, the blend of hydrogen will be less. As much as the process of solving becomes colder, the rate of penetration will decreases. This situation can originate from the extreme amount of hydrogen or lack of its penetration. According to these conditions hydrogen can be a main factor of arragonce in metal. Noticing the explanations aboves, electrode with less hydrogen content, (E7018), instead of cellology E7010 electrodes can cause the reduction of delay cracking formation in HAZ.

Conclusion

In order to reduce the delay cracks in heat affected zone one should prevent from occurrence of one of crack reasons mentioned above. To achieve this goal it suggested utilizing low

hydrogen electrode of E7018 instead of cellulosic electrode of E7010 in welding process of industrial natural gas pipelines. This is where it is still using E7010 as standard electrode in these particular applications.

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