Weld Bead Morphology and Mechanical Characterization of Dissimilar Weld of Duplex and Ferritic Stainless Steel

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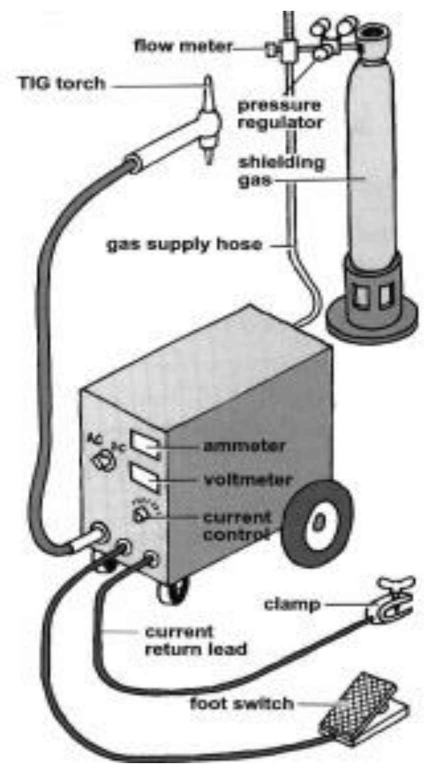
ABSTRACT

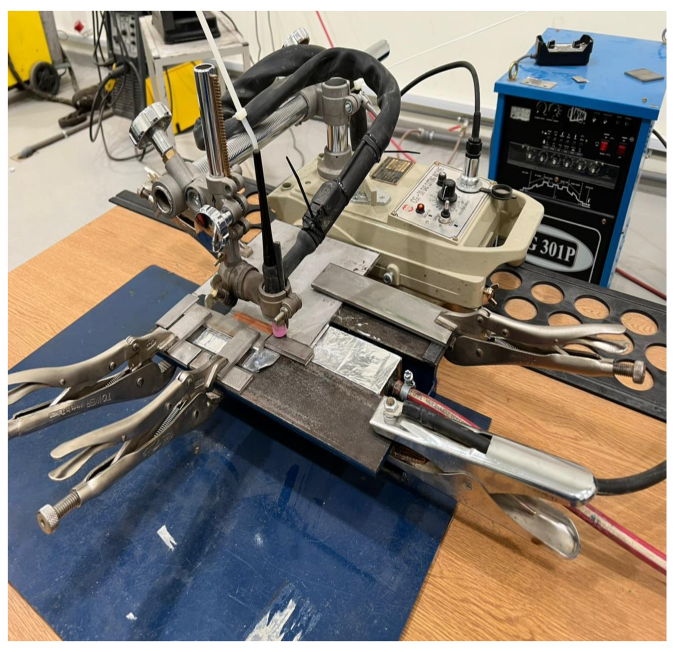
Welding is an important process in many industries such as aeronautics, nuclear, cryogenics, marine, and offshore platforms. TIG (Tungsten Inert Gas) welding is a common arc welding technology used for its high-quality beads at minimal investment and running costs. It is constrained by the low depth of penetration. The ATIG (Activation Tungsten Inert Gas) technique is a good solution for boosting weld penetration. This study investigates the welding joint shape and mechanical properties (tensile, microhardness and impact tests) of TIG and ATIG welding of dissimilar duplex stainless steel and ferritic stainless steel. Depth and width of welds as well as tensile, hardness and impact tests have been taken to compare between TIG and ATIG dissimilar welds. The effects of adding 2% azote gas to argon shield gas on the mechanical properties are also studied.

MATERIALS and EXPERIMENTATION

The experimental work is focused on comparison of weld depth (D) and weld ratio (R).

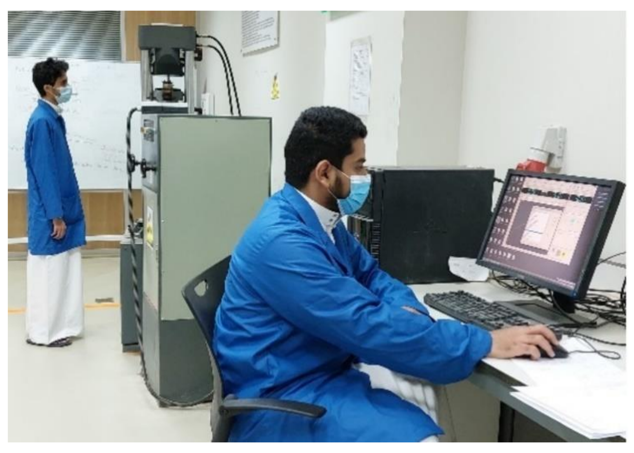


Typical TIG welding machine.



Motorized carriage TIG welding machine.

Chemicals and oxides.



Students operating on the tensile test machine.

OBJECTIVES

- ✓ Elaboration of the optimal flux.
- ✓ Comparison between morphology of conventional TIG weld and ATIG weld.
- ✓ Study the effect of adding 2% azote gas to argon shield gas on the mechanical properties.

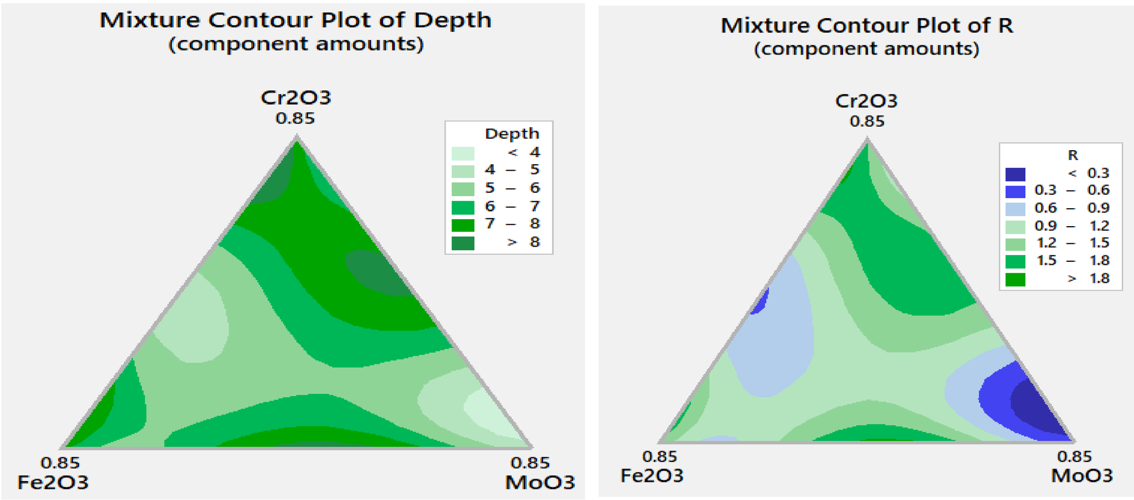
CONSTRAINTS

Our study takes in consideration **Safety, Environment** and **Economy**.

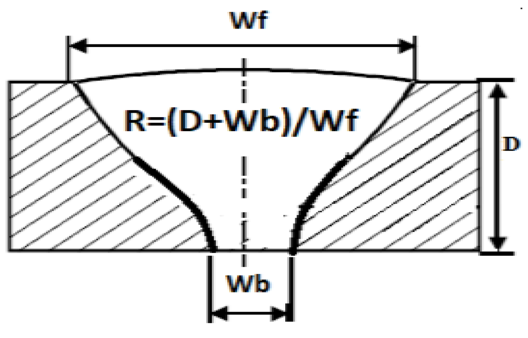
RESULTS

❑ Design of experiments

Among sixteen oxides, three oxides (MoO_3-Fe_2O_3-Cr_2O_3) that gave the highest depth were selected for the optimal combination. Based on Minitab17 software, nineteen combinations were prepared using design mixing method. Optimizer module available in Minitab is used to get the best formulation of flux.

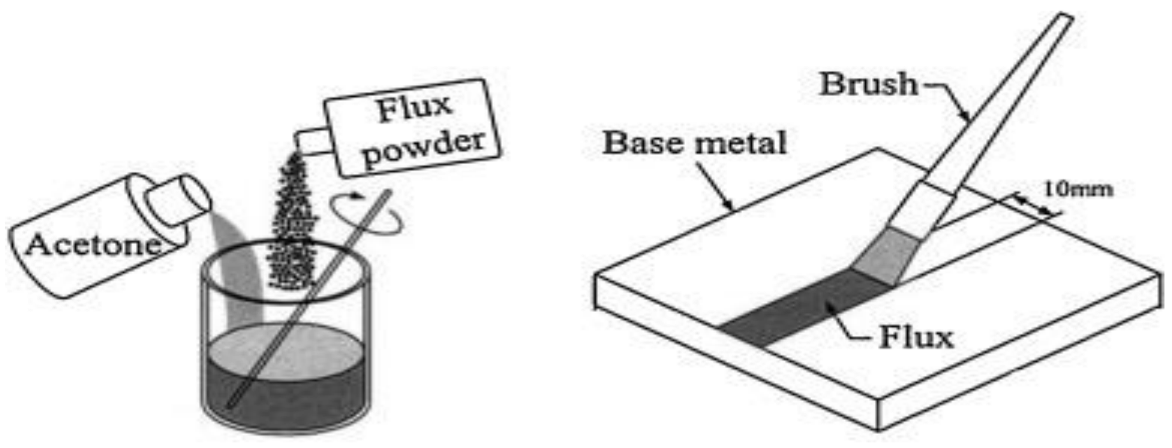


Mixture contour plot for depth D and ratio R.



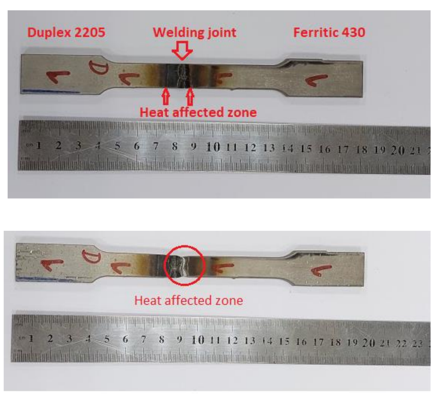
	Depth D	Wf	Wb	Ratio R
TIG	2.98	12	-------	0.25
ATIG	8	10	7.65	1.57

Morphology of ATIG and conventional TIG weld results with 100% argon

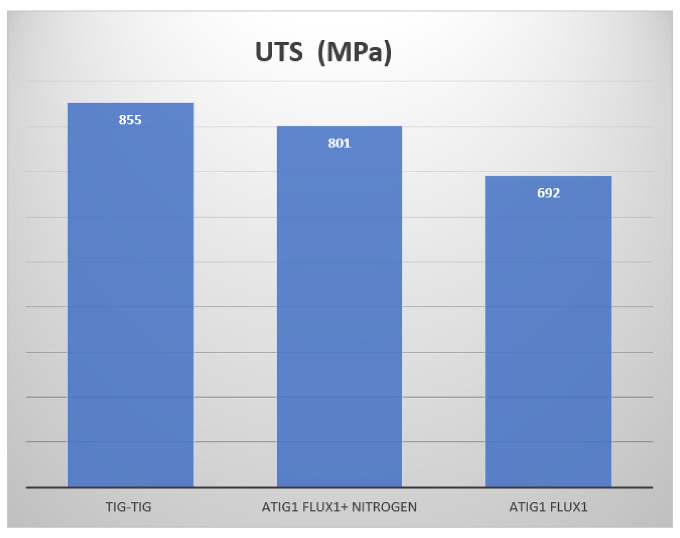


Flux preparation and deposition on welding sample.

❑ Tensile test

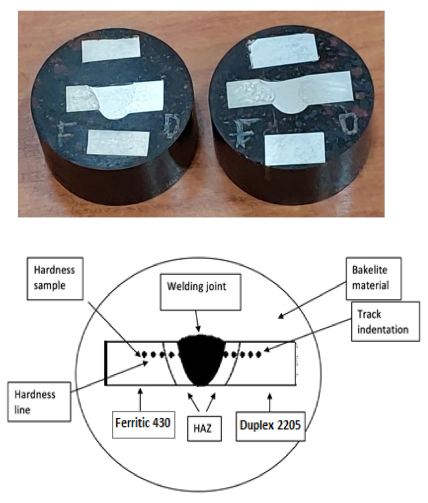


Sample before and after the tensile test.

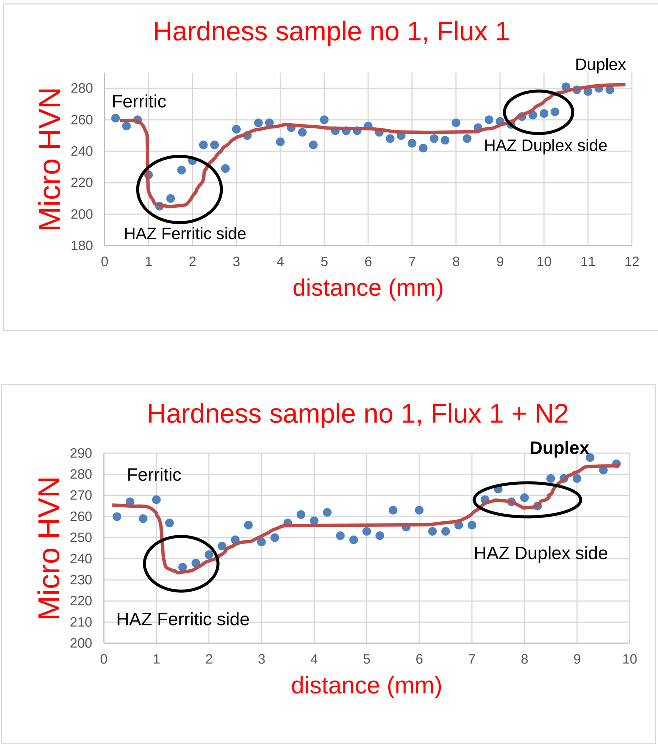


Tensile test results.

❑ Hardness test



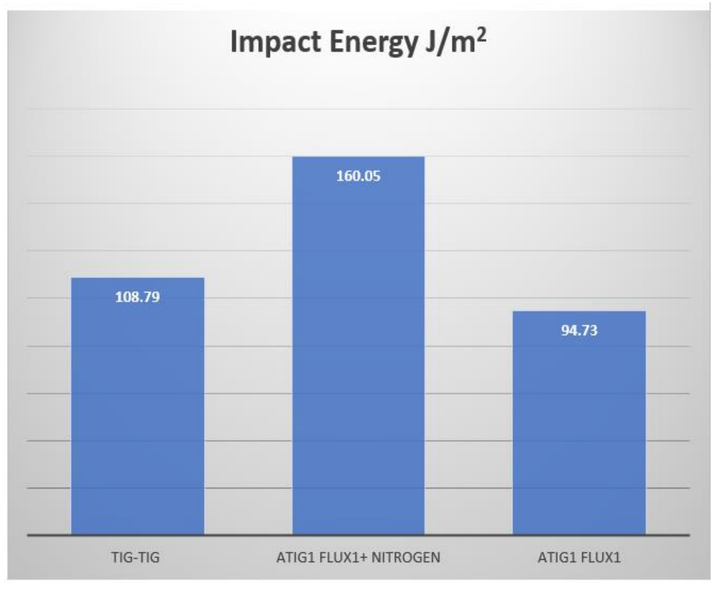
Hardness samples.



Hardness test results.

❑ Impact test

Sample before and after the impact test.



Impact test results.

CONCLUSION

- ❖ The optimal flux is composed of **75% Cr_2O_3+9% Fe_2O_3+1% MoO_3+10% Ni+5% CuO.**
- ❖ ATIG depth is increased by **2.68** times and the ratio is increased by **6.28** compared to TIG.
- ❖ Adding Nitrogen gas to the shielding gas (Argon) has positive effects on the strength, hardness, and impact energy.

Saudi Arabia, Prince Sattam bin Abdulaziz University, College of Engineering, Mechanical Engineering Department