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Analysis of Effect of Nitrogen Implus GTAW Welding Pipe Material SUS 304

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Abstrak-Pengelasan Tungsten Inert Gas adalah salah satu teknik pengelasan yang digunakan secara luas untuk menyambung besi dan logam bukan besi. Proses pengelasan TIG memiliki beberapa keuntungan seperti menyambung logam yang berbeda, pengaruh daerah panas rendah, tidak ada terak dan sebagainya dibandingkan dengan pengelasan MIG. Ketelitian dan kualitas sambungan las sebagian besar tergantung pada jenis catu daya (DCSP dan DCRP), kecepatan pengelasan, jenis pelindung gas mulia yang digunakan. Penulisan ini berhubungan dengan penelitian tentang pengaruh penggunaan gas nitrogen terhadap hasil pengelasan. Diperoleh hasil lasan yang bagus dan rata. Kondisi di dalam dinding pipa telah dilas tetap bersih tanpa kotoran dan sisa lasan yang tak Nampak menempel. Hasil x-ray terlihat bagus dan tidak ada rongga. Gambar yang diperoleh untuk pengelasan menggunakan impulse gas nitrogen hasilnya lebih baik karena bentuk sudut V terisi penuh atau tidak ada cacat las pada logam las.

Kata Kunci: pengelasan TIG, SUS 304, impuls nitrogen, sinar x

Abstract-Tungsten Inert Gas welding is one of the widely used techniques for joining ferrous and non-ferrous metals. TIG welding process offers several advantages like joining of unlike metals, low heat effected zone, absence of slag etc compared to MIG welding. The accuracy and quality of welded joints largely depends upon type of power supply (DCSP or DCRP), welding speed, type of inert gas used for shielding. This paper deals with the investigation of effect of use nitrogen gas to weld results. A good weld and flat was obtained. The conditions inside wall of the pipe has been welded kept clean without droppings and invisible residual welds attached. The results of x-ray can be saw great results no cavities, photograph obtained for welding use the nitrogen gas welding impulses better results because of its shape at the corner V filled or no weld defects in the weld metal

Keywords: TIG welding, SUS 304, impulse nitrogen, x-ray

1. Introduction

Austenitic stainless steel welding is widely performed in the fabrication of various components for the chemical, pharmaceutical, nuclear, food processing and other industries. In these areas, the welding of piping must be of a quality that will safe guard the full operating life of the plant and will avoid costly shutdowns for reasons of weld repairs.

The oil and gas plants must select the most cost-effective and reliable materials due to their diverse applications and conditions. Much oil and gas technology is mature practice. In large part, the stainless steels are employed in plant and associated equipment where the corrosion resistance of plain carbon or low-alloy steels is in adequate. The austenitic grades find applications where their excellent elevated temperature or cryogenic mechanical properties are of advantage (Gooch,T.G.2010).

Welding is the simplest and easiest way to join sections of pipe. Welded pipe has reduced flow restrictions compared to mechanical connections and the overall installation costs are less. Shielding is obtained from a gas or gas mixture. For the high-quality stainless steel pipe welds required for power plants, petrochemical facilities, pharmaceutical, brewery, and food processing factories, the gas tungsten arc welding (GTAW) process is preferred (Bergquist et al., 2011). Raafal et l. (2009) stated that stainless steel is used when both the properties of steel and resistant to corrosion are required. The welding of automotive exhaust gas systems, stainless steel pipes, repairing of chemical industries equipments, etc. are done with the help of Tungsten Inert Gas Welding (Lothongkum et al., 2001). Austenitic stainless steels are probably the most commonly used material of all the stainless steels. Typically, in all arc welding processes, problems such as chemical in homogeneities in the weld, microporosity, cold laps, microfissures, and hot cracks reduce the quality of the joint (Malik,1981). Austenitic stainless steels are particularly prone to the hot cracking phenomenon. It has been determined however, that hot cracking may be reduced in austenitic stainless steel weldments by using filler materials that contain a small percentage of retained ferrite (Sadek and El-Sheikh, 2000;Vannan and Thangavel, 1978; David et al.,1979). Singh et al. (2003) evaluated fatigue life on Gas Tungsten Arc Welded (GTAW) load-carrying cruci form joint so fAISI304L stainless steel with Lack of Penetration (LOP) using conventional S-N and crack initiation-propagation (I-P) methods. Sonsuvitet al.(2005) investigated the effects of TIG pulse welding parameters and nitrogen gas mixed in Argon shielding gas on weld bead formation and microstructure of weld metals of AISI 304L stainless steels at the10-h welding position.

There is little published literature about the effects of purging gases on the microstructural, corrosion, and mechanical properties of SUS304 austenitic stainless steel that is applicable to the oil and gas industry and refinery applications where severe corrosion conditions are common. Thus, the aim of this study was to detect the effects of purging gases on the microstructural properties, corrosion resistance, and mechanical properties of the GTA welded joints of SUS304 stainless steel pipes used in refinery applications.

2. Research Method

2.1 Materials

Chemical composition of the base metals, filler metal and shielding gas used in the experiments is given below.

2.1.1 Chemical Composition

Table1 presents the chemical analysis and transverse tensile properties for SUS 304 stainless steel pipe with 3,6 mm wall thickness and 50,8 mm in-diameter, 57,1 mm out-diameter.

2.1.2 Filler metal

Table 2 presents the Mechanical Properties. The filler metal used in this project is a stainless steel AWS.A5.9: ER308 filler rod of Ø1.6mmx 1000 mm. The chemical composition of filler rod is given on Table 3.

2.2 Experiment procedure

To achieve the objectives of this second stainless steel pipe is set up according to the figure 1, then the second pipe welding studs to prevent changes in the dimensions in figure 2. After welding studs on both the 304 stainless steel pipe, then both ends of the 304 stainless steel pipe wrapped with tape.The following also with the results shown in figure 3. The hose connections are nitrogen gas was added to 304 stainless steel tubing, then TIG welding is done gradually by opening masking tape on the weld studs and done gradually shown in figure 3.

3. Result and Discussion

Figure 4 shows a comparison of the results of welded connections without impulse and with impulse nitrogen. Impulse welding with additional nitrogen is not found dirt and smooth in the wall area welds in pipes that occur in areas near the connection, but otherwise without using impulse nitrogen contained dirt and flakes in the wall area welds in pipes that occur in areas near the connection close connection results. The joint without any purge gas nitrogen revealed a wide chromium oxide layer. This oxide layer decreases the corrosion resistance since it contains chromium that has been taken from the metal immediately beneath this layer. These flakes will cause cavitation in the pipe, which will cause the erosion of the pipe wall. Erosion occurs continuously causing pipe leaks that would cause an explosion as seen on Figure 5.

Table 1. Chemical Composition and Mechanical Properties

Carbon (C)	Silicon (Si)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)	Nickel (Ni)	Chromium (Cr)
≤ 0.08%	≤1.00%	≤2%	≤0.045%	≤0.030%	≤8-10.5%	≤18.00-20.00%

Table 2. Mechanical Properties

Density (kg/m3)	Young's Modulus (GPa)	Tensile Strength (MPa)	Yield Strength (MPa)	Poisson's ratio	Density (kg/m^3)	Young's Modulus (GPa)
8000	190	520	240	0.27-0.30	8000	190

Table 3. Composition of ER 308

Carbon (C)	Silicon (Si)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)
0,01 – 0,15%	0,80 – 1,15%	1,85%	< 0,025%	<0,35%

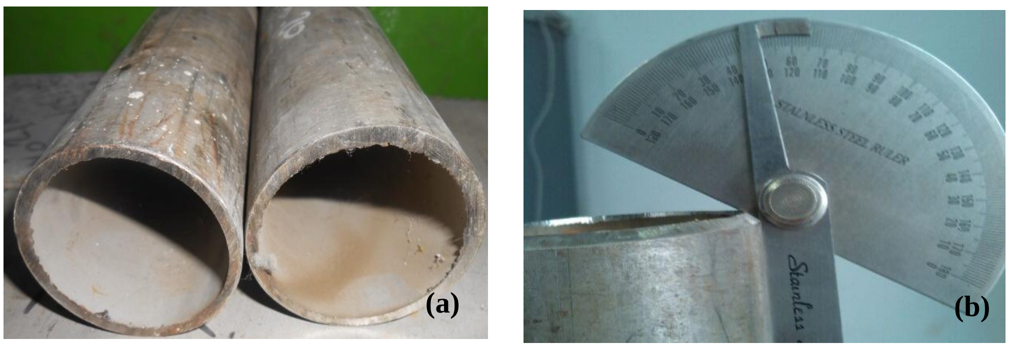

Figure 1(a). Material stainless steel 304 pipe and (b) groove V = 45^0

Figure 6 showed the photos x- ray welds result, found that the welding nitrogen without additional impulse there is a gap, this gap affects microporousity and corrosion. In contrast with the results of additional nitrogen impulse welded connection not found gap. Nitrogen was added to the shielding and/or purging gas mainly to improve pitting corrosion resistance but also to improve mechanical strength to some extent. Corrosion resistance at the root side was also increased by using pure N_2 in the purging gas.

Figure 2. Tack welding at both 304 stainless steel pipe

Figure 3. Pipe wrapped in duct tape

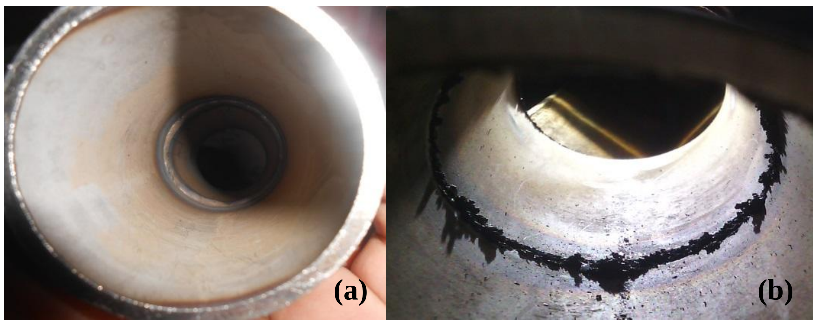

Figure 4. Result TIG welding (a) using nitrogen gas impulse (b) without nitrogen gas impulse

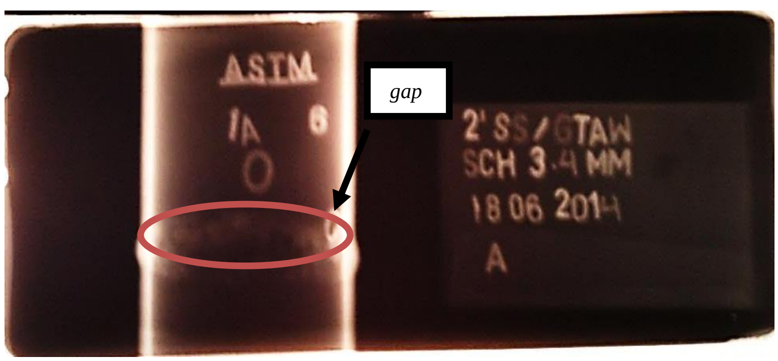

Figure 5. Results of X-Ray in TIG welding Without Using Impulse Gas Nitrogen.

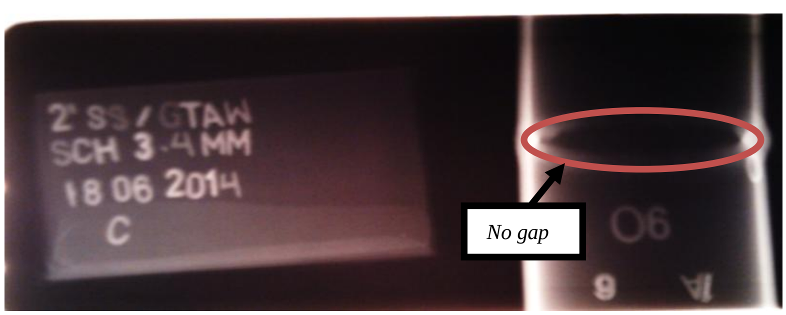

Figure 6. The X-Ray of TIG welding using Nitrogen Gas Impulse

4. Conclusion

1. Properties of the nitrogen and argon purged joints and hence it can be concluded that nitrogen can very well be used as a purging gas in the welding of austenitic unstabilized stainless steels.
2. Nitrogen is just used as a flux to avoid oxidation due to air from atmosphere
3. Nitrogen is used to prevent porosity in the welding member by preventing oxygen
4. The effect of nitrogen content in the argon shielding gas of tungsten inert gas (TIG) welding on the corrosion resistance of a stainless steel

References

Bergquist, E.L., Huhtala,T., and Karlsson, L. (2011). The effect of purging gas on 308 LTIG root pass ferrite content. Welding in theWorld3/4, 55:57–64.

David S.A., Goodwin GM. And Braski D.N., (1979). Solidification behavior of austenitic stainlesssteel fillermetals, Welding Journal,Vol.58, No.11, p.330-s– 336-s.

Gooch, T.G.(2010).Welding new stainless steels for the oil and gas industry. TheWelding Institute,March,16pages.

Lothongkum G, Viyanit E, Bhandhubanyong P. (2001). Study on the effects of pulsed TIG welding parameters on delta-ferrite content, shape factor and bead quality in orbital welding of stainless steel plate. J Mater Process Technol 110 233-238.

Malik R.K., (1981).HIP heals defects in austenitic stainless steel welds, Metal Progress,Vol.119, No.4, p.86.

Palaniappan M., Subbaratnam R., BaskaranA., Chandramohan R.,(1996). Effect of repeated repairs on the stainlesssteel welds upon the ultrasonic examination sensitivity, 14thWorld Conference on Non Destructive Testing

Sadek A.Z., El-Sheikh A.M., (2000). Failure analysis of SS304 weldments by metallurgically enhanced stress corrosion cracking in laboratory environments, Corrosion 2000, Orlando.

Singh P.J.,Achar D.R.G, Guha B ,Nordberg H. (2003). Fatigue life prediction of gas tungsten arc welded AISI304 L cruci form joints with different LOP sizes, International Journal of Fatigue, Vol.25,No.1,pp.1-7.

Sonsuvit N., Somrerk C.-A., Gobboon L.,(2005). Effects of TIG pulse welding parameters and nitrogen gas mixed in argon shielding gas on weld bead formation and microstructure of weld metals of AISI304 L stainless steels at the10-h welding position, Session PE3: Pipeline Symposium: Properties & Structures.

Raafal M. Molak, Krystian Paradowski, (2009) Measurement of mechanical properties in 316L stainless steel welded joint, Int.J.Pressure vessels and piping, 86 (43-47).

Vannan K.V., Thangavel B.,(1978). Occurrence of delta ferrite in type 304/304L stainless steel pipe welds, The Third International Symposium of the Japan Welding Society, Tokyo, Japan, Delhi, India, 8–13 December.