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EFFECT OF RECYCLE SUBMERGED ARC WELDING (SAW) FLUX ON CHEMISTRY AND MECHANICAL PROPERTIES OF WELD METAL

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Abstract: - The flux used for shielding in submerged arc welding is converted into slag during welding which is a waste and has to be disposed of. Slag generated during submerged arc welding has been recycled. Slag was crushed and meshed to the granular size typical of fresh flux. This recycled slag in combination with EL8 and EM12k filler wire was used in these investigations. It was further investigated that the weld metal chemical composition and mechanical properties of weld metal prepared using recycled slag is within the acceptable range of AWS (American Welding Society) specifications or not.

Keywords: Submerged arc welding, Slag, Weld metal composition.

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INTRODUCTION

In general, submerged arc welding (SAW) produces a coalescence of metal by heating them with an arc between an electrode and base metal. The arc and molten metal are submerged in blanket of fusible flux. Flux and welding parameters are the two main variables in SAW process [1]. Chemistry of weld metal is depends on combination of electrode and flux. The flux used for shielding in submerged arc welding is converted into slag. In general, one kg of flux is consumed for every kg of weld metal deposited. Flux consumption increases with increase in arc voltage. Presently slag generated during submerged arc welding is thrown away as a waste and needs land fill space for dumping. It is not possible to stop the generation slag as it is a bio-product of the process but could be reused. So an attempt has been made to recycle the slag. Slag was crushed and meshed to the granular size typical of fresh flux. Slag has been processed in such a manner that allows it to be used as a flux and its effect on chemistry of weld metal and mechanical properties has been investigated.

EXPERIMENTAL WORK

In this experimental work SAW wires EL-8 and EM-12k of 3.15 mm diameter and agglomerated flux of basicity index 1.6 used. The chemical composition of electrodes and basemetal used in this work are given in Table I .Weld metal pad for chemical analysis with combination of EL-8 and EM12k electrode with fresh and crushed slag made as per ASME SFA-5.17[2] shown in Fig 1. Chemical analysis of weld pad given in Table II.

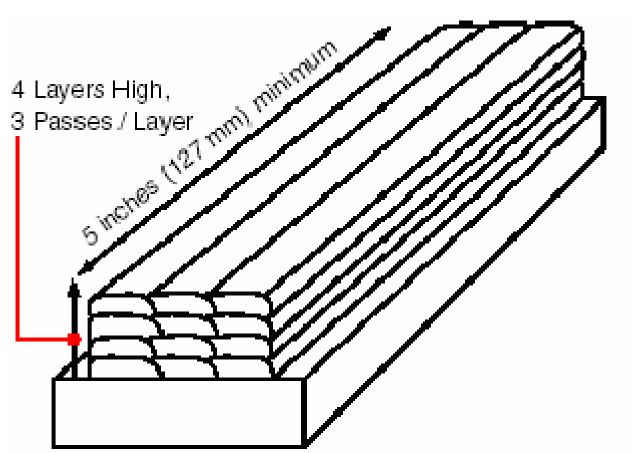
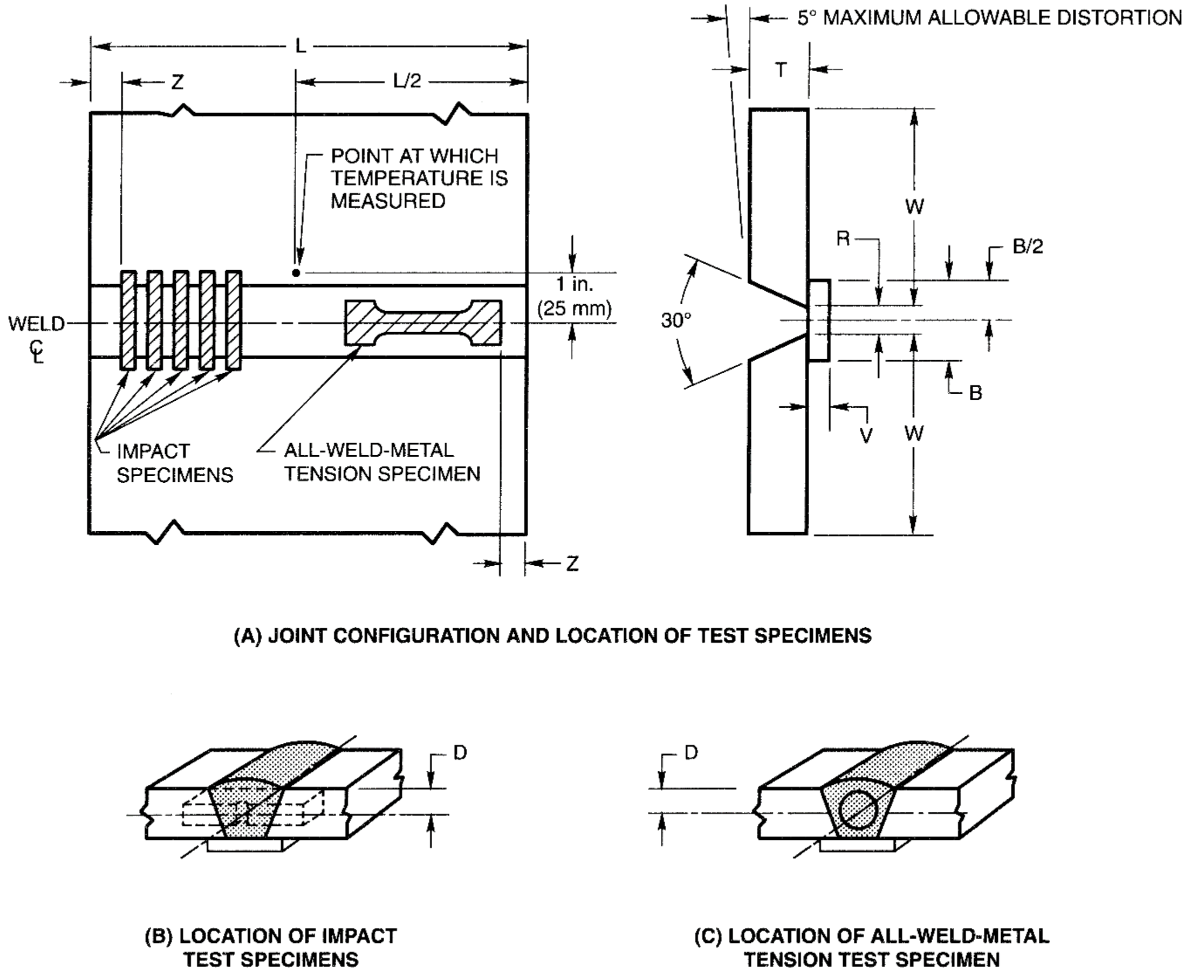


Fig. 1: Weld metal pad for chemical analysis (ASME SFA-5.17)

TABLE I: Chemical composition of Base metal and Electrode

Elements (%)	Base Metal	EL-8	EM-12K
C	0.165	0.08	0.1
Mn	0.4	0.5	1
Si	0.17	0.05	0.2
S	0.05	0.018	0.018
P	0.046	0.018	0.018
Cu	-	0.25	0.25

The four groove weld joints were made with constant voltage D.C submerged arc welding power source using 3.15 mm diameter wires with fresh and crushed slag as shown in Fig 2. To expel any moisture absorbed during storage of flux was heated in a draying oven at 300°C for 2 hours prior to use. DCEP polarity was used throughout the experimentation. The interpass temperature was kept minimum 150°C. The welding parameters and other conditions were in accordance with ASME SFA 5.17. Mechanical properties of groove weld test assembly given in Table II.



Letter	Dimensions	in.	mm
L	Length (min)	12	305
T	Thickness	1 ± 1/16	25 ± 1.5
W	Width (min)	5	127
V	Backup Thickness	1/2 ± 1/16	13 ± 1.5
D	Specimen Center	3/8 ± 1/32	9.5 ± 1.0
B	Backup Width (min)	2	50
R	Root Opening	1/2 ± 1/16	13 ± 1.5
Z	Discard (min)	1	25

Fig. 2: Groove Weld Test Assembly for Mechanical testing (ASME SFA-5.17)

RESULT & DISCUSSION

A. Chemical composition

As is well known, the reactions between liquid weld metal and fused flux in the SAW process are similar to those between molten metal and slag in the steel making process. [3]

As shown in Table II carbon, manganese, silicon, phosphorus, sulphur of the weld metal decrease when weld metal produced with electrode and crushed slag combination.

TABLE II: Weld Pad Chemical composition (wt %)

Electrode	Flux	C	Mn	Si
EL-8	Fresh Flux	0.052	0.700	0.250
EL-8	Crushed slag	0.030	0.547	0.170
EM-12K	Fresh Flux	0.080	1.300	0.450
EM-12K	Crushed slag	0.050	0.800	0.323

Transfer of Carbon

It is very difficult to predict the extent of carbon transfer during welding, but usually the weld metal has a lower carbon content than expected from nominal composition of electrode due to effect of dilution and Oxidation of carbon.

In the present study, percentage of Carbon in weld metal deposited with EL8 and crushed slag is 0.03% which is less than the EL-8 and fresh flux shown in Table II. It is due to oxidation of carbon as deoxidizers have already been exhausted from the slag.

Transfer of Manganese

Manganese content of weld metal depends on the initial manganese content of filler wire, basicity index, amount of manganese and manganese oxide of the flux. Slag metal reaction involving an exchange of manganese.

In the present study, percentage of Manganese in weld metal deposited with EL8 and crushed slag is 0.547% which is less than the EL-8 and fresh flux shown in Table II.

Transfer of Silicon

The loss of silicon from the weld metal deposited with pure slag is expected due to oxidation.

However, it is observed that silicon content of weld metal deposited with pure slag is 0.17% which is more than the filler wire used. It indicates that silicon has been transferred from slag to weld metal. Which may be attributed to the dissociation of $SiO2$ present in the slag. [3]

B. Weld metal mechanical properties

The mechanical properties of weld metal are primarily the result of: (i) the weld metal chemical composition, (ii) microstructure and (iii) the cooling rate. The cooling rate experienced by weld metal deposit is controlled by a combination of heat input and heat extraction. Under identical condition of welding, viz. joint design and plate thickness, heat extraction maybe assumed to be remain same. Therefore, weld metal chemical composition and heat input controlling microstructure are the governing factors responsible for the mechanical properties of weld metal.

YS and UTS value decrease when weld metal produced with crushed slag because of decrease in carbon and manganese percentage in weld metal as shown in Table III.

TABLE III: Mechanical properties of groove weld assembly

Wire	Flux	YS	UTS	Impact values
		Mpa	Mpa	J at (-40 ^{0}C)
EL-8	Fresh Flux	360	430	20
EL-8	Crushed slag	290	350	13
EM-12K	Fresh Flux	420	520	50
EM-12K	Crushed slag	355	420	22

YS: yield strength, UTS: ultimate tensile strength increase.

CONCLUSION

Submerged arc welding slag can be recycled. Recycled slag with EM12k can produce weld metal having chemical composition and mechanical properties within the acceptable range of AWS of EL8 and fresh flux.

REFERENCES

1. P. Kanjilal, T.K. Pal, S.K. Majumdarc, Combined effect of flux and welding parameters on chemical composition and mechanical properties of submerged arc weld metal, Journal of Materials Processing Technology,2006, pp .223–231

2. ASME Boiler and Pressure Vessel Code, Section II Part C, SFA 5.17, New York Edition 2015.

3. KULWANT SINGH, V. SAHNI, S. PANDEY, Slag Recycling in Submerged Arc Welding and its Influence on Chemistry of Weld Metal Asian Journal of Chemistry, vol21.