DEPOSITION DATA

Deposition Rates, Electrode Efficiency, and Electrode Weld Metal Recovery!

What are the differences?

Deposition Rates

The deposition rate of a welding consumable (electrode, wire or rod) is the rate at which weld metal is deposited (melted) onto a metal surface. Deposition rate is expressed in kilograms per hour (kg/hr).

Deposition rate is based on continuous operation, not allowing for stops and starts such as, electrode change overs, chipping slag, cleaning spatter, machine adjustments or other reasons.

When welding current is increased so to does the deposition rate. When electrical stick out is increased in the case of GMAW and FCAW the deposition rate will also increase.

Deposition rates are calculated by doing actual welding tests, and the following shows the formula for measuring deposition rates.
Deposition Rate = Weight of test plate before welding — Weight of test plate after welding ÷ Measured period of time (normally 60 seconds).

e.g. Plate before welding: 2kg - 2.95kg Plate after welding = 95grams, welded in 60 seconds.
95grams x 60/1000 = 5.7kg/hr.

Electrode Efficiency (Deposition Efficiency)

Technically to ISO 2401-1972 electrode efficiency (AS/NZS 1553.1: 1995 deposition efficiency) is the difference between the weight of the weld metal deposited and the weight of the filler metal consumed (not including flux and stub ends) in making the weld. The efficiency of an electrode is calculated by using the following formula;

Electrode Efficiency % to ISO 2401and AS/NZS 1553.1 =

$$\frac{\text{Weight of test plate including weld metal} - \text{Weight of test plate before welding}}{\text{Mass of the Core Wire of 5 electrodes} - \text{Weight of core wire of the stub ends}} \times 100$$

e.g. Satincraft 13 Ø4mm x 380mm.
Plate before welding: 2kg - 2.15kg Plate after welding = 150grams,
weight of five (5) electrode core wires, Ø4mm x 380mm long before welding = 188grams,
weight of five (5) electrode stub ends, Ø4mm x 50mm long after welding = 24.7grams,
150grams ÷ 163.3grams x 100 = 91.85% Electrode Efficiency (Deposition Efficiency).

e.g. Ferrocraft 22 Ø3.2mm x 380mm.
Plate before welding: 2kg - 2.167kg Plate after welding = 167grams,
weight of five (5) electrode core wires, Ø3.2mm x 380mm long before welding = 124grams,
weight of five (5) electrode stub ends, Ø3.2mm x 50mm long after welding = 16.3grams,
167grams ÷ 107.7grams x 100 = 155.06% Electrode Efficiency (Deposition Efficiency).

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Electrode Weld Metal Recovery (Process Efficiency)

Electrode weld metal recovery to ISO 2401-1972 allows us to calculate the amount of welding consumable which will actually be deposited into the finished weld metal less any waste such as, stub ends, slag and spatter not adhered to the test plate.

An example is when 100kgs of electrodes are used with a quoted efficiency of 60%, the net result is that only 60kg of the weight of that electrode will actually end up in the deposited weld metal. The remaining 40% (40kg) of the electrode is waste.

To achieve weld metal recovery rates practical tests are carried out by weighing the test plate before and after welding, weighing the consumables before welding and then using the following formula allowing for 50mm stub ends. If the welder discards more than 50mm stub ends than the recovery rate (process efficiency) will be lower.

Weld Metal Recovery % to ISO 2401 =

$$\frac{\text{Weight of test plate before welding} - \text{Weight of test plate after welding}}{\text{Weight of the Consumable}} \times 100$$

e.g. Satincraft 13 Ø4mm x 380mm.
Plate before welding: 2kg - 2.15kg Plate after welding = 150grams,
weight of five (5) electrodes, Ø4mm x 380mm long before welding = 261.20grams,
150grams ÷ 261.20grams x 100 = 57.43% Weld Metal Recovery (Process Efficiency).

e.g. Ferrocraft 22 Ø3.2mm x 380mm.
Plate before welding: 2kg - 2.167kg Plate after welding = 167grams,
weight of five (5) electrodes, Ø3.2mm x 380mm long before welding = 281.50grams,
167grams ÷ 281.50grams x 100 = 59.33% Weld Metal Recovery (Process Efficiency).

General Process Efficiencies

Generally process efficiencies can be stated as averages for costing purposes. The following table outlines CIGWELD's suggested process efficiency percentages.
If the welding application calls for the Oxy-Acetylene or GTAW welding processes to be employed, then it is prudent to use all of the consumable by joining stub ends to ensure that 100% of the filler metal is utilised.

Welding Process			Average Efficiency
Gas Tungsten Arc Welding (GTAW) & Oxy-Acetylene Welding (OAW)			100%
Manual Metal Arc Welding (MMAW)			60%
Gas Metal Arc Welding (GMAW)	Short Arc,	Ar + 25% CO_2	92%
Gas Metal Arc Welding (GMAW)	Spray Arc,	Ar + 25% CO_2	95%
Gas Metal Arc Welding (GMAW)	Pulse Arc,	Ar + 25% CO_2	98%
Flux Cored Arc Welding (FCAW)	E70T-4 types,	self shielded	82%
Flux Cored Arc Welding (FCAW)	E71T-1 types,	Ar + 25% CO_2	85%
Flux Cored Arc Welding (FCAW)	E70T-5 types,	Ar + 25% CO_2	88%
Flux Cored Arc Welding (FCAW)	E70C-6M types,	Ar + 25% CO_2	92%
Cobalarc Flux Cored Hardfacing Wires		Gas shielded	80%

GMAW and FCAW average efficiencies can vary in result depending upon the shielding gases used, machine settings, stick out, spatter losses, wire sniped off before starts etc.

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CIGWELD Electrodes, Deposition Rates, Electrode Efficiencies, and Electrode Weld Metal Recovery Rates

The following Table lists some popular CIGWELD consumables and their Deposition Rates, Electrode Efficiencies and Weld Metal Recovery Rates:

CIGWELD Product	Size (mm)	Amps	Deposition Rate kg/hr	Electrode Efficiency	Weld Metal Recovery
Ferrocraft 12XP	3.2	110	0.90	109%	66%
Ferrocraft 12XP	4.0	150	1.20	111%	69%
Satincraft 13	3.2	115	0.92	91%	56%
Satincraft 13	4.0	160	1.30	92%	58%
Ferrocraft 11	3.2	110	1.00	90%	64%
Ferrocraft 11	4.0	145	1.30	90%	66%
Ferrocraft 21	3.2	120	1.20	113%	63%
Ferrocraft 21	4.0	170	1.70	112%	62%
Ferrocraft 22	3.2	150	2.00	155%	59%
Ferrocraft 22	4.0	210	2.80	157%	61%
Ferrocraft 16TXP	3.2	120	1.20	95%	58%
Ferrocraft 16TXP	4.0	165	1.60	90%	56%
Ferrocraft 7016	3.2	120	1.10	101%	63%
Ferrocraft 7016	4.0	170	1.50	97%	60%
Ferrocraft 61	3.2	125	1.30	110%	57%
Ferrocraft 61	4.0	180	1.80	113%	59%
Alloycraft 90	3.2	125	1.30	111%	60%
Alloycraft 90	4.0	180	1.80	114%	62%
Satincrome 316L-17	3.2	95	0.90	105%	55%
Satincrome 316L-17	4.0	130	1.10	108%	54%
Castcraft 55	3.2	100	0.95	116%	69%
Castcraft 55	4.0	125	1.15	115%	70%
Cobalarc 750	3.2	115	1.00	109%	62%
Cobalarc 750	4.0	145	1.30	112%	64%
Cobalarc CR70	3.2	115	1.20	191%	69%
Cobalarc CR70	4.0	165	1.70	206%	71%
Cobalarc 9	8.0	180	1.30	85%	77%

The information provided in this table is a guide only, actual on the job figures may vary. Results are influenced by many factors including, welding parameters, arc length, travel speed and machine characteristics.

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CIGWELD Solid and Flux Cored Wires, Deposition and Weld Metal Recovery Rates

The following Table lists some popular CIGWELD consumables and their Deposition and Weld Metal Recovery Rates:

CIGWELD Product	Size (mm)	Volts	Amps	WFS m/min	Deposition Rate kg/hr	Weld Metal Recovery
Autocraft LW1-6	0.8	20	150	12.0	2.5	96%
Autocraft LW1-6	0.9	26	180	12.0	3.1	96%
Autocraft LW1-6	1.0	28	240	13.5	4.8	95%
Autocraft LW1-6	1.2	32	300	10.8	5.6	97%
Autocraft Silicon Bronze	0.9	24	180	13.2	3.2	95%
Autocraft 316LSi	0.9	22	180	10.0	2.8	97%
Autocraft 316LSi	1.2	26	250	8.5	4.4	98%
Autocraft AL5356	1.0	22	180	16.3	1.5	90%
Autocraft AL5356	1.2	24	220	14.0	2.5	92%
Satin-Cor XP	1.6	28	300	5.5	4.3	86%
Satin-Cor XP	1.6	29	350	6.5	5.4	87%
Satin-Cor XP	1.6	30	400	7.0	6.0	89%
Satin-Cor XP	2.4	30	400	4.2	5.7	85%
Satin-Cor XP	2.4	31	450	5.0	6.8	86%
Satin-Cor XP	2.4	32	500	6.0	8.2	90%
Verti-Cor 3XP	1.2	25	200	6.7	2.7	86%
Verti-Cor 3XP	1.2	26	250	9.9	3.8	84%
Verti-Cor 3XP	1.2	28	320	15.0	5.9	88%
Verti-Cor 3XP	1.6	27	300	6.2	4.1	86%
Verti-Cor 3XP	1.6	28	350	9.5	6.4	81%
Verti-Cor 3XP	1.6	29	400	12.0	8.1	88%
Metal-Cor XP	1.2	26	250	10.0	5.0	92%
Metal-Cor XP	1.6	28	350	6.6	5.6	94%
Supre-Cor 5	1.2	22	170	7.8	2.3	86%
Supre-Cor 5	1.6	26	320	5.9	3.3	89%
Tensi-Cor 110TXP	1.6	28	280	5.0	3.0	88%
Tensi-Cor 110TXP	2.4	29	400	3.8	5.8	90%
Shieldcrome 309LT	1.2	26	190	11.4	3.7	84%
Shield-Cor 4XP	2.4	29	375	5.4	7.0	84%
Shield-Cor 4XP	3.0	30	500	2.9	6.7	86%
Shield-Cor 15	0.9	17	120	3.9	0.7	75%
Shield-Cor 11	1.2	17	150	3.0	1.0	80%

The information provided in this table is based on welding with constant voltage (C.V.) GMA Welding machines. Results may vary and are influenced on the job by shielding gases used, machine settings, stick out, spatter losses, wire sniped off before starts etc.

DEPOSITION DATA

Manual Arc Electrode Consumption Calculator Guide

Instructions for Use of this Data

The following tables provide data on the approximate mass in kilograms required of the different types of electrodes for welding the various weld joints used throughout industry today. This data will aid in estimating material requirements and costs. The basis for the following tabulations is given below. Where variations from the given conditions or joint preparations are encountered, adjustments in the tabulated values must be made to compensate for such differences.

Basis of Calculations

Electrode requirements have been calculated as follows:

Where M = Mass of electrodes required
D = Mass of weld metal to be deposited
E = Proportion of electrode lost

$$M = \frac{D}{1 - E}$$

To arrive at the mass of weld metal to be deposited it is necessary to calculate first the volume of metal to be added (area of the cross section of the weld multiplied by the length). This volumetric value is converted to mass by multiplying by the factor 0.0079 kilograms per cubic centimetre for steel.

Square Butt Joints, Welded both sides

Joint Dimensions		kg of electrodes per linear metre of weld* (Approx.)	kg of weldmetal deposited per liner metre of weld (Approx.)
Plate Thickness	Root Gap (R)	With Reinforcement**	With Reinforcement**
3mm	0	0.23	0.14
	1mm	0.26	0.16
5mm	1mm	0.38	0.23
	1.6mm	0.41	0.25
6mm	1.6mm	0.48	0.29
	2.5mm	0.56	0.34

** Includes spatter losses and 50mm stub end loss.*
*** Height of Reinforcement = 2mm.*

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Horizontal-Vertical (HV) Fillet welds

Fillet Weld leg length Dimensions	kg of electrodes per linear metre of weld* (Approx.)	kg of weldmetal deposited per liner metre of weld (Approx.)
3mm	0.06	0.04
5mm	0.16	0.10
6mm	0.24	0.14
8mm	0.42	0.25
10mm	0.65	0.39
12mm	0.95	0.57
16mm	1.68	1.01
20mm	2.62	1.57
25mm	4.10	2.46

** Fillet weld figures are calculated based on true mitre fillets. Convex or overwelded fillets can increase these figures by 33% or more.*

Single Vee Butt Joints, (single groove butts)

Joint Dimensions			kg of electrodes per linear metre of weld* (Approx.)	kg of weldmetal deposited per liner metre of weld (Approx.)
Plate Thickness	Root Face (F)	Root Gap (R)	With Reinforcement**	With Reinforcement**
6mm	1.6mm	1.6mm	0.39	0.23
8mm	1.6mm	1.6mm	0.63	0.38
10mm	1.6mm	1.6mm	0.87	0.52
12mm	3mm	3mm	1.33	0.80
16mm	3mm	3mm	2.22	1.33
20mm	3mm	3mm	3.37	2.02
25mm	3mm	3mm	5.14	3.08

** Includes spatter, 50mm stub ends and back gouging losses.*
*** Height of Reinforcement = 2mm.*

Double Vee Butt Joints, Welded both sides (double groove butts)

Joint Dimensions			kg of electrodes per linear metre of weld* (Approx.)	kg of weldmetal deposited per liner metre of weld (Approx.)
Plate Thickness	Root Face (F)	Root Gap (R)	With Reinforcement**	With Reinforcement**
12mm	1.6mm	1.6mm	0.92	0.55
16mm	1.6mm	1.6mm	1.46	0.88
20mm	1.6mm	1.6mm	2.12	1.27
25mm	3mm	3mm	3.33	2.00

** Includes spatter, 50mm stub ends and back gouging losses.*
*** Height of Reinforcement = 2mm.*

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Consumable Weights & Lengths Tables:

1. Gas Metal Arc Welding (GMAW - MIG) Wires for Mild and Low Alloy Steels

WIRE SIZE (mm)	0.6	0.8	0.9	1.2	1.6
gms of wire per metre	2.2	4	4.85	8.5	15.7
metres of wire per kg	450	254	200	113	63

2. Flux Cored Arc Welding (FCAW) Wires for Mild and Low Alloy Steels

WIRE SIZE (mm)	1.2	1.6	2.0	2.4
gms of wire per metre	7.5	13	21	28.5
metres of wire per kg	132	77	50	36

3. Submerged Arc Welding (SAW) Wires for Mild and Low Alloy Steels

WIRE SIZE (mm)	2.0	2.4	3.2	4.0	4.8
gms of wire per metre	24.6	35.5	63	99	142
metres of wire per kg	40.5	28	16	10	7

4. Stainless Steel Gas Metal Arc Welding (GMAW - MIG) Wires

WIRE SIZE (mm)	0.9	1.2	1.6
gms of wire per metre	5.1	9	16
metres of wire per kg	198	111	63

5. Aluminium Gas Metal Arc Welding (GMAW - MIG) Wires

WIRE SIZE (mm)	0.9	1.2	1.6
gms of wire per metre	1.7	3.1	5.4
metres of wire per kg	582	327.5	184

6. Autopak Gas Metal Arc Welding (GMAW - MIG) Wires

WIRE SIZE (mm)	0.9	1.0	1.2	1.6
gms of wire per metre	4.85	6.1	8.5	15.7
km of wire / 300kg Pack	62	49	35	16 (250kg Pack)