UNCLASSIFIED

OAK RIDGE NATIONAL LABORATORY

Operated By

UNION CARBIDE NUCLEAR COMPANY

POST OFFICE BOX P
OAK RIDGE, TENNESSEE ORNL
CENTRAL FILES NUMBER

CF-56-8-125

External Transmittal
Authorized

COPY NO. 47

DATE: August 20, 1956

SUBJECT: Use of Nitrogen as Inert Gas Backing in
Welding Austenitic Stainless Steels

TO: G. M. Adamson

FROM: W. J. Leonard

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

Photostat Price \$ 1.80

Microfilm Price \$ 1.80

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

UNCLASSIFIED

338 001

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

UNCLASSIFIED

G. M. Adamson

-2-

August 20, 1956

Summary

Results are reported on welds made with HRP-2 procedures, except various grades of nitrogen are used as the back-up gas. A recommendation is made that, in the interest of economy, National Cylinder Gas (High Purity Dry) nitrogen be used as the back-up gas in HRP welding.

Discussion

The present specification for welding austenitic stainless steel (HRP-2A) requires the use of argon or helium gas for use as the inert blanket on the back side of welds. The possibility of using nitrogen gas for this application was considered over a year ago. Welds were made in 1/4-in. type 347 plate using argon, helium and nitrogen. Mechanical properties were evaluated and corrosion properties in uranyl sulphate solutions were determined.¹ The results of this study indicated there was no difference in microstructure or dynamic corrosion resistance in the solution used for welds made with helium, argon or nitrogen.

-
1. W. J. Leonard et al, HRP Quar. Prog. Rep., Oct. 31, 1955, ORNL-2004, p. 156.
-

During the intervening time, numerous welds have been made in welder training, welding development, non-critical equipment in 9204-1 and other miscellaneous service in which the HRP-2A specifications were met, except nitrogen was substituted as the back-up gas. Since from this experience, nitrogen appeared to be satisfactory, a study of the effects of the impurities in the various available grades was made. Average chemical analyses from cylinders of each type are presented in Table I. The original work had been carried out with K-25 water-pumped gas. Also available on the area are National Cylinder Gas Liquid Pumped (High Purity Dry) and Linde (High Purity Dry) cylinders.

Table I. Average of Chemical Analyses (ppm) for Oxidizing Gases in Inert Gas Available at Y-12 Plant

Grade	O ₂	CO ₂	H ₂ O	Others
Nitrogen K-25	125	1	4	CH ₄ 9 A-25
Nitrogen N. CG	18	1	2	A30
Nitrogen Linde	< 2	0	< 1	--
Helium U.S. Govt. (Cylinder)	5	--	1	--

UNCLASSIFIED

395 002

UNCLASSIFIED

G. M. Adamson

-3-

August 20, 1956

Table 1 (Continued)

Grade	O ₂	CO ₂	H ₂ O	Others
Helium--Tank Car; Y-12 Plant Gas Line	2	--	<1	--
Argon Linde (99.9% min.)	8	--	1	--

In order to systematically evaluate the effects of different grades of nitrogen on the type of surface film, surface contamination, mechanical properties, and micro-structure of the weld, the following experimental program was pursued.

A welder, qualified under HRP-2A specifications, went through a requalification using each grade of nitrogen. Four pipe welds, using 2-in. schedule 80, type 347 material, were made with each grade of nitrogen. Tensile specimens, bend specimens, and micro-specimens were taken from each weld.

The welds made with K-25 type nitrogen would often exhibit a thin yellow to purple film at some positions. The other grades had no film that contained color. Root and face bend samples made from all welds bent 180 degrees in the guided bend test. Mechanical properties are summarized in Table 2.

Table 2. Mechanical Test Results on Type 347 Stainless Steel Weld Specimens. Bend 180° Satisfactory

Specimen	Tensile Strength* (psi)	Per Cent Elongation 1-1/4 in.
K-25	70620	40
K-25	76680	37.5
Linde	78780	40
Linde	73530	42.5
N. CG.	71430	42.5
N CG.	72410	50

*All specimens broke in base metal.

UNCLASSIFIED

395 003

UNCLASSIFIED

G. M. Adamson

-4-

August 20, 1956

T10711

Fig. 1. Type 347 Stainless Steel Guided Face And Root Bend Specimens.

UNCLASSIFIED

395 004

UNCLASSIFIED

G. M. Adamson

-5-

August 20, 1956

The average microhardness (VPN 100 g load) was 188, 195, 197, respectively, for weld metal using K-25, Linde and National Cylinder Gas nitrogen. The resulting microstructure does not vary using different grades of nitrogen. No increase in hardness or visible film could be noted near the root surface of any weld section. Comparisons of these data with mechanical properties and micro-sections of welds made by HRP-2 specification using argon and helium showed no essential difference.

Since the K-25 nitrogen oxidizable gas content is not controlled as closely by specifications as the other two grades, oxidizable gas may be present up to 1000 ppm and still meet specifications. Although not encountered in the K-25 nitrogen used for this investigation, cylinders of this grade have been delivered to the weld test shop on occasion. For this reason, liquid pumped National Cylinder Gas Nitrogen (H-P Dry) is preferred for obtaining reliable quality gas. The K-25 gas would be acceptable provided each cylinder is checked for oxygen and water and a quality control procedure is established.

Cost-wise, a 220 cu ft cylinder of K-25 nitrogen is approximately \$1.00; National Cylinder Gas, \$2.00; Linde, \$6.85. A cylinder of Linde Argon is \$21.00 (approx); helium is \$7.00, but helium purging requires about three times the volume of argon or nitrogen used, which places argon and helium on the same relative cost level.

W. J. Leonard

WJL:fl