OPTIMIZING THE ROOT GAP FOR ORBITAL WELDED SS321 PIPE

SREERAM SAI[1], Dr. L. SREE VARDHAN[2]

[1]SRF, CAS-DRDO
[2]SC- 'F', Technology Director (R&QA), CAS-DRDO.

Abstract – In this work Orbital welding of nine SS321 pipes is done with root gap of 0.05mm ,0.10mm, 0.15mm, 0.20mm,0.30mm. Filler gauge is used to maintain the gap between workpieces. After the welding done, now welded samples are investigated for Radio Grapy Test to check weld defects if any. After the RT test done, weld samples are tested for tensile strength using universal Testing Machine. We now examine the behavior of weld samples at various root gaps as mentioned above.

***Key Words*: Orbital welding, SS 321,UTM, Radio Graphy Test, Tensile test.**

1. INTRODUCTION

Orbital welding is a specialized arc welding process whereby tubes or pipes are secured as the electrode rotates (or orbits) around the object to form the weld. Orbital welding is a specialized area of welding whereby the arc is rotated mechanically through 360° (180 degrees in double up welding) around a static workpiece, an object such as a pipe, in a continuous process. The process was developed to address the issue of operator error in gas tungsten arc welding processes (GTAW), to support uniform welding around a pipe that would be significantly more difficult using a manual welding process, and to ensure high quality repeatable welds that would meet more stringent weld criteria set by ASME. In orbital welding, computer-controlled process runs with little intervention from the operator.[1]

History: The orbital welding process was invented by Rodrick Rohrberg of North American Aviation to address fuel and hydraulic fluids leaking in and around the plumbing of the X-15 Rocket Research plane.

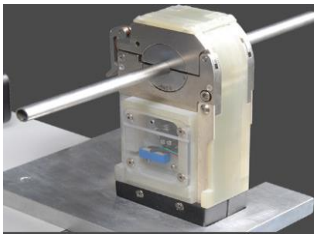


Fig 1.Chucks holding ss pipes

Fig 2.Orbital Welding Machine

1.1 Material Properties (SS321 or ER347)

- Density : 8027 gm/cm3
- ID : 6mm
- OD : 8mm
- Thickness : 1mm
- Temperature Range: 538 to 870 degree C
- Tensile Strength: 515 Mpa
- Yield Strength : 205 Mpa
- Elongation : 40%
- Rockwell Hardness : 95 HRB

Fig 3. SS321 Pipes ready for welding process

1.2 Weld parameters:

- Pre purging : 30secs
- Post purging : 30secs
- Purging gas : Inert gas
- Overlap : 10 degrees
- Gas flow force : 15 lit/min(initially given)
- Gas flow force : 12 lit/min(intake)
- Rotor start delay : 5secs
- Down slope time : 5 secs
- Gas Flow force time : 10secs(at the end of the weld)
- Final current : 5 amps(at the end of the weld)

2. WELDING METHODOLOGY

6/8 SS321 Pipe is used for welding. Orbital welding is done on the 9 specimens of SS321 pipe by the following root gaps.Filler gauge is used to put the root gap between the pipes to be welded after one pipe is clamped.

Joint	Root Gap in mm
1	0.05
2	0.05
3	0.10
4	0.10
5	0
6	0.20
7	0.20
8	0.30
9	0.15

Table1. Joint & Root Gap

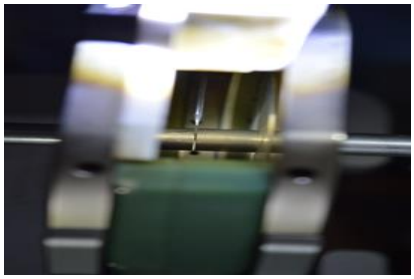


Fig 4. SS321 Pipe with root gap clamped in the collar chuck

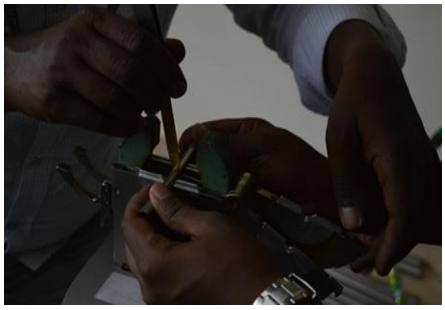


Fig 5.Filler gauge used to specify root gap

LEVEL	ANGLE IN DEGREES	HP/LP Current in amps	Rotor speed	HP/LP Time in secs
1	90	31/12	80mm/min	0.10
2	180	28/11.5	80mm/min	0.10
3	270	28/11.5	80mm/min	0.10
4	370	28/11.5	80mm/min	0.10

Table2. Weld Mechanism

Fig 6.Orbital Welded ss pipe at root gap 0.05 mm

Fig 6.Orbital Welded ss pipe at root gap 0.10 mm

Fig 7.Orbital Welded ss pipe at root gap 0.20mm

Fig 8.Orbital Welded ss pipe at root gap 0.15mm

Fig 9.Orbital Welded ss pipe at root gap 0.30mm

3. RADIOGRAPHY TESTING

- Radiographic Testing (RT) is a non-destructive testing (NDT) method which uses either x-rays or gamma rays to examine the internal structure of manufactured components identifying any flaws or defects.
- In Radiography Testing the test-part is placed between the radiation source and film (or detector).
- 9 welded specimens are sent for radiography testing.

Fig 10.RT Testing Machine

4. TENSILE TEST (UTM)

Tensile Test is performed on Universal Testing Machine to examine the variation of Ultimate Tensile Strength of Orbital Welded Specimen Pipes at various Root Gapes.

Fig 11.Universal Testing Machine pipes gripped in chucks

5. RESULTS & DISCUSSIONS:

The results obtained from RT Test and Tensile test are as fallows :

RT Test shows fallowing Impressions and defects

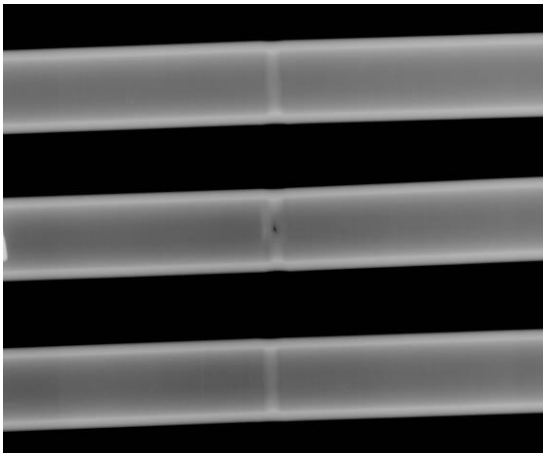


Fig 12. Mild Porosity defect at 0.20 root gap as shown above in middle specimen

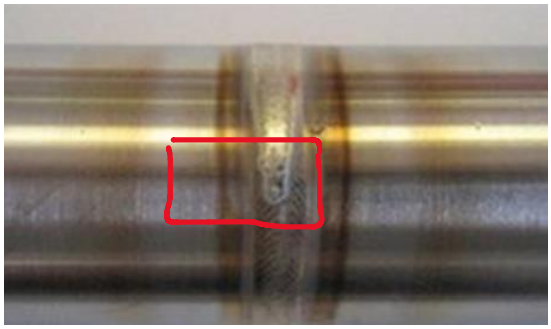
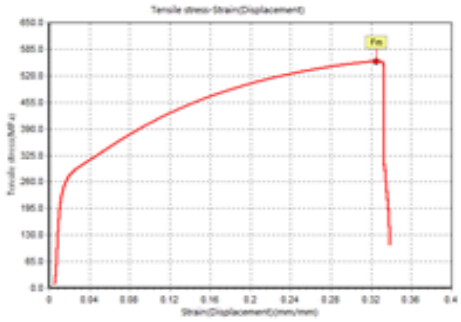


Fig 13. Mild Porosity defect at 0.20 root gap as shown above on specimen

Tensile Test shows fallowing results :

S.no	Maximum load (kN)	Tensile strength (MPa)	Upper yield load (kN)	Upper yield strength (MPa)	Lower yield load (kN)	Lower yield strength (MPa)
1	12.2	555	5.55	252	5.55	252

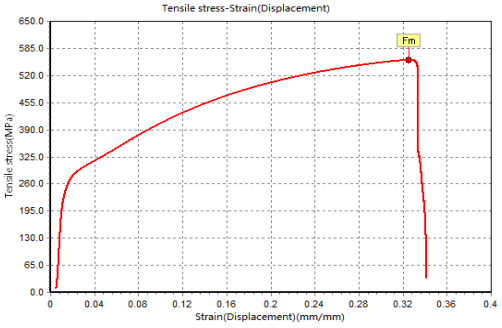
Table 3. Tensile test report for 0.05 mm root gap



Graph1. Tensile stress (mpa)vs Displacement(mm) for 0.05 mm root gap

S.no	Maximum load (kN)	Tensile strength (MPa)	Upper yield load (kN)	Upper yield strength (MPa)	Lower yield load (kN)	Lower yield strength (MPa)
1	12.27	558	5.59	254	5.59	254.5

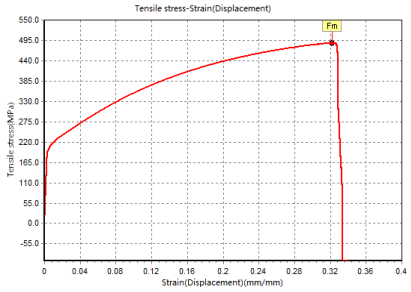
Table 4. Tensile test report for 0.10 mm root gap



Graph2. Tensile stress (mpa)vs Displacement(mm) for 0.10 mm root gap

S.no	Maximum load (kN)	Tensile strength (MPa)	Upper yield load (kN)	Upper yield strength (MPa)	Lower yield load (kN)	Lower yield strength (MPa)
1	11.67	530.2	5.3	241	5.3	241

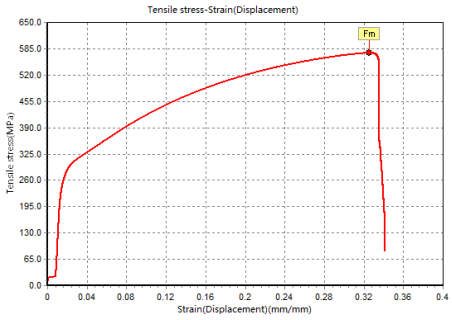
Table 5. Tensile test report for 0.20 mm root gap



Graph3. Tensile stress (mpa)vs Displacement(mm) for 0.20 mm root gap

S.no	Maximum load (kN)	Tensile strength (MPa)	Upper yield load (kN)	Upper yield strength (MPa)	Lower yield load (kN)	Lower yield strength (MPa)
1	12.63	574	5.76	262	5.76	262

Table 6. Tensile test report for 0.15 mm root gap



Graph4. Tensile stress (mpa)vs Displacement(mm) for 0.15 mm root gap

6. CONCLUSIONS

From the above tensile test results & RT Radio Grapy test results, we can conclude that Average Ultimate Tensile Strength is high for the specimen with root gap 0.15mm and the porosity Weld Defect is seen in RT Radio Grapy Test for the specimen with Root Gap 0.20mmand weld is not formed for specimen with Root Gap 0.30mm.

We can finally conclude that best suitable root gap for SS321 pipe is found to be 0.15mm beyond this root gap weld formed may have weld defects as porosity seen above in Fig12&Fig13. At 0.30mm root gap weld cannot be formed. Best suitable root gap for SS321 is 0.15mm.

7. FUTURE SCOPE

Orbital Welding can be performed on similar or dissimilar metals by considering various other parameters like deformation characteristics of the metal, angle of tool, Amperage, travel speed, wire speed.

REFERENCES

1. Orbital TIG Welding Handbook by AXXAIR: https://offres.axxair.com/en/download-orbital-tig-welding-handbook
2. "Orbital Welding vs. Traditional GTAW". Critical Systems Inc. Retrieved 7 February 2015.
3. Roderick, Rohrberg "Welding Apparatus" patent nr US3238347A, Washington, United States Patent Office, 26 Oct 1964.
4. "Orbital vs Manual TIG Welding - SFI Orbital Blog". SFI orb Imax Blog. 2017-11-17. Retrieved 2018-09-01.
5. R. Patro et al. Finite element model simulation and optimization of an orbital welding process parameter