EFFECT OF NITROGEN CONTENT IN ARGON SHIELDING AND BACKING GASES ON PROPERTIES OF HYPER DUPLEX UNS S32906

By

Mohamed Mahmoud Ali Ali Hassan

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENC
in
METALLURGICAL ENGINEERING

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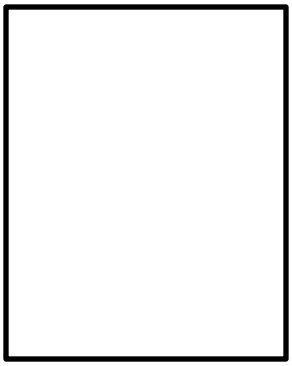

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Title of Thesis: Effect of nitrogen content in argon shielding and backing gases on properties of hyper duplex UNS S32906.

Key Words

Hyper duplex; nitrogen; shielding gas; backing gas; root weld; corrosion

Summary: This research was aimed at investigating the effect of shielding and backing gases composition by supplementing nitrogen compared to usage of pure argon on: **(i)** microstructure of hyper duplex stainless steel root weld and phase balance within the weld regions; **(ii)** mechanical properties of the root weld zone in terms of amount of impact toughness and Vicker's hardness; **(iii)** ferrite Content measurement); **(iv)** susceptibility to pitting corrosion in terms of mass losses It was found that adding 2% nitrogen to argon in the composition of the shielding/backing gases in welding the root passes by gas tungsten arc welding process significantly improves the weld mechanical characteristics, phase balancing and noticeably enhances the corrosion resistance of the weldment. This is related to nitrogen which is a strong austenite stabilizer which leads to increase the austenite content in the weld zone during welding. And it was found that inferior mechanical properties, imbalanced microstructure which leads to poor corrosion resistance in the root weld zone were obtained in case of using pure argon gas as a shielding/backing gas.

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List of Symbols and Abbreviations

AISI	**American Iron and Steel Institute**
AMS	**Aerospace Material Specifications**
ASME	**American Society of Mechanical Engineers**
ASTM	**American Society for Testing and Materials**
ASS	**Austenitic Stainless steel**
SASS	**Super Austenitic Stainless steel**
AWS	**American Welding Society**
SAE	**Society of Automotive Engineers**
API	**American Petroleum Institute**
BCC	**Body Centered Cubic**
BHN	**Brinell Hardness number**
C	**Carbon atom**
CCT	**Continuous Cooling Transformation**
Cm	**Centimeter**
CVN	**Charpy V-Notch (Impact Test or Specimen)**
Cr	**Chromium**
Cr2N	**Chromium Nitrides**
CR	**Corrosion Resistant**
CSCC	**Chloride Stress Corrosion Cracking**
DBTT	**Ductile-To-Brittle Transition Temperature**
EDS	**Energy-Dispersive Spectroscopy**
etc.	**et cetera (and so forth)**
FCC	**Face Centered Cubic**
FCAW	**Flux-Cored Arc Welding**
Fe	**Iron**
FeCL3	**Ferric Chloride**
FIG.	**Figure**
FN	**Ferrite Number**
GMAW	**Gas Metal Arc Welding**
GTAW	**Gas Tungsten Arc Welding**
HAZ	**Heat Affected Zone**
H_2S	**Hydrogen Sulfide**
HDSS	**Hyper Duplex Stainless Steels**
HD	**Hyper Duplex Stainless Steels**
HIC	**Hydrogen Induced Cracking**
HV	**Vickers hardness**

- **IIW** International Institute of welding
- **IGA** Intergranular Attack
- **IGSCC** Intergranular Stress Corrosion Cracking
- **ISO** International Organization for Standardization
- **J** Joule
- **Kev** Kilo Electron Volt
- **KSI** (1000 lb.) per Square Inch
- **M** Meter
- **Mo** Molybdenum
- **MC** Metal Carbides
- **MIC** Microbiologically Influenced Corrosion
- **MPa** Mega Pascal
- **NACE** National Association of Corrosion Engineers
- **N** Nitrogen atom
- **NA** not available
- **NAOH** Sodium Hydroxide
- **NACL** Sodium Chloride
- **Ni** Nickel
- **OFW** Oxy fuel gas welding
- **OP** Optical microscope
- **PAW** Plasma arc welding
- **Para.** Paragraph
- **PMI** Positive Material Indicator
- **Ppm** Parts per Million
- **PPt.** Precipitates
- **Psi** Pound per Square Inch
- **PQR** Procedure Qualification Record
- **PRE** Pitting Resistance Equivalent
- **PREN** Pitting Resistance Equivalent Number
- **PWHT** Post Weld Heat Treatment
- **REF** Reference
- **SAW** Submerged Arc Welding
- **SiC** Silicon Carbides
- **SCC** Stress Corrosion Cracking
- **SEM** Scanning Electron Microscope
- **SMAW** Shielded Metal Arc Welding
- **TGSCC** Trans -granular Stress corrosion Cracking