PROCESS DATA

FOR

"UNIONARC" WELDING

TRADE-MARK

Introduction

The welding of carbon steel constitutes about 90 per cent of the entire welding field. The UNIONARC welding process has been especially developed for the efficient and economical welding of carbon and low alloy steels and combines the versatility of manual covered electrodes with the high deposition rates of submerged arc welding.

Definition

UNIONARC welding is an electric arc welding process using bare wire automatically fed through a welding torch. A magnetic welding flux is suspended in a conveying gas stream and carried to the arc zone. The flux is attracted to the wire within the nozzle by the magnetic field established around the wire by the welding current (Figure 1). UNIONARC flux forms a slag that shields and refines the weld metal, preventing oxidation and nitration of the weld puddle. The carrier gas stream continues through the nozzle and acts as a supplementary shield for the weld.

Carbon dioxide is the carrier gas presently used for UNIONARC welding.

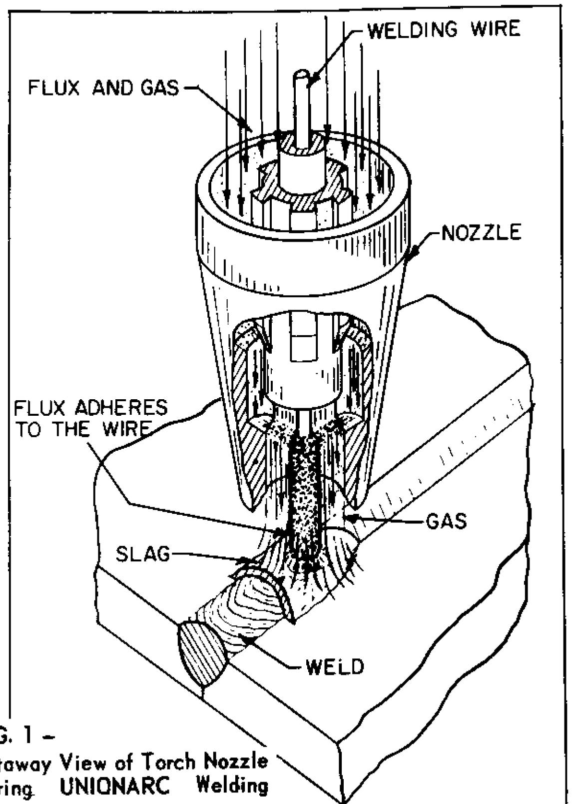

FIG. 1 - Cutaway View of Torch Nozzle During UNIONARC Welding

Be sure this information reaches the operator. You can get extra copies through any Linde office.

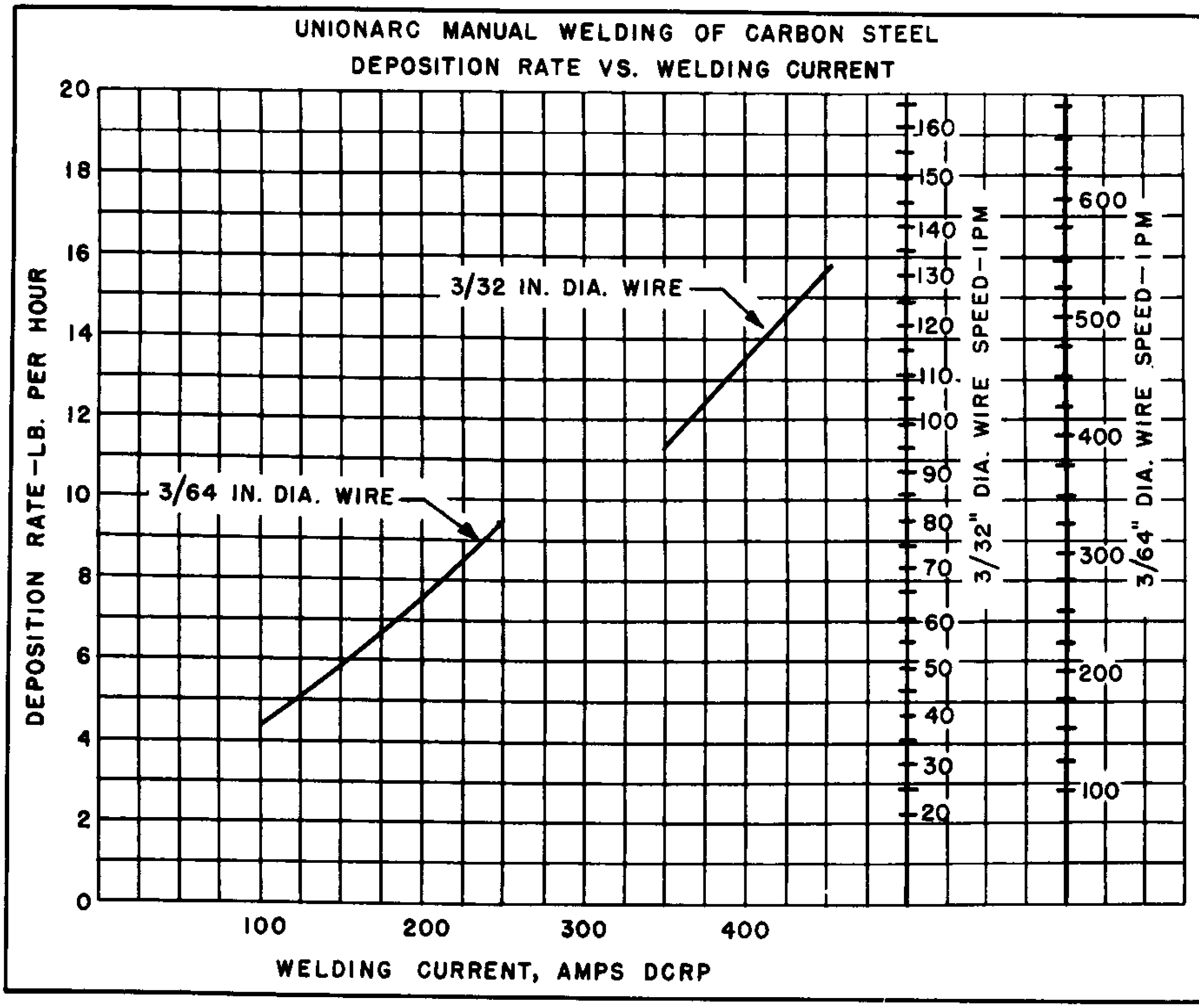

FIG. 2 – Deposition Rates for UNIONARC Welding Process

Advantages of UNIONARC Welding Process

A. High-Deposition Rates

Deposition rates for the UNIONARC welding process, using the UAM-1 Welding Machine, are approximately 0.6 lb. per min. per 1000 amp. for 3/32-in. wire and 0.67 lb. per min. per 1000 amp. for 3/64-in. wire. Figure 2 indicates deposition rates for both wire sizes at various welding currents. Extended production time studies have shown deposition rates averaging 50 per cent greater than with E-6010 and E-6012 electrodes. Deposition rates can exceed even those obtained with iron powder electrodes.

B. High Welding Speeds

Welding speeds are approximately 50 to 100 per cent greater than speeds obtained with covered electrodes.

C. Low Cost Welds

The high welding speeds attainable make UNIONARC welding a low-cost production-welding process. Moreover, since UNIONARC welding utilizes a continuously-fed electrode, the operator can devote more time to actual welding. The higher operating factor significantly reduces unit labor and overhead costs. Total welding costs for the UNIONARC welding process average 35 to 75 per cent less than those for covered electrodes.

D. All-Position Welding

Since the flux is gas-conveyed to the arc zone and is magnetically attracted to the welding wire, there is no physical limitation on the position of the torch or the angle of wire feed. Vertical, overhead or downhand welds can be made with equal or greater facility than with covered electrodes. Wire of 3/64-in. diameter is used for all-position welding. Wire of 3/32-in. diameter is preferred for flat position welding, because of the higher deposition rates obtainable with the increased current range for this wire.

E. High-Quality Welds

Multipass UNIONARC welds prepared in accordance with AWS-ASTM standards and tested as 0.505-in. dia. all weld metal specimens, show excellent physical and mechanical properties. Typical mechanical test data for UNIONARC welds are as follows:

Ultimate Strength	
As welded:	75,000 to 80,000 psi
Stress relieved:	Approximately 70,000 psi
Yield Strength	
As welded:	65,000 to 70,000 psi
Stress relieved:	Approximately 60,000 psi
Elongation in 2 inches	25 to 30%
Reduction of Area	60 to 70%
Charpy Vee Notch Impact Test	15 foot-pounds at -40 deg. F.

UNIONARC welds show a greater and more uniform weld penetration with considerably less tendency toward undercutting than those obtained with covered electrodes, and will readily meet ASME Boiler Code requirements. The welds are equal to or better than those obtained with E-6010, E-6012, E-6013, E-6020, E-6030, and iron powder electrodes.

F. Easy Bridging of Root Spaces

Root openings of as much as 1/8-in. can be readily bridged in both butt and fillet welding, with full penetration and excellent weld quality, without sacrificing speed of welding.

G. Tolerance for Rust

UNIONARC welding is relatively insensitive to plate composition and surface conditions. The presence of moderate amounts of surface rust, scale, dirt, or moisture does not noticeably affect weld quality. The use of oxygen-cutting equipment in preparing the base metal does not disturb the UNIONARC welding process.

H. Easy Slag Removal

The ease of slag removal is about comparable to that of covered electrode welds. Factors such as undercutting and spatter largely influence the degree of slag locking. In deep narrow grooves, slag removal may be reasonably difficult at times, as with other welding processes. On butt weld cover passes and fillet welds, the slag is virtually self-cleaning.

I. Easy Spatter Removal

Spatter from UNIONARC welding is not very tenacious and is readily removed from the torch nozzle and workpiece. During welding, spatter collects at the nozzle and after a short period of time, usually drops off. In time, a fine spatter collects around the bottom of the torch collet body and may impede the flow and distribution of UNIONARC flux. To avoid process difficulties, the spatter should be removed as necessary.

Equipment Requirements

The LINDE "UNIONARC" UAM-1 Welding Machine is designed for manual UNIONARC welding. Manual welding is the field in which there is the greatest need for the economic advantages of the UNIONARC welding process. See F-9812, "Instructions and Parts Data for the LINDE 'UNIONARC' UAM-1 Welding Machine".

UNIONARC Welding Process Characteristics

A. Arc Power Requirements

Constant potential arc power is preferred for the majority of applications. Constant potential arc power is significantly superior to conventional ("drooping" volt-ampere characteristic) power for operations at low welding currents since it prevents sticking of the wire to the workpiece, especially when variations of torch-to-work distance occur. Moreover, arc starting is easier with constant potential power. In position welding, where a short arc length must be maintained at relatively low current, constant potential arc power is by far the best.

For welding in the flat position, both conventional and constant potential arc power produce welds of equivalent quality and appearance.

B. Type of Welding Current

Direct current reverse polarity is preferred for manual UNIONARC welding because of its smooth operation. Straight polarity is usable to some extent with 3/32-in. dia. wire at welding currents on the order of 500 amperes, but excessive spatter renders it impracticable for most applications.

C. Welding Current Range

With 3/32-in. dia. wire, welding currents are usually in the range of 350 to 475 amperes DCRP. Usually a welding current of approximately 400 amperes will be completely satisfactory for downhand welding.

With 3/64-in. dia. wire, welding can be performed in the range of 100 to 275 amperes DCRP. Position welding will require welding currents in the range of 150 to 250 amperes.

D. Welding Wire

OXWELD 43 welding wire is recommended for all mild steel applications in order to obtain the best combination of physical properties in the weld. When this wire is used, the weld contains about 0.10 per cent carbon, 0.80 per cent manganese, and 0.30 per cent silicon. The use of UNIONARC flux makes it unnecessary to employ a highly deoxidized welding wire to develop sound welds.

E. UNIONARC Flux

The flux used with the UNIONARC welding process is known as type CS (formerly grade H-13) and is non-gas evolving. Its composition is balanced to obtain the best combination of arc characteristics, weld puddle characteristics, weld soundness and weld physical properties. It is available in only one mesh size, 20 X D.

The majority of manual welding applications will require flux to wire ratios in the range of .5 to .6. Greater ratios may be required for stringer bead welding and smaller ratios may be required for some position applications.

F. Shielding Gases

Carbon dioxide is considered the best all-around gas from the standpoints of performance and economy. Little process advantages can be gained by use of argon, helium (with or without oxygen) or combinations of these gases with carbon dioxide. Nitrogen and air cannot be used for mild steel welding.

Transverse draft velocities up to six miles per hour can be tolerated in the work area when a flow of 35 cfh of carbon dioxide is used with a 3/4-in. torch to work distance. Under given conditions, the UNIONARC process is capable of resisting drafts of about twice the velocity of those tolerated by sigma welding. When welding outdoors, a shroud should be placed around the weld area, as is done with covered electrodes.

G. Metal Transfer

Metal transfer for UNIONARC welding under normal conditions is of the "spray" type. The flux-to-wire ratio and the magnitude of the welding current greatly affect the type of metal transfer. With insufficient flux-to-wire ratios or low welding currents, the metal transfer is globular and is typical of that obtained with carbon dioxide shielding alone. Spatter evolution is high and weld porosity may result from the insufficient slag coverage.

As the flux-to-wire ratio, or the welding current, is increased, the size of the metal drops transferred across the arc is decreased, and hence the amount of spatter is reduced.

An excessive amount of flux tends to cool the weld, and will also hide or submerge the weld puddle and welding arc. Too high a welding current produces a very fluid weld puddle and develops a very deep crater.

UNIONARC Welding Process Applications

A. Positions

The greatest application of UNIONARC welding will be to weldments positioned flat or horizontal. Wire of 3/32-in. diameter is used for this application. Under these conditions, the greatest economic advantages can be derived from UNIONARC welding's high deposition rate and high welding speed.

Wire of 3/64-in. diameter is used for all positions: flat, vertical up and down, horizontal or "3-o'clock", and overhead.

See Table I for typical UNIONARC welding conditions for several joints in various positions.

B. Method of Welding

Skill requirements and welding methods for flat position work, such as butt welding, are about the same as with covered electrode and sigma welding. An arc length on the order of 1/8-in. should be used to obtain proper coalescence and minimize undercutting in grooves. This will facilitate slag removal. Straight line or back-stepping techniques may be used with a backhand motion. Where large passes must be deposited, transverse weaves or circular motions may be used.

For horizontal fillet welding, the skill requirements are again about the same as for the other processes. Although the coalescence of the weld puddle must be observed with all welding processes, the welding technique used with UNIONARC welding or fillet welds is slightly different from that used with sigma welding. The arc must be played into the root and should favor the bottom rather than the top leg of the joint. A simple straight line, straight line back-stepping, or elliptical or circular motion may be used. Backhand welding is generally preferred, except on some light gage applications where forehand welding may be superior. As in the case of butt welding, the arc length should be about 1/8-in.

Skill requirements for all-position welding are rather high, as is the case for covered electrode welding. Welding techniques for the various joints and positions are about the same as those for covered electrodes.

C. Material Thickness

When 3/32-in. diameter wire is used, UNIONARC welding is generally limited to the downhand position, and to materials of 3/16-in. thickness and greater. Although lighter materials have been successfully welded, using 3/32-in. wire, they may prove troublesome because of the relatively high welding speeds required.

For materials of 3/32-in. and 1/8-in. thickness, wire of 3/64-in. diameter is preferred since the lower welding speeds and currents are easier to handle.

TABLE I
WELDING CONDITIONS
MANUAL "UNIONARC" WELDING CARBON STEEL

Plate Thickness In.	Type of Joint	Edge Preparation	Position	Wire Diameter In.	Flux-Wire Ratio lb./lb.	Welding Current Amps DCRP	Arc Voltage Volts	No. Pass	Welding Speed IPM
1/4	1/4-in. fillet	-	Horizontal	3/32	.5	380	27	1	16
1/4	1/4-in. fillet	-	Horizontal	3/32	.5	400	27	1	18
1/4	1/4-in. fillet	-	Horizontal	3/32	.5	425	28	1	20
1/4	1/4-in. fillet	-	Horizontal	3/32	.5	450	29	1	24
1/4	1/4-in. fillet	-	Horizontal	3/64	.4	200	28	1	12
1/4	1/4-in. fillet	-	Horizontal	3/64	.4	300	37	1	17
1/2	3/8-in. fillet	-	Horizontal	3/32	.5	400	28	1	9
1/2	3/8-in. fillet	-	Horizontal	3/32	.5	450	30	2	11 (overall)
1/2	3/8-in. fillet	-	Flat	3/32	.5	425	28	1	11
1/4	Lap fillet	-	Horizontal	3/32	.5	400	28	1	15
1/4	Lap fillet	-	Horizontal	3/64	.4	250	31	1	13
1/4	1/4-in. fillet	-	Vertical Up	3/64	.6	160	26	1	10
1/4	1/4-in. fillet	-	Overhead	3/64	.6	200	28	1	11
1/4	Butt	Square	Flat	3/32	.6	375	25	2	18
1/2	Butt	60° Double V Zero Nose	Flat	3/32	.5	400 425	27 28	2	15
3/4	Butt	60° Double V Zero Nose	Flat	3/32	.5	425 450	28 29	2	12
3/4	Butt	30° Double V* Zero Nose (3/32 opening)	Horizontal	3/64	4	220 260 220 220	27 30 27 27	4	12 14 12 12

** Top plate prepared with 30 deg. bevel. No bevel on bottom plate.*

Comparison of UNIONARC Welding with Covered Electrode Welding

In the flat position, UNIONARC welding produces welds of excellent appearance and quality at higher speeds and lower cost than welds made with covered electrodes. UNIONARC welding with 3/32-in. diameter wire is usually done at a better than 2:1 speed and cost advantage over E-6010, E-6012, and E-6015 type electrodes. When compared with E-6020 or "hot-rod" type of electrodes, the advantage is slightly less. Where iron-powder or contact type E-6024 electrodes are used, the speed advantage of UNIONARC welding is on the order of 20 per cent. However, for comparable weld quality and appearance, UNIONARC welding speeds are usually 50 per cent greater than those obtained with iron-powder electrodes.

For position welding, the welding speeds are usually two to three times greater with UNIONARC welding than with covered electrode welding. Welding costs are about half those of covered electrodes. This is true of all types of covered electrodes currently in use.

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LINDE COMPANY
Division of Union Carbide Canada Limited
General Office: 40 St. Clair Ave., E., Toronto 7, Canada
EDMONTON, ALTA., Highway 16 and Government Road
TORONTO 4, ONTARIO, 805 Davenport Road
MONTREAL 9, QUEBEC, 8311 Royden Road
VANCOUVER 6, B. C., 1175 Grant Street
ST. BONIFACE, MANITOBA, 733 Tache Avenue

Outside United States and Canada

Linde Department
UNION CARBIDE INTERNATIONAL COMPANY
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y., U. S. A.
GENEVA, SWITZERLAND, Union Carbide Europa, S. A., 1-3 Rue de Chantepoulet
MEXICO 15, D. F. MEXICO, National Carbon-Eveready S. A., Calzado Mariano Escobedo No. 543

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